

Table 8. Composite sensitivities of observation groups to model parameter groups for the Northeast Metro Lakes Groundwater-Flow model, northeast Twin Cities Metropolitan Area, Minnesota.[m/d, meter per day; ++, indicates a parameter group was one of the three most sensitive parameter groups for a given observation group; SWB, soil-water-balance; m²/d, square meter per day]

Parameter group	Hydrologic property	Description	Parameter units	Number of observation groups for which a parameter is one of the three most sensitive parameters	Observation group sensitivity						
					Lake levels						
					Big Marine Lake	Lake Elmo	Pine Tree Lake	Snail Lake	Turtle Lake	White Bear Lake	Lake composite sensitivity
rchgm	Recharge	Recharge	m/d	16	0.184	2.67++	2.81++	8.27++	0.576	0.414	14.924
roff	Runoff	Lake specific multiplier for SWB generated runoff	unitless	0	0.299	0.161	1.34	0.53	0.345	0.484	3.159
riv_con	Riverbed conductance	River cells, separate parameters for major rivers, small streams, lakes, and wetlands	m ² /d	10	0.875	0.852	1.27	1.27	0.783	1.43	6.48
lak_k	Lakebed leakance multiplier for lakes requiring small (less than 1 order of magnitude) increment changes during model calibration	One parameter for each lake bed zone for each of six lakes modelled with the Lake package	m ² /d	4	8.98++	0.391	3.57++	0.484	4.44++	9.56++	27.425
qhk	Horizontal hydraulic conductivity	Glacial aquifers	m/d	12	5.02++	1.06++	3.62++	0.99	2.46++	5.92++	19.07
qvk	Vertical hydraulic conductivity	Glacial aquifers	m/d	0	0.0921	0.0461	0.322	0.23	0.138	0.161	0.9892
qvkd	Vertical hydraulic conductivity of deep sediments	Glacial aquifers	m/d	0	0.921	0.161	0.553	0.253	0.898	1.4	4.186
ostphk	Horizontal hydraulic conductivity	St. Peter aquifer	m/d	1	0.184	0.0921	0.345	1.93++	0.23	0.461	3.2421
ostpvk	Vertical hydraulic conductivity	St. Peter aquifer	m/d	0	0	0	0	0	0	0	0
ostpbk	Vertical hydraulic conductivity multiplier for confining part of aquifer	St. Peter aquifer	unitless	0	0.0691	0.023	0.0691	0	0.0691	0.115	0.3453
opdchk	Horizontal hydraulic conductivity	Prairie du Chien aquifer	m/d	10	0.668	0.944++	2.28	2.46++	0.76	1.38	8.492
opdevk	Vertical hydraulic conductivity	Prairie du Chien aquifer	m/d	0	0.023	0.0461	0.0921	0.0461	0.023	0.0461	0.2764
opdebk	Vertical hydraulic conductivity multiplier for confining part of aquifer	Prairie du Chien aquifer	unitless	0	0.023	0.023	0.0691	0.0461	0.023	0.0461	0.2303
cjdnhk	Horizontal hydraulic conductivity	Jordan aquifer	m/d	7	4.65++	0.345	2.46	0.852	2.69++	5.39++	16.387
cjdnvk	Vertical hydraulic conductivity	Jordan aquifer	m/d	0	0	0	0	0	0	0	0
cstlhk	Horizontal hydraulic conductivity	St. Lawrence confining unit	m/d	0	0.0461	0	0.023	0.0461	0.0461	0.0921	0.2534
cstlvk	Vertical hydraulic conductivity	St. Lawrence confining unit	m/d	0	0	0	0	0	0	0	0
k_mult	Conductivity multiplier	Multiplier for horizontal and vertical hydraulic conductivities of stratigraphically lower bedrock hydrogeologic units: Tunnel City aquifer, Wonewoc aquifer, Eau Claire confining unit, and Mount Simon-Hinckley aquifer	unitless	0	0	0	0	0	0	0	0

Table 8. Composite sensitivities of observation groups to model parameter groups for the Northeast Metro Lakes Groundwater-Flow model, northeast Twin Cities Metropolitan Area, Minnesota.—Continued[m/d, meter per day; ++, indicates a parameter group was one of the three most sensitive parameter groups for a given observation group; SWB, soil-water-balance; m²/d, square meter per day]

Parameter group	Hydrologic property	Description	Parameter units	Number of observation groups for which a parameter is one of the three most sensitive parameters	Observation group sensitivity					
					Base flows					
					Brown's Creek	Mississippi River at Prescott, Wisconsin	Rice Creek	Mississippi River at St. Paul, Minnesota	Valley Creek	Base-flow composite sensitivity
rchgm	Recharge	Recharge	m/d	16	17,600++	1,720,000++	90,700++	399,000++	60,800++	2,288,100
roff	Runoff	Lake specific multiplier for SWB generated runoff	unitless	0	115	0	691	9,900	0	10,706
riv_con	Riverbed conductance	River cells, separate parameters for major rivers, small streams, lakes, and wetlands	m ² /d	10	37,200++	1,300,000++	132,000++	782,000++	56,700++	2,307,900
lak_k	Lakebed leakance multiplier for lakes requiring small (less than 1 order of magnitude) increment changes during model calibration	One parameter for each lake bed zone for each of six lakes modelled with the Lake package	m ² /d	4	1,010	25,300	1,840	5,990	23	34,163
qhk	Horizontal hydraulic conductivity	Glacial aquifers	m/d	12	13,700++	513,000++	71,100++	274,000++	43,000++	914,800
qvk	Vertical hydraulic conductivity	Glacial aquifers	m/d	0	1,980	124,000	26,700	48,600	391	201,671
qvkd	Vertical hydraulic conductivity of deep sediments	Glacial aquifers	m/d	0	1,660	9,210	11,700	44,400	1,310	68,280
ostphk	Horizontal hydraulic conductivity	St. Peter aquifer	m/d	1	1,150	57,600	3,450	211,000	737	273,937
ostpvk	Vertical hydraulic conductivity	St. Peter aquifer	m/d	0	0	0	0	1,610	0	1,610
ostpbk	Vertical hydraulic conductivity multiplier for confining part of aquifer	St. Peter aquifer	unitless	0	0	6,910	461	4,140	437	11,948
opdchk	Horizontal hydraulic conductivity	Prairie du Chien aquifer	m/d	10	2,690	352,000	32,900	140,000	27,600	555,190
opdevk	Vertical hydraulic conductivity	Prairie du Chien aquifer	m/d	0	276	13,800	461	5,760	368	20,665
opdebk	Vertical hydraulic conductivity multiplier for confining part of aquifer	Prairie du Chien aquifer	unitless	0	599	11,500	461	21,400	875	34,835
cjdnhk	Horizontal hydraulic conductivity	Jordan aquifer	m/d	7	4,670	203,000	3,910	40,300	5,110	256,990
cjdnvk	Vertical hydraulic conductivity	Jordan aquifer	m/d	0	23	0	0	0	46.1	69.1
estlhk	Horizontal hydraulic conductivity	St. Lawrence confining unit	m/d	0	207	9,210	691	1,840	576	12,524
estlvk	Vertical hydraulic conductivity	St. Lawrence confining unit	m/d	0	0	0	0	0	46.1	46.1
k_mult	Conductivity multiplier	Multiplier for horizontal and vertical hydraulic conductivities of stratigraphically lower bedrock hydrogeologic units: Tunnel City aquifer, Wonewoc aquifer, Eau Claire confining unit, and Mount Simon-Hinckley aquifer	unitless	0	0	3,2200	0	0	1,450	33,650

Table 8. Composite sensitivities of observation groups to model parameter groups for the Northeast Metro Lakes Groundwater-Flow model, northeast Twin Cities Metropolitan Area, Minnesota.—Continued[m/d, meter per day; ++, indicates a parameter group was one of the three most sensitive parameter groups for a given observation group; SWB, soil-water-balance; m²/d, square meter per day]

Parameter group	Hydrologic property	Description	Parameter units	Number of observation groups for which a parameter is one of the three most sensitive parameters	Observation group sensitivity				
					Groundwater levels in wells				
					Glacial aquifers	St. Peter aquifer	Prairie du Chien aquifer	Jordan aquifer	St. Lawrence confining unit
rchgm	Recharge	Recharge	m/d	16	0.153++	0.567++	0.917++	0.488++	1.44++
roff	Runoff	Lake specific multiplier for SWB generated runoff	unitless	0	0.00398	0.0114	0.0194	0.0043	0.00999
riv_con	Riverbed conductance	River cells, separate parameters for major rivers, small streams, lakes, and wetlands	m ² /d	10	0.0899++	0.306++	0.399++	0.236	0.655
lak_k	Lakebed leakance multiplier for lakes requiring small (less than 1 order of magnitude) increment changes during model calibration	One parameter for each lake bed zone for each of six lakes modelled with the Lake package	m ² /d	4	0.0336	0.0887	0.121	0.0472	0.318
qhk	Horizontal hydraulic conductivity	Glacial aquifers	m/d	12	0.0782	0.166	0.242	0.288	0.734
qvk	Vertical hydraulic conductivity	Glacial aquifers	m/d	0	0.0146	0.028	0.0461	0.0157	0.0622
qvkd	Vertical hydraulic conductivity of deep sediments	Glacial aquifers	m/d	0	0.0209	0.0474	0.0746	0.0323	0.121
ostphk	Horizontal hydraulic conductivity	St. Peter aquifer	m/d	1	0.0536	0.276	0.299	0.0394	0.0458
ostpvk	Vertical hydraulic conductivity	St. Peter aquifer	m/d	0	0.000538	0.00178	0.00121	0.000236	0.000291
ostpbk	Vertical hydraulic conductivity multiplier for confining part of aquifer	St. Peter aquifer	unitless	0	0.00389	0.0175	0.0452	0.0307	0.0149
opdchk	Horizontal hydraulic conductivity	Prairie du Chien aquifer	m/d	10	0.11++	0.343++	0.75++	0.373++	0.82++
opdevk	Vertical hydraulic conductivity	Prairie du Chien aquifer	m/d	0	0.0044	0.0126	0.0262	0.0122	0.0352
opdebk	Vertical hydraulic conductivity multiplier for confining part of aquifer	Prairie du Chien aquifer	unitless	0	0.0128	0.0366	0.0885	0.143	0.236
cjdnhk	Horizontal hydraulic conductivity	Jordan aquifer	m/d	7	0.0728	0.221	0.398	0.326++	1.01++
cjdnvk	Vertical hydraulic conductivity	Jordan aquifer	m/d	0	0.00159	0.000698	0.00503	0.0076	0.0729
estlhk	Horizontal hydraulic conductivity	St. Lawrence confining unit	m/d	0	0.00384	0.00908	0.0188	0.0176	0.101
estlvk	Vertical hydraulic conductivity	St. Lawrence confining unit	m/d	0	0.000546	0.000368	0.00172	0.00323	0.0549
k_mult	Conductivity multiplier	Multiplier for horizontal and vertical hydraulic conductivities of stratigraphically lower bedrock hydrogeologic units: Tunnel City aquifer, Wonewoc aquifer, Eau Claire confining unit, and Mount Simon-Hinckley aquifer	unitless	0	0.00112	0.00267	0.002	0.00726	0.0159

Table 8. Composite sensitivities of observation groups to model parameter groups for the Northeast Metro Lakes Groundwater-Flow model, northeast Twin Cities Metropolitan Area, Minnesota.—Continued[m/d, meter per day; ++, indicates a parameter group was one of the three most sensitive parameter groups for a given observation group; SWB, soil-water-balance; m²/d, square meter per day]

Parameter group	Hydrologic property	Description	Parameter units	Number of observation groups for which a parameter is one of the three most sensitive parameters	Observation group sensitivity				
					Groundwater levels in wells				
					Tunnel City Group aquifer	Wonewoc aquifer	Eau Claire confining unit	Mount Simon-Hinckley aquifer	Groundwater-level composite sensitivity
rchgm	Recharge	Recharge	m/d	16	0.519++	0.403++	0.507++	0.488	5.482
roff	Runoff	Lake specific multiplier for SWB generated runoff	unitless	0	0.00169	0.00723	0.0155	0.000878	0.074368
riv_con	Riverbed conductance	River cells, separate parameters for major rivers, small streams, lakes, and wetlands	m ² /d	10	0.205	0.365++	0.461	0.532++	3.2489
lak_k	Lakebed leakance multiplier for lakes requiring small (less than 1 order of magnitude) increment changes during model calibration	One parameter for each lake bed zone for each of six lakes modelled with the Lake package	m ² /d	4	0.0113	0.0595	0.041	0.00273	0.72303
qhk	Horizontal hydraulic conductivity	Glacial aquifers	m/d	12	0.235	0.329	0.608++	0.817++	3.4972
qvk	Vertical hydraulic conductivity	Glacial aquifers	m/d	0	0.0197	0.0361	0.0396	0.0355	0.2975
qvkd	Vertical hydraulic conductivity of deep sediments	Glacial aquifers	m/d	0	0.0294	0.0421	0.0382	0.0191	0.425
ostphk	Horizontal hydraulic conductivity	St. Peter aquifer	m/d	1	0.0178	0.0359	0.06	0.00616	0.83366
ostpvk	Vertical hydraulic conductivity	St. Peter aquifer	m/d	0	0.000111	0.000195	0.000238	0.0000712	0.004670
ostpbk	Vertical hydraulic conductivity multiplier for confining part of aquifer	St. Peter aquifer	unitless	0	0.0123	0.0128	0.0114	0.00293	0.15162
opdchk	Horizontal hydraulic conductivity	Prairie du Chien aquifer	m/d	10	0.282++	0.296	0.77++	0.766++	4.51
opdevk	Vertical hydraulic conductivity	Prairie du Chien aquifer	m/d	0	0.0108	0.00934	0.00879	0.0062	0.12573
opdcbk	Vertical hydraulic conductivity multiplier for confining part of aquifer	Prairie du Chien aquifer	unitless	0	0.0838	0.144	0.0296	0.0169	0.7912
cjdnhk	Horizontal hydraulic conductivity	Jordan aquifer	m/d	7	0.237++	0.38++	0.364	0.19	3.1988
cjdnvk	Vertical hydraulic conductivity	Jordan aquifer	m/d	0	0.0448	0.0369	0.00186	0.00153	0.172908
estlhk	Horizontal hydraulic conductivity	St. Lawrence confining unit	m/d	0	0.0676	0.0349	0.0204	0.0637	0.33692
estlvk	Vertical hydraulic conductivity	St. Lawrence confining unit	m/d	0	0.0513	0.0434	0.0233	0.0186	0.197364
k_mult	Conductivity multiplier	Multiplier for horizontal and vertical hydraulic conductivities of stratigraphically lower bedrock hydrogeologic units: Tunnel City aquifer, Wonewoc aquifer, Eau Claire confining unit, and Mount Simon-Hinckley aquifer	unitless	0	0.0479	0.0414	0.0359	0.0309	0.18505