No.	County	Area mi²	Reference Bulletin & pub yr	Aquifer	Avg. precip (in/yr)	Avg. temp. °F	Recharge from ac-ft/yr (in/yr) precip.	stream	lateral inflow	irrig.	Total recharge (in/yr) ac-ft/yr	Method	Reference	Soils	Topog	Avg. depth to water table	Vegetation and land use	Comments
1	Wallace	910	KGS B18 1931 KGS B161 1963	Alluvium[1d] Ogallala[1d] (present in approx. 2/3 of the county)	17.03	55	[1a]not known but studies in other similar High Plains area indicate 1/4 in. of recharge. More in southern part than in northern part of the county.	most of the streams are influent so contribute appreciable recharge. But less in northern part of the county due to nearness of shale to land surface.	[1b]estimated to be approx. 36,500 ac-ft/yr. Inflow occurs along the western edge of county.	[1b]about 10% of applied water. Relatively high in alluvial valleys.	5000[1c] (0.1 in/yr)	author's estimate	[1a]no reference source mentioned Hodson, W.G. (1963) [1b]Hodson, W.G. (1963) [1c]KWRB 67	silty and silty and loamy	High Plains section of the Great Plains physiographic province	[1c]12 ft-30 ft at alluvium [1c]30 ft-100 ft at Ogallala	crops and grasses farm land and pasture	[1c]KGS B161
				Alluvium Ogallala			1040[1d] (0.02 in/yr) 12500[1d] (0.25 in/yr)					soil-water budget	[1d]USGS 91					
2	Greeley	788	KGS B 108 1954 KGS Irr. Ser.2 1976	Ogallala Fm (unconsolidated and gravel): as much as 300 ft thick, of which as much as 145 ft was saturated.as of 1971-72. Yields 100 to 2000 gpm. Dakota Fm. (sandstone aquifer): 400-550 ft thick. Similar aquifer in adjacent counties yield 30-300 gpm.	16.98	52.5	[2a]0.1 in/yr [2b]4000 ac-ft/yr (0.05 in/yr) 1971-72	considerable, but unknown	[2a]estimated to be about 5000 ac-ft/yr (0.06 in/yr)	considered low due to relatively impermeable loess cover	[2b]44000 ac-in/yr) irr. land) [2b]27000 (0.28 in/yr) [2c]6000 (0.14 in/yr)	author's estimate) 10% of pcp in irrigated and 1% of pcp. in non-irrigated land (163,000 ac irrigated & 390,000 ac of nonirrigated land in Greeley and Wichita) 1971-72 20% of irr. plied (0.22" in irr. and 0.05" in non- Darcy's Law (irr&nonirr. land) +Lat. in. (0.17+ .05)+.06 soil-water budget	[2a]Prescott, G.C., et al. 1954 [2b]Slagle and Weakly, 1976 [2c] KWRB' 67 [2d]USGS '91	silty	High Plains sec. of Great Plains physiographic province. Flat to gently rolling upland plains.	[2e]25 ft-40 ft at alluvium [2e]20 ft-80 ft at Ogallala	crops and grasses agriculture	[2e]ref. KGS B108 [2b]For Greeley and Wichita combined. Lateral inflow, subsurface outflow & total recharge are for Wichita and Greeley combined.
				Ogallala			[2d]11100 (0.26 in/yr)											

No.	County	Area mi²	Reference Bulletin & pub yr	Aquifer	Avg. precip (in/yr)	Avg. temp. °F	Recharge from ac-ft/yr (in/yr) precip.	stream	lateral inflow	irrig.	Total recharge (in/yr) ac-ft/yr	Method	Reference	Soils	Topog	Avg. depth to water table	Vegetation and land use	Comments
3	Wichita	717	KGS B108 1954 KGS Irr. Ser.2 1976	Ogallala is the principal water-bearing fm. Small amt is also obtained from alluvium and Niobrara. Ogallala Fm. (unconsolidated sand and gravel) as much as 300 ft thick, of which as much as 145 ft is saturated. Yields 100 to 2000 gpm . Dakota Fm. (sandstone aquifer) 400-550 ft thick. Similar aquifer in adjacent counties yield 30-300 gpm. Ogallala	18.63	52.5	[3a]0.1 in/yr [3b]4000ac-ft/yr (0.05 in/yr) during 1971-72 [3c]0.28 in/yr [3d]1-10% of annual pcp. (120-1200 ac-ft) in intensive study area [3f]17600 ac-ft/yr (0.46 in/yr)	44 ac-ft of loss per mile as per the study in Whitewoman Creek in July 1972	[3a]estimated to be about 5000 ac-ft/yr (0.06 in/yr) occurs at western boundary of the county.	negligibly low	[3b]27000 [3b]10000 (0.26 in/yr)	author's estimate Darcy's Law (irr & non irr land)+ Lat. in (0.17+.05) +.06 (author's estimate) 10% of pcp. in irrigated & 1% of pcp. in nonirr land. (163000 ac irr & 390000 ac of nonirr land in Greeley and Wichita) 1971-72 mathematical model (steady state) soil-water budget	[3a]Prescott, G.C. et al, 1954 [3b]Slagle and Weakly, 1976 [3c] Dunlap, L.E., et al., 1980 [3d]Gutentag and Stulken, 1976 [3c]KWRB '67 [3f]USGS '91	silty	High Plains section of the Great Plains physiographic province. Flat to gently rolling upland plains.	[3g]15 ft-40 ft at alluvium [3g]10 ft-80 ft at Ogallala In the period of 1948-1972 water level declined from 10-50 ft in places where irrigation is practiced.	crops and grasses agriculture	[3g]ref. KGS B108 [3b]For Greeley and Wichita combined. Lateral inflow, subsurface outflow & total recharge for Wichita and Greeley combined [3c]based on the study in an area of 12 mi² in northwestern Wichita, west-central KS referred to by the authors as "intensive study area."
4	Scott	724	KGS B66 1947 KGS Irr. Ser. 1 1976	Alluvium ranges from few feet to as much as 200 ft in the southern part. Yields from 250-1500 gpm. Ogallala Fm. is the major aquifer and thickness ranges from few feet to 215 ft in central Scott Co.	18.61	53.3	[4a]probably less than 1/2 inch						[4a]Theis, C. V., 1937 (KGS B66)	silty and loamy soils	High Plains section of the Great Plains physiographic province . 85% upland plains & 15% stream flood plains & intermediate slopes.	Based on depth of water table Scott Co. may be divided into: 1. Shallow water area depth between <25 ft to 75 ft. 2. Intermediate depth between <50 ft to 100 ft. 3. Deep water area	Agriculture 38% cropland & 62% for grazing as of 1939 crops and grasses	

No.	County	Area mi²	Reference Bulletin & pub yr	Aquifer	Avg. precip (in/yr)	Avg. temp. °F	Recharge from ac-ft/yr (in/yr) precip.	stream	lateral inflow	irrig.	Total recharge (in/yr) ac-ft/yr	Method	Reference	Soils	Topog	Avg. depth to water table	Vegetation and land use	Comments
	Scott (contd.)			Yield ranges from 100-1000 gpm.												depth >100 ft (as of 1947).		
				Chalk aquifer (Niobrara Fm) Yields from 500-1000 gpm.			[4b]14,000 ac-ft (0.36") in 1971 [4b]24,000 ac ft (0.62") in 1972				[4b]53,000 (1.4 in/yr) in 1971 [4b]52,000 (1.3 in/yr)	assuming 10% & 1% of the precipitation to percolate in irrigated and nonirrigated land, respectively during the growing season.	[4b]Gutentag and Stulken, 1976					total recharge including seepage of irrigation water. 1972 being a wet year, infiltration is high but irrigation recharge low due to low application.
				Sandstone aquifer (Dakota Fm) 430 ft in southwestern Scott to 710 ft in thickness in southwestern Lane County. Yields from 30-300 gpm.					[4b]9,000 ac-ft/yr (0.23 in/yr)	[4b]30,000 ac-ft (0.78") in 19,000 ac-ft (0.49") in 1972		based on pumpage figures Darcy's Law A=583,400 sq ft (0.2093 sq mi) I= 0.0029 K=64 ft/day				[4g]15 ft-20 ft at alluvium [4g]30 ft-120 ft at Ogallala In period from 1940-48 to 1973, in about half of area in Scott and Lane, water level declined from <10 to 10 ft; in about 10% of area decline was >30 ft and decline of as much as 50 ft was also observed.		[4g]ref. KGS B66 lateral inflow along the Scott-Wichita county line Water table depletion; ref. KGS B27, KGS B93 and comparing the data with similar data collected in 1973
										[4c]about 20% of irr. applied	[4c]9000 (0.23 in/yr)	experiment in Finney County	[4c]Meyer, W.C., et al., 1953 [4c]KWRB '67					
				Ogallala			[4f]16600 ac-ft/yr (0.43 in/yr)					soil-water budget	[4f]USGS '91					
5	Lane	720	KGS B93 1951 KGS Irr. 1976	Alluvium: Thickness ranges from few feet to as much as 200 ft in the southern part. Yields from 250-1500gpm.	18.77	53.6	[5a]340 (0.009 in/yr)					soil-water budget	[5a]USGS' 91			10% to 60% of sat. thickness has been reduced throughout most of the main body of the unconsolidated aquifer. 1940-48 to 1973.		
				Ogallala Fm. is the major aquifer. Thickness ranges from few feet to 215 ft in central Scott County. The median thickness is 110 ft. Yield ranges from 100-1700 gpm.			[5a]9550 (0.25 in/yr)											
							[5b]about 1/4 inch					From study in southern High Plains. Estimation based on assumption that 10% of pcp in irr and 1% in	[5b]Frye, J.C., 1942	silty soils and silty and loamy soil			agriculture and pasture 460800 ac farmland (1946 census) crops and grasses	

No.	County	Area mi²	Reference Bulletin & pub yr	Aquifer	Avg. precip (in/yr)	Avg. temp. °F	Recharge from ac-ft/yr (in/yr) precip.	stream	lateral inflow	irrig.	Total recharge (in/yr) ac-ft/yr	Method	Reference	Soils	Topog	Avg. depth to water table	Vegetation and land use	Comments
							[5c]3,000 ac-ft (0.08 in) in 1971 6,000 ac-ft (0.16 in) in 1972	negligible, as all streams in Lane are ephemeral				nonirr land percolates down to water table	[5b]Gutentag and Stulken, 1976			[5f]25 ft-50 ft at alluvium [5f]<25 ft-75 ft at Ogallala		[5f]ref. KGS B93
				Sandstone aquifer (Dakota Fm) 430 ft in southwestern Scott to 710 ft in thickness in southwestern Lane Co. Yields from 30-300 gpm.						[5c]6,000 ac-ft (0.16 in) in 1971 5,000 ac-ft (0.13 in) in1972	18,000 in 1971[5c] (0.46 in/yr) 20,000 in 1972[5c] (0.52 in/yr)	based on pumpage pcp+lat.inf +irr pcp+lat.inf +irr						
				Chalk aquifer (Niobrara Fm.) Thickness of about 400 ft. Not an important aquifer as yield is small.						[5d]about 20% of irr. applied	8,600[5c] (0.22 in/yr)	experiment in Finney Co.	[5d]Meyer, W.R. et al., 1953 [5c]KWRB '67					
	Summary (District avg.)										0.33 in/yr[a] (std. dev. 0.10)	[1]arithmetic avg.	[a]USGS '91					[1]all averages are calculated considering only the counties included in the GMD.
											0.19 in/yr[b] (std. dev. 0.07)	[1]arithmetic avg.	[b]KWRB '67					
											0.24 in/yr[c] (std. dev. 0.16)	[1]arithmetic avg.	[c]KGS Bulletins					

NOTE:

KWRB'67: Irrigation in Kansas. Kansas Water Resources Board, 1967. Report 16e.
USGS' 91: Hansen, C. V., 1991, Estimates of freshwater storage and potential natural recharge for principal aquifers in Kansas: U.S. Geological Survey, Water-Resources Investigations Report 87-4230.
KGS B: Kansas Geological Survey Bulletin
std. dev.: standard deviation
Exponents indicate corresponding information from the same study.

EQUUS BEDS AQUIFER (GMD 2 Region)

No.	County	Area mi²	Reference Bulletin & pub yr	Aquifer	Avg. precip (in/yr)	Avg. temp. °F	Recharge from ac-ft/yr (in/yr) precip.	stream	lateral inflow	irrig.	Total recharge ac-ft/yr (in/yr)	Method	Reference	Topog and Soils	Avg. depth to water table	Vegetation and land use	Comments
1	McPherson	896	KGS B79 1949		28.91	56					[1a]20% of pcp. 7 in/yr or 365 ac-ft/yr/mi² for the period of record 1938-1943 in Wichita well field area (85 mi2)	[1a]Water-level fluctuation and sp. yield 20%	[1a]Williams & Lohman 1949	nearly level to gently sloping silty and clayey soils on uplands	10 ft-110 ft	farm and pasture -1945	area covered in B79= 2,340 m² includes McPherson and parts of Marion, Harvey, Reno, and Sedgwick cos.
											6 in/yr or 320 ac-ft/yr/mi² for normal pcp. in Wichita well field area (0.2*28.91 = 5.8 ≅ 6 in/yr for norm. pcp.)						
											[1b]138,000 (2.89 in/yr)		[1b]KWRB '67				
				Alluvium			[1c]9,220 (0.19 in/yr)					soil-water budget	[1c]USGS '91				
				Equus Beds			[1c]70,700 (1.47 in/yr)										
											[1d]0.1-4.5 in/yr	[1d]3-D,finite, diff., ground-water flow model	[1d]Spinazola, J. M. et al., 1985				[1d]recharge for predevelopment period (before 1940)
2	Reno	1262	KGS B79 1949		28.53				quantity not known but small compared to that from pcp.		[2a]20% of pcp. 0.2*28.53= 5.7 in/yr	[2a]ground-water level fluctuation and sp. yield (20%)	[2a]Williams and Lohman, 1949	nearly level to moderately sloping loamy soils on uplands; nearly level, loamy and sandy soils on floodplains	<10 ft-50 ft	farmland and pasture	area covered in KGS B79= 2,340 mi² includes McPherson and parts of Marion, Harvey, Reno, and Sedgwick cos.
			KGS B64 1946		27.83	54.3					[2b]20% of pcp. 300 ac-ft/mi²/yr in the Arkansas River valley (5.56 in/yr)	[2b]water-table fluctuation records and sp. yield ests.	[2b]Williams, C.C., 1946				
									[2c]500 ac-ft/mi into McPherson Fm.=1.07 in/yr			[2c]permeability, water-table gradient, well logs (Darcy's Law)	[2c]Williams, C.C., 1946				[2c]500*11.4= 5,700 ac-ft/yr =1.07 in/yr in 100 mi² of study area in vicinity of

No.	County	Area mi²	Reference Bulletin & pub yr	Aquifer	Avg. precip (in/yr)	Avg. temp. °F	Recharge from ac-ft/yr (in/yr) precip.	stream	lateral inflow	irrig.	Total recharge ac-ft/yr (in/yr)	Method	Reference	Topog and Soils	Avg. depth to water table	Vegetation and land use	Comments
									about 20,000 ac-ft/yr=3.75 in/yr from Arkansas Valley upstream into Hutchison area (study area of 100 mi²)		[2d]276,400 (4.1 in/yr)		[2d]KWRB '67				Hutchinson; inflow=500 ac-ft/mi/y; 11.4 mi= length of inflow boundary for the study area (approx.)(see pl. 1 KGS B64, part 5)
				Alluvium			[2e]3,880 (0.06 in/yr)					soil-water budget	[2e]USGS '91				
				Equus Beds			[2f]139,000 (2.07 in/yr)				[2f]0.1-5.5 in/yr	3-D finite diff., ground-water flow model	[2f]Spinazola, J. M., et al., 1985				[2f]recharge for predevelopment period (before 1940)
3	Harvey	540	KGS B79 1949								[3a]from 1938-1943 about 20% of pcp. Or 320 ac-ft/sq mi/yr in the well field area=6 in/yr (well field area 85 sq mi)	[3a]change in storage and pumpage data estimated area of water table affected -100 sq mi	[3a]Williams and Lohman, 1949	nearly level to gently sloping loamy and silty soils on uplands; nearly level, loamy and sandy soils on floodplains	10 ft-40 ft	farmlands and pastures	[3a]avg. pcp. for the period 29.7 in - from the data for Wichita, Sedgwick Co.
			KGS B119 1956		33.69 (1940-48)						[3b]3.75 in/yr from 1940-48	[3b]change in storage sp. yield 20%	[3b]Stramel, G.J., 1956				The area covered in this report includes parts of Harvey and Sedgwick cos., referred to as well field area (378 mi²) Equus Beds area: 2,340 mi²
					34.18 (1948-1952)						[3b]8.8 in/yr from 1948-1952	[3b]change in storage sp. yield 20%					
					33.62 (1938-1952) pcp. data for Wichita, Sedgwick Co.						[3b]6 in/yr ave. from 1938-1952	[3b]change in storage sp. yield 20%					
											[3c]88,700 (3.08 in/yr)		[3c]KWRB '67				
				Equus Beds			[3d]61,700 (2.14 in/yr)					soil-water budget	[3d]USGS '91				
			[3e]USGS WRIR 87-4097 (Sophocleous and Perry, 1987)		29.05 (1966-1982)	(13.4°C) 56.12	[3e]6.06 in/yr at Burrton from Feb. to June 1983 = 154 mm					[3e]Darcy's Law and mass balance	[3e]Sophocleous and Perry, 1987				
											[3f]0.1–5.0 in/yr	[3f]3-D, finite, diff., ground-water flow model	[3f]Spinazola, J. M., et al., 1985				[3f]recharge for predevelopment period (before 1940)

No.	County	Area mi²	Reference Bulletin & pub yr	Aquifer	Avg. precip (in/yr)	Avg. temp. °F	Recharge from ac-ft/yr (in/yr) precip.	stream	lateral inflow	irrig.	Total recharge ac-ft/yr (in/yr)	Method	Reference	Topog and Soils	Avg. depth to water table	Vegetation and land use	Comments
4	Sedgwick	1000	KGS B79[4a] 1949 KGS B119[4a] 1956		30.2 (1917–1944)	57					[4a,a′]20% of pcp. approx. 6 in/yr or 320 ac-ft/yr/mi²	[4a,a′]ground-water level fluctuation and sp. yield (20%)	[4a]Williams and Lohman, 1949 [4a]Stramel, G. J., 1956	nearly level to moderately sloping loamy soils on uplands nearly level, loamy and sandy soils on floodplains	<10 ft–30 ft	farmland and pasture	[4a]Area covered in this report is 2,340 sq mi includes McPherson and part of Marion, Reno, Sedgwick, and Harvey
			[4b]USGS WRIR 88-4225-1989		28.6 (1888–1985)	56.3	[4b]avg. from 0.1–8.8 in/yr depending on local condition (from summary; no source)	[4b]streams are in equilibrium with ground water or are gaining	[4b]no inflow from north but gains from east and west but outflow from southern boundary is probably equal so net effect on recharge is insignificant		[4ba]0.4–5.5 in/yr in Arkansas River valley of Sedgwick Co. and adj. areas	[4ab]3-D, finite, diff., ground-water flow model	[4ba]Spinazola, J.M. et al., 1985				[4b]The study area includes Sedgwick and parts of Reno, Kingman, Harper, Harvey, Sumner, Marion, Butler, and Cowley cos.
											[4c]193,000 (3.59 in/yr)		[4c]KWRB ‘67				
				Alluvium			[4d]41,900 (0.78 in/yr)					soil-water budget	[4d]USGS ‘91				
				Equus Beds			[4d]36,500 (0.68 in/yr)										
											[4e]0.4–5.5 in/yr (2.5–5.5 in/yr in Arkansas River valley of Sedgwick Co. and adj. areas)	[4e]3-D, finite, diff., ground-water flow model	[4e]Spinazola, J. M. et al., 1985				[4e]Recharge for predevelopment period (before 1940)
	Summary	11,523		Lower Arkansas unit that includes the Equus Beds aquifer	<22 to >32	57	[a]20% of pcp. in Equus Beds	streams are effluent	some from adjacent areas to the west but insignificant		precise estimate cannot be made based on available data (1960). Because of the variable local conditions annual recharge could range from practically zero to as much as 50% of annual pcp. in some areas.		[a]KWRB, 1980				includes Rice, McPherson, Reno, Harvey, Sedgwick, and Ellsworth cos.
	Equus Beds modeling area	240 (area selected in the report as indicated in cited reference)	[b]KWRRI 1982 (Sophocleous et al.)	Equus Beds	30		[b]Non-sand dune Equus Beds model area: 4.2 cm/yr or 1.65 in/yr. Sand dune area north of Burrton 16.3 cm/yr or 6.4 in/yr.					[b]ground-water flow model (steady-state ground-water flow in two dimensions) parameters used transmissivity, areal recharge, leakage of the stream beds and specified head.	[b]Sophocleous, M. A. et al., 1982				

No.	County	Area mi²	Reference Bulletin & pub yr	Aquifer	Avg. precip (in/yr)	Avg. temp. °F	Recharge from ac-ft/yr (in/yr)				Total recharge ac-ft/yr (in/yr)	Method	Reference	Topog and Soils	Avg. depth to water table	Vegetation and land use	Comments
							precip.	stream	lateral inflow	irrig.							
		1406	[c]USGS WRIR 85-4336 (Spinazola et al.)	Equus Beds	[c]30.37 preceding 1940 30.58 (1951–1980)	56.6	[c](1.70 in/yr) 1940 (predev.) (1.91 in/yr) 1971–79 dev. period [ca]20% of pcp. [cb]3.75 in. (during period Sept. 1940 to Jan. 1948) 8.8 in. during period Jan. 1948 to Jan. 1952	0.02 in/yr 1940 (predev.) 0.22 in/yr 1971–79 dev. period	[c](0.14 in/yr) 1940 (predev.) (0.19 in/yr) 1971–79 dev. period		1.86 in/yr 2.32 in/yr	[c]A modular 3-D finite diff. ground-water flow model (McDonald and Harbaugh, 1984) [ca]from fluctuation of water table and sp. yield [cb]change in storage	[c]Spinazola, J. M. et al., 1985 [ca]Williams and Lohman, 1949 [cb]Stramel, G. J., 1956				[c]Parts of Harvey, Marion, McPherson, Reno, and Sedgwick cos.
	District avg.[1]	3698									[d]5.92 in/yr (std. dev. 0.15) [e]3.41 in/yr (std. dev. 0.54) [f]1.59 in/yr (st. dev. 0.68) [g]0.18–5.13 in/yr (std. dev. 0.15)	[1]arithmetic avg. [1]arithmetic avg. [1]arithmetic avg. [1]arithmetic avg.	[d]KGS Bulletins [e]KWRB ‘67 [f]USGS ‘91 [g]Spinazola et al., 1985				[1]all averages are calculated considering only the counties included in the GMD. [f]recharge for Equus Beds

NOTE: KWRB ‘67: Irrigation in Kansas, Kansas Water Resources Board, 1967, Report no. 16e.
USGS ‘91: Hansen, C. V., 1991, Estimates of freshwater storage and potential natural recharge for principal aquifers in Kansas: U.S. Geological Survey, Water-Resources Investigations Report 87–4230.
KGS B: Kansas Geological Survey Bulletin
std. dev.: standard deviation
Exponents indicate corresponding information from the same study.

SOUTHWEST KANSAS (GMD 3 Region)

No.	County	Area mi²	Reference Bulletin & pub yr	Aquifer	Avg. precip (in/yr)	Avg. temp. °F	Recharge from ac-ft/yr (in/yr) precip.	stream	lateral inflow	irrig.	Total recharge ac-ft/yr (in/yr)	Method	Reference	Topog and Soils	Avg. depth to water table	Vegetation and land use	Comments
1	Hamilton	992	KGS B49 1943		17.67	53.9	High in sand hills area due to porous soil and presence of basins without surface drainage. Relatively low in upland area due to impermeable soil.		Flow occurs southeastwards inflow occurs from Prowers Co., Colorado, and from Greeley Co.					Nearly level to gently sloping silty soils on uplands; nearly level, loamy and sandy soils on floodplains; rolling to hummocky sandy soils on uplands.	Alluvium <10 ft–25 ft dune sand 25 ft–50 ft rest>50–200 ft		
							[1a]Ark. Valley area 1000 or >1000 ac-ft/yr					[1a]Water balance inflow=outflow (neglecting the contribution of subsurface flow as it is low)	[1a]McLaughlin, T. G., 1943				
								[b]0.96 in/yr (1970–74) 1.59 in/yr (1975–79)			[1b]1.95 in/yr (1970–74) 4.21 in/yr (1975–79) (pcp+irr.-ET)	[1b]USGS 2-D finite element ground-water flow model	[1b]Barker, R. A., et al., 1983				[1b]In Arkansas River valley in Hamilton and Kearny Co. A=110,000 acres
											[1c]5,400 ac-ft/yr (0.1 in/yr)		[1c]KWRB ‘67				
				Alluvium			[1c]2,980 (0.06 in/yr)					[1c]Soil-water budget	[1c]USGS ‘91				
				High Plains (Ogallala)			[1c]9,410 (0.18 in/yr)										
2	Kearny	861	KGS B49 1943		15.85	53.9	High in sand hills area due to porous soil and presence of basins without surface drainage. Relatively low in upland area due to impermeable soil.	[2a]19000 ac-ft/y (4.24 in/yr) over the alluvial area of 53,760 ac from Hartland to Garden City along Arkansas River.	Inflow occurs in north from Wichita and in west from Hamilton			[2a]Difference in discharge at different points along the stream	[2a,2b]McLaughlin, T. G., 1943	Sloping silty soils on uplands; nearly level, loamy and sandy soils on floodplains; rolling to hummocky sandy soils on uplands.	Alluvium 10 ft–25 ft dune sand 25 ft–50 ft rest>50–200 ft		
							[2b]Arkansas Valley area					[2b]Water balance inflow=outflow					

No.	County	Area mi²	Reference Bulletin & pub yr	Aquifer	Avg. precip (in/yr)	Avg. temp. °F	Recharge from ac-ft/yr (in/yr) precip.	stream	lateral inflow	irrig.	Total recharge ac-ft/yr (in/yr)	Method	Reference	Topog and Soils	Avg. depth to water table	Vegetation and land use	Comments
							1,000 or > 1,000 ac-ft/yr					(neglecting the contribution of subsurface flow as it is low)					
								[2c]0.96 in/yr (1970–74) 1.59 in/yr (1975–79)			[2c]1.95 in/yr (1970–74) 4.21 in/yr (1975–79) (pcp+irr-ET)	[2c]USGS 2-D finite element ground-water flow model	[2c]Barker, R. A., et al., 1983				[2c]In Arkansas River valley in Hamilton and Kearny Co. A= 110,000 acres
							[2d]2.08 in/yr (1974–1980) for sandhills and Arkansas River valley 0.5 in/yr for High Plains	[2d]1.10 in/yr (1974–1980) for sandhills and Arkansas River valley 0.9 in/yr for High Plains				[2d]USGS 3-D model (Trescott, 1975)	[2d]Dunlap, L. E., et al., 1985				[2d]Model area of upper aquifer (Arkansas River valley+ Sand dunes area)=603 mi² and for lower aquifer (main High Plains aquifer)= 1,227 mi² in Kearny and Finney Cos.
											[2c]10,800 (0.24 in/yr)		[2c]KWRB '67				
				Alluvium			[2f]1,750 (0.04 in/yr)					[2f]soil-water budget	[2f]USGS '91				
				High Plains (Ogallala)			[2f]25,700 (0.56 in/yr)										
3	Finney	1302	KGS B55 1944		20.22	54.7	[3a]1.4 in/yr (1940–1952) period of above-normal pcp.		[3b]45,000 ac-ft/yr 0.98 in/yr over the area considered, from the west and north of Scott Co. But the discharge from the co. was 47,000 ac/yr (area=552960 ac)	[3c]15% of irr. applied 10% for ditches	[3d]124,000ac-ft/yr or 2.7 in/yr (1940–1964) <0.5 in/yr predevelopment period (1922–1930) considering equili-	[3a]Change in water level in observation wells S=0.2 and delta h=7 ft [3b]Using water level map of Latta-1944 and Q=TIL [3c]Experiment on irr. efficiency and measurement of Q in two points of canal. [3d]water-balance equation	[3abcd]Meyer, W.R., et al., 1970	Rolling to gently sloping to nearly level sandy, loamy, and silty soils on the uplands; nearly level loamy and sandy soils on floodplains.			[3abcd]Area under consideration 552,960ac [3d]2.7 in/yr reflects additional recharge resulting from recycled ground water for irrigation & an accompanying increase in effective recharge from

No.	County	Area mi²	Reference Bulletin & pub yr	Aquifer	Avg. precip (in/yr)	Avg. temp. °F	Recharge from ac-ft/yr (in/yr) precip.	stream	lateral inflow	irrig.	Total recharge ac-ft/yr (in/yr)	Method	Reference	Topog and Soils	Avg. depth to water table	Vegetation and land use	Comments
											brium of system <0.05 in/yr long-term avg. (1940–1964)						precipitation on the irrigated land.
											[3h]16000 ac-ft/yr (0.23 in/yr)		[3h]KWRB '67				
								[3i]max. 25,300 ac-ft/yr from Arkansas River between Hartland and Garden City (alluvium area of 53,760 ac) for the period of Oct. 1922–Sept. 1942 5.65 in/yr	[3j]max 2,100 ac-ft/yr in narrow part of Arkansas River valley near Hartland (alluvium was 2,250 ft wide and avg. thickness 33 ft)			[3i]Flow difference between Syracuse and Garden City	[3i]KGS B55 [3j]Latta, B. F., 1944			[3i]Channel width avg. 0.05 mi; length from Hartland to Garden City 22 mi; channel area where seepage occurs=1.1 mi²= 704 ac
									[3k]approx. 1,000 ac-ft/yr near Hartland				[3k]McLaughlin, T. G., 1943			
				Alluvium and High Plains (Ogallala)			[3l]600 ac-ft/yr (0.00006 in/yr) [3l]38,400 ac-ft/yr (0.65 in/yr)	[3m]1,700 ac-ft/yr from Arkansas River				[3l]soil-water budget	[3l]USGS '91 [3m]Meyer, W. R., et al., 1970				
								[3n]37,646 ac-ft/yr\ 8.4 in/yr (1991–1998) for the valley area (53,760 ac) between Syracuse and Garden City 55,745 ac-ft/yr\ 10.45 in/yr (1991–99) for the valley area (64,000 ac) between Garden City and Dodge City.				[3n]water balance of stream	[3n]Whittemore, D. O., et al., 2001			
							[3o]2.08 in/yr (1974–1980) for sand hills and Arkansas River valley 0.5 in/yr for High Plains	[3o]1.10 in/yr (1974–1980) for sand hills and Arkansas River valley 0.19 in/yr for High Plains				[3o]USGS 3-D model (Trescott, 1975)	[3o]Dunlap, L. E. et al., 1985				[3o]Model area of upper aquifer and valley=603 mi² and for lower aquifer=1,227 mi² in Kearny and Finney Cos.

No.	County	Area mi²	Reference Bulletin & pub yr	Aquifer	Avg. precip (in/yr)	Avg. temp. °F	Recharge from ac-ft/yr (in/yr) precip.	stream	lateral inflow	irrig.	Total recharge ac-ft/yr (in/yr)	Method	Reference	Topog and Soils	Avg. depth to water table	Vegetation and land use	Comments
							[3p]0.5 in/yr in vegetated sand dune area, but higher in the barren sand dune area				[3q]0.02–0.04 in/yr 0.12 in/yr for irr. land	[3p]neutron probe [3q]heat dissipation sensors and Darcy's Law	[3p]Prill, R. C., 1968 [3q]Sophocleous, M., et al., 2002				[3p]Study area located in dune sand area in the Arkansas River valley near Garden City for the period 1964–66 (period of high rainfall)
4	Gray	873	KGS B55 1944	High Plains (Ogallala)	21.43		[4b]43700 ac-ft/yr (0.94 in/yr)	Arkansas River is gaining throughout its course in the county			[4a]14,800 ac-ft/yr (0.32 in/yr)	[4b]soil-water udget	[4a]KWRB '67 [4b]USGS '91	Nearly level to gently sloping silty soils on uplands; undulating sandy soils on uplands; nearly level loamy and sandy soils on floodplains			
5	Ford	1082	KGS B43 1942	Alluvium High Plains (Ogallala)	20.5	54.3	small; estimated to be about <0.5 in/yr due to low permeability, high evaporation and high ET Data not adequate for quantitative estimate but considered to be low [5d]370 (0.006 in/yr) [5c]54400 (0.94 in/yr)	small as Arkansas River was effluent (gaining) most of the times in a year and so were other small rivers		some in places in the vicinity of irr. ditches and fields	[5b]0.6 in/yr (1980–81) [5c]34,700 (0.6 in/yr)	[5b]water budget [5d]soil-water budget	[5b]Spinazola and Dealy, 1983 [5c]KWRB '67 [5d]USGS '91	Nearly level to gently sloping silty soils on uplands; undulating sandy soils on uplands; nearly level loamy and sandy soils on floodplains	10 ft>150 ft		[5b]Water budget for 1980 conditions over 700 mi² underlain by Ogallala aquifer of the Arkansas River
6	Stanton	685	KGS B168 1964		15.03		[6a]0.3 in/yr equivalent to 2% of pcp (over area of 160 mi² between Johnson and Ulysses) [6b]<0.5 in/yr due to impermeable soil	[6b]large quantity from Bear Creek and possibly Sand Arroyo after rains. But actual quantity not known	[6b]receives some from the rainwater that reaches underground reservoir in southeastern Colorado		[6c]11,700 (0.32 in/yr)	[6a]Difference in flow at two different locations	[6a]Fader, S. W., et al., 1964 [6b]Theis, C. V., et al., 1935 [6c]KWRB '67	Nearly level to gently sloping silty and loamy soils on uplands	<25 ft–250 ft		

No.	County	Area mi²	Reference Bulletin & pub yr	Aquifer	Avg. precip (in/yr)	Avg. temp. °F	Recharge from ac-ft/yr (in/yr) precip.	stream	lateral inflow	irrig.	Total recharge ac-ft/yr (in/yr)	Method	Reference	Topog and Soils	Avg. depth to water table	Vegetation and land use	Comments
				High Plains (Ogallala)			[6d]14,000 (0.39 in/yr)					[6d]soil-water budget	[6d]USGS '91				
7	Grant	571	KGS B168 1964		17.24	54.6	[7a]0.3 in/yr equivalent to 2% of pcp. (over area of 160 mi² between Johnson and Ulysses)	[7b]Gain some water from Bear Creek, Lakin Draw, and Sand Arroyo, whereas Cimarron River is losing in some regions and gaining in some	[7b]inflow occurs from Stanton Co. on the west and Kearny Co. on the north		[7c]9,300 (0.31 in/yr)	[7a]difference in flow at two different locations underground	[7a]Fader, S. W., et al., 1964 [7b]McLaughlin, T. G., 1946 [7c]KWRB '67	nearly level to gently sloping silty, loamy, and sandy soils on uplands and floodplains	alluvium 10 ft–50 ft rest <50 ft to >200 ft		
				High Plains (Ogallala)			[7d]22,300 (0.73 in/yr)					[7d]soil-water budget	[7d]USGS '91				
8	Haskell	580	KGS B61 1946		18.0	54.6		[8a]Gain some water from Bear Creek, Lakin Draw, and Sand Arroyo, whereas Cimarron River is losing in some regions and gaining in others	[8a]inflow occurs from Grant Co. on the west and Finney Co. on the north		[8b]9,600 (0.31 in/yr)		[8a]McLaughlin, T. G., 1946 [8b]KWRB '67	nearly level to gently sloping silty and loamy soils on uplands	70 ft–250 ft		
				High Plains (Ogallala)			[8c]30,200 (0.98 in/yr)					[8c]soil-water budget	[8c]USGS '91				
9	Morton	720									[9a]12,000 (0.31 in/yr)		[9a]KWRB '67	nearly level to gently sloping silty soils on uplands; nearly level to undulating loamy and sandy soils on uplands and floodplains			
				High Plains (Ogallala)			[9b]16,300 (0.42 in/yr)				[9c]0.004–0.01 for native grass land	[9b]soil-water budget [9c]heat dissipation sensors and Darcy's Law	[9b]USGS '91 [9c]Sophocleous, M., et al., 2002				
10	Stevens	731	KGS B61 1946		17.87	54.6		[10a]Gain some water from	[10a]inflow occurs from				[10a]McLaughlin, T. G., 1946	nearly level to undulating	alluvium <10 ft to 20 ft, rest		

No.	County	Area mi²	Reference Bulletin & pub yr	Aquifer	Avg. precip (in/yr)	Avg. temp. °F	Recharge from ac-ft/yr (in/yr) precip.	stream	lateral inflow	irrig.	Total recharge ac-ft/yr (in/yr)	Method	Reference	Topog and Soils	Avg. depth to water table	Vegetation and land use	Comments
								Bear Creek, Lakin Draw, and Sand Arroyo	Morton Co. on the west		[10b]12,000 (0.31 in/yr)		[10b]KWRB '67	loamy and sandy soils on uplands and floodplains; nearly level to gently sloping silty soils on uplands	80 ft–150 ft		
				High Plains (Ogallala)			[10c]29,200 (0.75 in/yr)					[10c]soil-water budget	[10c]USGS '91				
11	Seward	643	KGS B69 1948		19.01		[11a]0.4 in/yr	[11a]some from Cimarron River in northwestern part of the county	[11a]from Stevens Co. on the west and Haskell Co. on the north but quantity is not known		[11b]10,000 (0.29 in/yr)	[11a]change in water level of 0.22 ft (1941–44) Sy=15%	[11a]Byrne and McLaughlin, 1948 [11b]KWRB '67	gently sloping loamy and sandy soils on uplands and floodplains; nearly level to gentlysloping silty soils on uplands	<10 ft–20 ft alluvium rest 50 ft> 200 ft		
				High Plains (Ogallala)			[11c]34,100 (0.99 in/yr)					[11c]soil-water budget	[11c]USGS '91				
12	Meade	979	KGS B45 1942		18.43 (17 in. avg. snow)	56	small from the pcp. that falls on the area due to impervious soil	small due to steep slope of streams		some, as the shallow water table is quite high	[12a]10,000 ac-ft/yr (0.27 in/yr) (eqv. to 1.5% of pcp.)	[12a]equating recharge to the discharge from the aquifer	[12a]Frye, J. C., 1942	nearly level to moderately sloping silty soils on uplands	<10 ft > 150 ft		recharge into the artesian aquifer including the upward leakage through the confining beds. Area involved=685 mi² (recharge area of artesian water includes Finney, Haskell, Gray, Seward, and Meade Cos.
											[12b]14,800 (0.28 in/yr)		[12b]KWRB '67				
				Alluvium			[12c]4,430 (0.08 in/yr)					[12c]soil-water budget	[12c]USGS '91				
				High Plains (Ogallala)			[12d]50,300 (0.96 in/yr)										
	Summary						[a]0 to 2 in/yr (0.24 in/yr in avg.) [a]0.25 in/yr in dune sand area to the south and Arkansas River valley					[a]2-D finite difference model (Trescott, 1976)	[q,b]Stulken, L. E., et al., 1985				
							[b]0.24 in/yr	[b]0.08 in/yr	[b]0.07 in/yr		[b]0.39 in/yr	[b]simulated steady-state water budget (pre-1950)					
							[c]0.58 in/yr	[c]0.05 in/yr	[c]outflow higher than inflow		[c]0.63 in/yr (pcp +stream)	[c]3-D MODFLOW (for 1982 period)	[c]Watts, K. R., 1989				[c]active node model area for the High Plains aquifer:2,695,680 ac

No.	County	Area mi²	Reference Bulletin & pub yr	Aquifer	Avg. precip (in/yr)	Avg. temp. °F	Recharge from ac-ft/yr (in/yr) precip.	stream	lateral inflow	irrig.	Total recharge ac-ft/yr (in/yr)	Method	Reference	Topog and Soils	Avg. depth to water table	Vegetation and land use	Comments
							[d]0.34 in/yr (0.45 in/yr in Meade, Seward, and eastern Stevens but 0.23 in/yr in Morton and western Stevens)					[d]2-D finite difference USGS model (Trescott, 1976)	[d]Havens and Christenson, 1984				[d]active node model area 14,208,000 ac (includes part of Oklahoma and Morton, Stevens, Seward, and Meade Cos. in Kansas)
							[c]0.6 in/yr over total area; 175,000 ac-ft\ 1.5 in/yr in irr. area of 1,400,000 ac and 35,000 ac-ft\ 0.15 in/yr in nonirr. area of 2,824,000 ac in 1975 based on 15 in. of pcp. during growing season		[g]inflow from north and west of co. 8,400 ac-ft/yr\ 0.024 in/yr; outflow 15,300 ac-ft/yr\ 0.04 in/yr to east	[f]420,000 ac-ft/yr to 560,000 ac-ft/yr (1.2–1.6 in/yr) –1975	[c]period (1922–1930) considering equilibrium of system <0.05 in/yr long term avg. (1940–64)	[e]10% of pcp. in irr. land and 1% of pcp. in nonirr. land [f]20%of applied irr. [g]Darcy's Law	[e,f,g]Gutentag, E. D., et al., 1981				
											[h]165000 ac-ft/yr (0.29 in/yr)		[h]KS Governor's Task Force report, 1977				
											[i]0.57 in/yr (0.3 in/yr in nonirr. land and 1.8 in/yr in irr. land)	[i]based on previous recharge estimates from pcp. and irr. to Ogallala aquifer in different subregions in western KS (1977)	[i]O'Connor and McClain, 1982				
	District avg.[1]										[j]0.70 in/yr (std. dev. 0.26)	[j]arithmetic avg.	[j]USGS '91				[j]arithmetic ave. for Ogallala
											[k]0.30 in/yr (std. dev. 0.11)	[k]arithmetic avg.	[k]KWRB '67				[1]all averages are calculated considering only the cos. included in the GMD
											[l]0.35 in/yr (std. dev. 0.09)	[l]arithmetic avg.	[l]KGS Bulletins				

Note: KWRB'67: Irrigation in Kansas: Kansas Water Resources Board, 1967, Report no. 16e.
USGS '91: Hansen, C. V., 1991, Estimates of freshwater storage and potential natural recharge for principal aquifers in Kansas: U.S. Geological Survey, Water-Resources Investigations Report 87–4230.
KGS B: Kansas Geological Survey Bulletin.
std. dev.: standard deviation
Exponents indicate corresponding information from the same study.

NORTHWEST KANSAS (GMD 4 Region)

No.	County	Area mi²	Reference Bulletin & pub yr	Aquifer	Avg. precip (in/yr)	Avg. temp. °F	Recharge from ac-ft/yr (in/yr) precip.	stream	lateral inflow	irrig.	Total recharge ac-ft/yr (in/yr)	Method	Reference	Soils	Topog	Avg. depth to water table	Vegetation and land use	Comments
1	Cheyenne	1027	KGS B100 1953		18	52					[1a]12,200 (0.22 in/yr)		[1a]KWRB '67	silty soils and loamy and silty soils	flat to rolling upland plains	90–175 ft along southern border 35–90 ft along southwestern border	cropland and pasture much of land is pasture	"Data on permeability and transmissibility are not adequate to permit estimating either subsurface flow into or out from the county." (KGS B100)
				Ogallala			[1b]23,200 (0.42 in/yr)				[1b]23,200 (0.42 in/yr)	soil-water budget	[1b]USGS '91					
2	Rawlins	1080	KGS B117 1956		18.5	52.3					[2a]10,500 (0.18 in/yr)		[2a]KWRB '67	silty soils	gently rolling	<10 ft at valleys to >200 ft at upland areas agriculture	cropland and pasture	
				Ogallala			[2b]41,800 (0.73 in/yr)					soil-water budget	[2b]USGS '91					
3	Decatur	900	KGS B196 1969	Ogallala Fm. avg. thickness 200 ft; avg. saturated thickness 45 ft Alluvial valleys yield range from 300 to 1,450 gpm depending on location	18.42	53.2	less than 1/2 inch		[3b]5,000 ac-ft/yr at western county boundary (0.10 in/yr)		[3a]17,500 (0.36 in/yr)	[3b]based on sat. thickness of water-bearing strata, water table gradient, and avg. K of 40.1 ft/day	[3a]KWRB '67	silty soils	gently rolling uplands	about 10–40 ft from surface in valleys to > 100 ft in most places and 200 ft or more in high parts Ogallala Fm. avg. thickness 200 ft; avg. saturated thickness 45 ft (1962)	cropland and pasture	
				Ogallala			[3c]36000 (0.75 in/yr)					soil-water budget	[3c]USGS '91					
4	Norton	880	KGS B81 1949		20.81	52.8	[4a]approx. 1/4–1/2 in.				[4b]15,400 (0.33 in/yr)		[4a]Frye, J. C., 1942 [4a]KWRB '67	silty soils	Plains border section of the Great Plains physiographic province	40 ft in valleys up to 175 ft in uplands; <10 ft in alluvium	cropland and pasture agriculture	
				Alluvium			[4c]2,180 (0.05 in/yr)					soil-water budget	[4c]USGS '91					
				Ogallala			[4c]41,100 (0.86 in/yr)											
5	Sherman	1055	KGS B105 1953		18	51.9					0.1 inch[5a]		[5a]Frye, J. C., 1942	mostly underlain by deposits of Tertiary Oga-	High Plains section consists of near-	in upland areas generally >100 ft<10 ft in stream valleys; avg.	cropland and pasture farmland and pasture	
							lower than		[5a]approx.			[5a]"estimate						

No.	County	Area mi²	Reference Bulletin & pub yr	Aquifer	Avg. precip (in/yr)	Avg. temp. °F	Recharge from ac-ft/yr (in/yr)				Total recharge ac-ft/yr (in/yr)	Method	Reference	Soils	Topog	Avg. depth to water table	Vegetation and land use	Comments
							precip.	stream	lateral inflow	irrig.								
							that from lateral inflow		21,480 ac-ft/yr from west and southwest (0.38 in/yr)			based on available data"		llala Fm. Silty soils and loamy and silty soils	flat to gently rolling upland plains	slope is 15 ft/mi		
											[5b]13,500 (0.24 in/yr)		[5b]KWRB '67					
				Ogallala			[5c]13,600 (0.24 in/yr)					soil-water budget	[5c]USGS '91					
6	Thomas	1070	KGS B59 1945		17.95	51.8	[6a]1/4 inch						[6a]Frye, J. C., 1942	silty soils	flat to gently rolling	>200 ft to only a few feet along valleys	cropland and pasture	
											[6b]20,700 (0.36 in/yr)		[6b]KWRB '67			<100 ft in east-central part	farmland	
				Ogallala			[6c]21,800 (0.49 in/yr)					soil-water budget	[6c]USGS '91					
7	Sheridan	893	KGS B116 1956		19.35	53.6					about 1/4 in.[7a]	author's estimate	[7a]Bayne, C. K., 1956	silty soils and silty and loamy soils	nearly flat to gently rolling	<10 ft to 160 ft	cropland and pasture	
											14,000[7b] (0.29 in/yr)		[7b]KWRB '67				agriculture	
				Alluvium			390[7c] (0.01 in/yr)				35,600[7c] (0.75 in/yr)	soil-water budget	[7c]USGS '91					
				Ogallala			35,200[7c] (0.74 in/yr)											
8	Graham	891	KGS B110 1955		20.56	53.9					[8b]7,000 (0.15 in/yr)		[8b]KWRB '67	silty soils and silty and loamy soils	High Plains section of Great Plains physiographic province	few feet to 140 ft	cropland and pasture	
							[8a]probably <1/2 in.					author's estimate	[8a]Prescott, G. C., 1955				agriculture; about 40% of land is pasture	[8a]avg. ET from free water surface in growing season is 11.5 in/month, and 75% of pcp. occurs in the growing season, so recharge is low (KGS B110, p. 31)
				Alluvium			[8c]2,710 (0.06 in/yr)					soil-water budget	[8c]USGS '91					
				Ogallala			[8c]32,500 (0.68 in/yr)											
9	Logan	1073	KGS B129 1958		18.97	53.3	[9b]1/6 in. (0.85% of the total pcp.)		[9a]approx. <25 ac-ft/yr in southern upland, negligible in northern upland	10% of applied		[9a]based on ground water contour map and saturated thickness	[9a,b,c]Johnson, C. R., 1958	silty soils and silty and loamy soils	High Plains section and plains border section in east	>40 ft from surface in uplands	cropland and pasture	[9a]on the northern upland of the county. Based on Darcy's Law at a section across N-S direction near eastern border of the county.
											[9c]estimated 3,000 in northern upland	[9c]from Darcy's Law at N-S section near						

No.	County	Area mi²	Reference Bulletin & pub yr	Aquifer	Avg. precip (in/yr)	Avg. temp. °F	Recharge from ac-ft/yr (in/yr) precip.	stream	lateral inflow	irrig.	Total recharge ac-ft/yr (in/yr)	Method	Reference	Soils	Topog	Avg. depth to water table	Vegetation and land use	Comments
											(calculated value 2,600 from pcp.)	eastern county boundary						
											[9d]5,000 (0.09 in/yr)		[9d]KWRB '67					
				Alluvium			[9e]1,880 (0.03 in/yr)				[9e]9,780 (0.17 in/yr)	soil-water budget	[9e]USGS '91			20 ft from surface in alluvium		
				Ogallala			[9e]7,900 (0.14 in/yr)									aquifer		[9e]avg. sat. thickness 30 ft K_{avg}=58.82 ft/day
10	Gove	1070	KGS B145 1960		20.89	53.2					[10a]11,000 (0.19 in/yr)		[10a]KWRB '67	silty soils and silty and loamy soils	High Plains section	50 ft–150 ft	cropland and pasture	
				Alluvium			[10b]1,700 (0.03 in/yr)					soil-water budget	[10b]USGS '91				agriculture 684000 ac.	
				Ogallala			[10b]11,600 (0.20 in/yr)											
11	Trego	900	KGS B174 1965		21.4		[11a]at least 10,000 ac-ft/yr (0.21 in/yr)				[11b]10,000 (0.21 in/yr)	author's estimate	[11a]Hodson, W. G., 1965 [11b]KWRB '67	silty and loamy	High Plains section	alluvium; few feet to 20 ft Ogallala< 10 ft to 100 ft	cropland and pasture agriculture	
				Alluvium			[11c]4,350 (0.1 in/yr)					soil-water budget	[11c]USGS '91					
				Ogallala			[11c]13,000 (0.27 in/yr)											
	Summary	8050	USGS OFR 4-75 1975	Alluvium has yield of as much as 1,500 gal/min	[β]16–21	51–78	0.25 in/yr or about 100,000 ac-ft/yr	most streams in western part lose water by infiltration. Runoff is only 1–2% of total pcp.					[β]Jenkins and Pabst, 1975	loessal	flat to gently rolling	alluvium is as much as 105 ft thick but =<65 ft is saturated	cropland and pasture	[β]mainly during 6 months of growing season (area is different in Open-file Report from the total area, as it reflects only the area in which the study was carried out)
				Ogallala Fm. has yield of 500–1,200 gal/min												Ogallala Fm. has saturated thickness ranging from 0–270 ft.		
				Dakota Fm. has yield of a few gal/min												Dakota Fm. lies 600–2600 ft below ground surface and its thickness ranges from 200 to 300 ft.		
	District avg.[1]	9059									[a]0.48 in/yr (std. dev. 0.25)	[1]arithmetic avg.	[a]USGS '91					[a]for Ogallala
											[b]0.23 in/yr (std. dev. 0.09)	[1]arithmetic avg.	[b]KWRB '67					[1]all averages are calculated considering only the cos. included in the GMD
											[c]0.29 in/yr (std. dev. 0.17)	[1]arithmetic avg.	[c]KGS Bulletins					

Note: KWRB '67: Irrigation in Kansas: Kansas Water Resources Board, 1967. Report no. 16e.
USGS '91: Hansen, C. V., 1991, Estimates of freshwater storage and potential natural recharge for principal aquifers in Kansas: U.S. Geological Survey, Water-Resources Investigations Report 87–4230.
KGS B: Kansas Geological Survey Bulletin
std. dev.: standard deviation
Exponents indicate corresponding information from the same study.

GREAT BEND PRAIRIE (GMD 5 Region)

No.	County	Area mi²	Reference Bulletin & pub yr	Aquifer	Avg. precip (in/yr)	Avg. temp. °F	Recharge from ac-ft/yr (in/yr) precip.	stream	lateral inflow	irrig.	Total recharge ac-ft/yr (in/yr)	Method	Reference	Topog. and Soils	Avg. depth to water table	Vegetation and land use	Comments
1	Barton	892	KGS B88 1950		24.18						[1a]83,100 (1.72 in/yr)		[1a]KWRB ‘67	nearly level to gently sloping silty soils on uplands	<10 ft>30 ft	farmland	
				GBP aquifer			[1b]33,800 (0.71 in/yr)					soil-water budget	[1b]USGS ‘91	nearly level silty soils on floodplains			
											[1c]22,700 (2.19 in/yr) for Walnut Creek valley alluvium	ground-water modeling	[1c]Nuzman, C., 1990				study area includes parts of Ness, Rush, and Barton Cos.
											[1d]60,000 (1.26 in/yr)	modification from KWRB ‘67	[1d]Fader and Morton, 1972				
2	Rice	721	KGS B85 1950		25.86 (1898–1942)	56					[2a]74,800 (1.93 in/yr)		[2a]KWRB ‘67	nearly level to gently sloping silty soils on uplands	20 ft	farmland	
				GBP aquifer			[2b]43,000 (1.11 in/yr)					soil-water budget	[2b]USGS ‘91	nearly level loamy and sandy soils on floodplains			
											[2c]75,000 (1.95 in/yr)	modification from KWRB ‘67	[2c]Fader and Morton, 1972				
3	Pawnee	755	KGS B80 1949		23.48			mainly in upland areas and the dune sand areas of the Arkansas River	from west and southwest		[3a]52,600 (1.30 in/yr)		[3a]KWRB ‘67	nearly level to gently sloping silty and loamy soils on uplands. Nearly level silty loamy and sandy soils on floodplains	dune sand: <10 ft–50 ft alluvium; 10 ft–30 ft terrace deposits: <20 ft–60 ft. Ogallala: <20 ft–>100 ft	agriculture	
				GBP aquifer			[2b]18,800 (0.47 in/yr)					soil-water budget	[3b]USGS ‘91				
											[3ca]0.6 in/yr for area of 325 mi² in Pawnee River valley	[3ca]mass balance (equilibrium of inflow and outflow)	[3ca]Sophocleous, M. A., 1981				
											[3cb]0.39 in/yr	[3cb]soil-moisture budget avg. of 3ca and 3cb	[3cb]Sophocleous, M. A., 1981				
											[3cc]0.5 in/yr		[3cc]Sophocleous, M. A., 1981				

No.	County	Area mi²	Reference Bulletin & pub yr	Aquifer	Avg. precip (in/yr)	Avg. temp. °F	Recharge from ac-ft/yr (in/yr) precip.	stream	lateral inflow	irrig.	Total recharge ac-ft/yr (in/yr)	Method	Reference	Topog. and Soils	Avg. depth to water table	Vegetation and land use	Comments
4	Stafford	794	KGS B88 1950	GBP aquifer	24.58		[4b]80,400 (1.9 in/yr)		B88, pl. 1 shows that the ground water flows into the county from Pawnee and Edwards Cos.		[4a]187,500 (4.42 in/yr) above [4b]soil-water budget [4c]190,000 (4.49 in/yr)	[4a]KWRB '67 [4b]USGS '91 [4c]modification from KWRB	[4c]Fader and Morton, 1972	undulating to gently sloping sandy, loamy, and silty soils on uplands	<20 ft–40 ft	farmland	
5	Reno	1262	KGS B79 1949 KGS B64 1946	Alluvium + Equus Beds and GBP aquifers	28.53 27.83	54.3	[5c]143,000 (2.12 in/yr)		quantity not known but small compared to that from pcp. [5c]500 ac-ft/mi into Equus Beds from dune sand northeast of Hutchinson =1.07 in/yr. About 20,000 ac-ft/yr=3.75 in/yr from Arkansas Valley into the Hutchinson study area of 100 mi²		[5a]20% of pcp 0.2* 28.53=5.7 in/yr [5b]20% of pcp. 300 ac-ft/mi²/yr in the Arkansas River valley (5.56 in/yr) [5d]276,500 (4.1 in/yr) [5f]0.1–5.5 in/yr [5g]270,000 (4.01 in/yr)	[5a]groundwater level fluctuation and sp. yield (20%) [5b]water fluctuation records and sp. yield estimates [5c]permeability, water gradient, well logs (Darcy's Law) [5e]soil-water budget [5f]3-D, finite diff. groundwater flow model [5g]modification from KWRB '67	[5a]Williams and Lohman, 1949 [5b,c]Williams, C. C., 1946 [5d]KWRB '67 [5e]USGS '91 [5f]Spinazola, J. M., et al., 1985 [5g]Fader and Morton, 1972	nearly level to moderately sloping loamy soils on uplands; nearly level, loamy and sandy soils on floodplains	<10 ft–50 ft	farmland and pasture	area covered in B79=2,340 mi² includes McPherson and parts of Marion, Harvey, Reno, and Sedgwick Cos. [5c]500*11.4= 5,700 ac-ft/yr= 1.07 in/yr in 100 mi² of study area in vicinity of Hutchinson; inflow=500 ac-ft/mi/yr, 11.4 mi=length of inflow boundary for the study area (approx.) (see pl.1, B64, part 5) [5f]recharge for predevelopment period (before 1940)
6	Edwards	619	KGS B80 1949	GBP aquifer	22.44		[6b]33100 (1 in/yr)				[6a]84,000 (2.54 in/yr) [6b]soil-water budget [6c]50000 (1.51 in/yr)	[6a]KWRB '67 [6b]USGS '91 [6c]modification from KWRB '67	[6c]Fader and Morton, 1972	undulating to gently sloping sandy and loamy soils on uplands	dune sand: <10 ft–50 ft; alluvium: 10 ft–30 ft; terrace deposits: <20 ft–60 ft; Ogallala: <20 ft–>100 ft	agriculture	
7	Kiowa	720	KGS B65 1948		22.15	56	[7a]in sandhills 2.2%	streams are in-	water enters Meade and			change in storage;	[7a]Latta, B. F., 1948	gentle to moderate slopes	dune sand: 10 ft–70 ft; Kingsdown	agriculture farming and	

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							of pcp. 0.58 in/yr	fluent but the amount of recharge is not known	Ogallala Fms. of this area from Ford and Clark cos.			porosity= 20%		and nearly flat surfaces with sandy, loamy, and silty soils	silt: >100 ft; Meade and Ogallala: <20 ft–60 ft; Ogallala: 20 ft	stock raising	
									A part of water in Meade and Ogallala Fms. is obtained from Dakota Fm.		[7b]99,600 (2.6 in/yr)		[7b]KWRB '67				
				Alluvium and GBP aquifer			[7c]50,070 (1.3 in/yr)					soil-water budget	[7c]USGS '91				
									[7d]500–1,000 (0.013–0.026 in/yr)			Darcy's Law	[7d]Fader and Stulken, 1978				
											[7c]50,000 (1.3 in/yr)	modification from KWRB '67	[7c]Fader and Morton, 1972				
8	Pratt	729	KGS B205 1973		24.04	avg. monthly: 8.2 in July 3.4 in Jan.	[8a]5–10% of pcp; 1.2–2.4 in/yr avg. 1.6 in/yr; higher recharge if for dune sand area	negligible	[8a]0.98 in/yr across the western boundary	5–10% of applied		[8a]Darcy's Law	[8a]Layton and Berry, 1973	nearly level to gently sloping silty and loamy soils on up-	alluvium:<10 ft–12 ft dune sand: <20 ft–50 ft but in southeastern part >50 ft–80 ft	agriculture	
									[8a]about 1,500 ac-ft/yr of saline water leaks upward from Permian rocks; actual amount is not known			measurement of chemical constituents in streamflow			Loveland and Crete Fm: 40 ft> 100 ft		
											[8d]169,000 (4.35 in/yr)		[8d]KWRB '67				
				GBP aquifer			[8c]77,800 (2 in/yr)					soil-water budget	[8c]USGS '91		Sappa and Grand Island Fm: 20 ft–60 ft		
											[8f]150,000 (3.86 in/yr)	modification from KWRB '67	[8f]Fader and Morton, 1972				
											[8g]3.5 in/yr from model calibrated ratio q/k= 8*10-6 for k=100 ft/day	STREAM–AQUIFER (Kemblowski, 1982), a model utilizing the integrated finite diff. method	[8g]Moya, P., 1985				[8g]q=natural recharge rate k=hydraulic conductivity
9	Kingman	864	KGS B144 1960		29.28	57.9		streams are effluent	some from Pratt Co. on the west	negligible (1955–	not known			lies in the Great Bend physio-	dune sand:<10 ft–20 ft; alluvium: <10 ft. Loveland	agriculture farm and cattle raising	

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										56)				graphic province	and Crete Fm: 10 ft–20 ft Ogallala: 10 ft–20 ft. Sappa and Grand Island Fm: 10 ft–70 ft. Fullerton and and Holdrege Fm: 20 ft–40 ft		
				alluvium and GBP aquifer			[9b]62,700 (1.36 in/yr)				[9a]201,600 (4.47 in/yr) [9c]150,000 (3.26 in/yr)	soil-water budget modification from KWRB	[9a]KWRB '67 [9b]USGS '91 [9c]Fader and Morton, 1972	nearly level to moderately sloping loamy soils on uplands			
10	Barber	1146	KGS OFR 29–1 1929	alluvium and GBP aquifer	24.89	57.3	[10b]18,280 (0.3 in/yr)				[10a]59,100 (0.97 in/yr) [10c]40,000 (0.65 in/yr)	soil-water budget modification from KWRB '67	[10a]KWRB '67 [10b]USGS '91 [10c]Fader and Morton, 1972	High Plains in northern and western parts and Plains border in the eastern part of the county moderately sloping to nearly level clayey and loamy soil			
11	Summary GBP	5400	KGS IR4 1978	GBP aquifer	22.5 at western border to 31.5 at the eastern		2 in/yr 5–10% of pcp. (1951–1971)					water-level fluctuation in wells	Fader and Stulken, 1978				counties included: all of Kiowa, Kingman, Pratt, and Stafford, and Barber, Barton, Edwards, Pawnee, Reno, and Rice
											0.75 in/yr (1950–1975)	USGS 2-D finite-difference model	Cobb, P. M., et al., 1983				
											0.28 in/yr (1950–1980)	regional flow model for the High Plains aquifer (USGS 2-D finite difference flow model)	Luckey, R. L., et al., 1986				
											4.3 in/yr (1982–83) (Rattlesnake Cr. basin)	daily soil-moisture budget	Sophocleous and McAllister, 1990 (KGS GW Series 11)				
	District avg.										2.87 in/yr (std. dev. 1.25)	[1]arithmetic avg.	KWRB '67				[1]all averages are calculated considering only the cos.
											2.62 in/yr	[1]arithmetic	Fader and				

No.	County	Area mi²	Reference Bulletin & pub yr	Aquifer	Avg. precip (in/yr)	Avg. temp. °F	Recharge from ac-ft/yr (in/yr) precip.	stream	lateral inflow	irrig.	Total recharge ac-ft/yr (in/yr)	Method	Reference	Topog. and Soils	Avg. depth to water table	Vegetation and land use	Comments
											(std. dev. 1.43) 1.33 in/yr (std. dev. 0.62) 1.9 in/yr (1985–1992) (std. dev. 0.71) 1.4 in/yr (1985–1990)	avg. [1]arithmetic avg. [1]arithmetic avg. area-weighted avg. field measured variables employing Darcy's method and water-budget analysis	Morton, 1972 USGS '91 Sophocleous, 1992				included in the GMD

Note: KWRB '67: Irrigation in Kansas, Kansas Water Resources Board, 1967, Report no. 16e.
USGS '91: Hansen, C. V., 1991, Estimates of freshwater storage and potential natural recharge for principal aquifers in Kansas: U.S. Geological Survey, Water-Resources Investigations Report 67–4230.
KGS B: Kansas Geological Survey Bulletin.
std. dev.: standard deviation
GBP: Great Bend Prairie
Exponents indicate corresponding information from the same study.