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# Acronyms for HSPF Model Parameters

| | |
|---|---|
| AGWO | Active groundwater outflow from pervious areas |
| AGWRC | Active groundwater recession constant |
| AGWETP | Active groundwater evapotranspiration rate |
| CEPE | Evapotranspiration losses from interception storage |
| DSN | Dataset number |
| FTABLE | Function table used to summarize geometric and hydraulic properties of a RCHRES |
| HRU | Hydrologic response unit |
| IFWO | Interflow outflow from pervious areas |
| IMPLND | Impervious land segment |
| INFILT | Infiltration rate |
| INTFW | Interflow inflow parameter |
| IRC | Interflow recession constant |
| IVOL | Inflow volume to a reach |
| KVARY | Parameter that modifies the linearity of the active groundwater recession constant |
| LZET | Evapotranspiration losses from lower-zone storage |
| LZETP | Lower-zone evapotranspiration parameter |
| LZLI | Lower-zone lateral input |
| LZSN | Lower-zone nominal storage |
| OUTDGT | Time-dependent component of the outflow demand for an individual exit of a reach |
| OVOL | Outflow volume from an individual exit of a reach |
| PERLND | Pervious land segment |
| PERO | Total runoff from pervious areas |
| RCHRES | Reach reservoir |
| SURI | Surface-water runoff from impervious areas |
| SURO | Surface-water runoff from pervious areas |
| UZET | Evapotranspiration losses from upper-zone storage |
| UZSN | Upper-zone nominal storage |
| WDM | Watershed data management file used to store time-series data |
| WDMUtil | A utility program for managing WDM files |

## Overview of HSPF

Streamflow in the Upper Scioto River Basin was simulated with the Hydrologic Simulation Program—Fortran (HSPF), version 12.2 (Bicknell and others, 2005). HSPF was chosen because it is one of the most complete and defensible watershed models for quantifying runoff, it is capable of simulating reservoir operations, and it has been successfully used to study water-management issues in other basins in the Midwest (for example, see Reutter and others, 2006).

HSPF is a process-based computer model that can simulate the hydrology and water quality of a watershed. In this model of the Upper Scioto River Basin, however, only the hydrology component of the HSPF model was used. Runoff is computed by the model as a response to measured climate data that are supplied to the model, along with subbasin characteristics that are represented by various model parameters. In HSPF, a basin is discretized into reaches (RCHRESs), consisting of streams, lakes, or reservoirs. The local drainage associated with each RCHRES is referred to as a "subbasin." These subbasins are represented by a group of hydrologically similar areas, referred to as "hydrologic response units" (HRUs). HSPF computes a water budget (inflows, outflows, and change in storage) for each HRU and RCHRES in the model at each time step. For a complete description of the computation of the water budgets, see the HSPF user's manual (Bicknell and others, 2005).

In this model, HRUs represent areas of similar land use and land cover that are important to producing a similar hydrologic response to climatic input. HRUs are divided into two classes of land segments, pervious-area land segments (PERLNDs) and impervious-area land segments (IMPLNDs). PERLNDs and IMPLNDs are represented by storage-volume zones and processes that move water between these zones. IMPLNDs are simple land segments for which it is assumed that all water that is not evaporated becomes surface runoff. PERLNDs are more complex, with multiple zones representing the movement and storage of water on and below the land surface. Variables that control infiltration rates and changes in storage have to be defined for each PERLND. Surface runoff from PERLNDs and IMPLNDs, as well as subsurface discharge from PERLNDs, are directed into RCHRESs.

RCHRESs represent the streams or reservoirs within each subbasin. The hydraulic characteristics of each RCHRES are supplied to the model through function tables (FTABLEs). FTABLEs define the relation between depth, surface area, storage, and discharge for each RCHRES, which is then used for kinematic wave routing of water from one RCHRES to another.

HSPF simulates several inflows to and outflows from a RCHRES. Surface runoff from IMPLNDs and PERLNDs within a subbasin can discharge to a RCHRES. From PERLND segments, infiltrated water can also be discharged to a RCHRES as either interflow (fast-responding shallow subsurface flow) or as active groundwater discharge (slow-responding base flow). Infiltrated water also can exit the subbasin as deep groundwater flow that discharges outside of the subbasin. Inflow to a RCHRES also occurs in the model as flow from an upstream RCHRES, precipitation directly onto the water surface, or from some other source specified in the model, such as return flow from a wastewater-treatment plant. In HSPF, outflows from a RCHRES can be represented by no more than five outflow exits.

Up to five outflow exits were designated for each RCHRES in the Upper Scioto River Basin model. For each RCHRES, municipal water withdrawals, if present, were assigned to the first outflow exits. These exits were followed by any commercial/industrial withdrawals and finally by outflow to the downstream reach. This convention was not followed for some reaches that contained reservoirs, owing to other special needs.

# Time-Series Data Used as Input to the Model

HSPF uses a binary, direct-access file called a Watershed Data Management (WDM) file as a data source for input of time-series data (precipitation, temperature, potential evapotranspiration, withdrawals, and return flows) required for simulations. WDM files can also store output time series generated by the model, or outputs can optionally be written to text-based files. Two separate WDM files were used for input to the model. The first WDM file contained all the withdrawal and return-flow time-series data, and the second contained all the climatic data.

The individual time series are referenced in the model and the WDM files by dataset numbers (DSNs). DSNs in the withdrawal and return-flow WDM file were numbered by RCHRES, using the first number of its two-digit DSN or the first two numbers of its three-digit DSN followed by a sequence number (for example, DSN 453 was the third time series for RCHRES 45). RCHRES DNSs for time series with sequence numbers greater than nine were numbered with a four-digit DSN starting with 5 followed by a two-digit RCHRES number and the last digit of the two-digit sequence number (for example, DSN 5020 corresponds to the 10th time series for reach 2 and DSN 5391 corresponds to the 11th time series for reach 39).

DSN numbers ranging from 1 to 14 were used in climate-data WDM file. Precipitation time series were stored in DSNs 1–10. Air temperature and potential evapotranspiration time series were stored in DSNs 11–14. The sources and methods used for climate, withdrawal, and return-flow time series are described in the following sections.

## Climate

Hourly precipitation data from January 1, 1989, to December 31, 2010, for the following 10 National Oceanic and Atmospheric Administration (NOAA) climate stations were used as input to the HSPF model: Centerburg 2 SE (NOAA station no. OH331404), Circleville (OH331592), Columbus WSO AP[1] (OH331786), Deer Creek Lake (OH332090), Delaware Lake (OH332124), Galion Wtr Wks (OH333021), Kenton (OH334189), Lancaster (OH334403), Marion 2 N[2] (OH334942), and Marysville (OH334979) (fig. A1). These climate stations provided acceptable coverage of basinwide rainfall conditions. Missing precipitation data were estimated on the basis of data from nearby climate stations. Table A1 shows the percentage of the precipitation record that was missing, the longest continuous interval of missing data, and the station numbers of climate stations used to estimate the missing data. Although every effort was made to provide reasonable substitutes for missing climate data, the substituted data may deviate somewhat from the true, but unknown, climate time series. The extent to which those deviations affected the computed hydrology is unknown and contributes to calibration/validation error and uncertainty in model results.

Hourly temperature data from January 1, 1989, to December 31, 2010, from the Columbus WSO AP (Weather Bureau Army Navy [WBAN] station no. 14821) and Marion 2 N (04855) stations were used as input to the HSPF model (fig. A1). Missing data for the Columbus WSO AP were estimated by calculating the mean of the measured values bracketing the missing interval. Missing data at Marion 2 N were filled in with temperature data from the Mansfield Lahm (14891) station. These values were adjusted to account for change in elevation between the two stations.

Hourly potential evapotranspiration (PET) values were computed as a function of daily minimum and maximum air temperatures and latitude of the climate station by using the Hamon PET method (Hamon, 1961). Computations were done with the WDMUtil (Hummel and others, 2001) (http://aquaterra.com/basins4/GenScnWDMUtilWinHSPF_2011_09_10.exx, accessed July 2, 2012) or version 2013-09-13 of the San Antonio River Authority (SARA) times-series utilities (http://www.aquaterra.com/resources/downloads/saratsutility.php, accessed September 24, 2013). The utilities first compute daily PET and then disaggregate the daily value to hourly values.

[1] Also called Columbus Intl AP.

[2] Also called Marion Municipal AP.

HSPF requires precipitation and PET data as input to effectively drive the hydrology of the watershed; actual evapotranspiration (AET) is calculated by the model, using the inputs for potential and ambient soil-moisture conditions (Duda and others, 2012). Changes in soil-moisture storages and vegetation characteristics affect AET by making more or less moisture available to evaporate or transpire (which in turn has a major impact on percolation) and ultimately are important in obtaining an annual water balance. The relatively simplistic methods used in this study to estimate PET and AET are subject to the criticisms described by Markstrom and others (2012) in their discussion of evapotranspiration and contribute to uncertainty in model results. Although those criticisms may be valid, the data required to perform more accurate simulations of PET and AET do not exist and cannot be practically estimated.

**Table A1.** Climate stations used to supply precipitation data in the HSPF model of the Upper Scioto River Basin, Ohio.

[NOAA, National Oceanic and Atmospheric Administration]

| Station name | Station number | Percentage of precipitation data missing | Longest continuous period of missing data | NOAA station number(s) used to fill missing data |
|---|---|---|---|---|
| Centerburg 2 SE | OH331404 | 11.0% | 228 days | OH331786, OH332124, OH332956 |
| Circleville | OH331592 | 32.0% | 4.2 years | OH331786, OH332090, OH332124, OH334403 |
| Columbus WSO AP | OH331786 | 0.4% | 31 days | OH332124 |
| Deer Creek Lake | OH332090 | 26.1% | 1.4 years | OH331592, OH331786, OH332124, OH334403 |
| Delaware Lake | OH332124 | 16.4% | 150 days | OH331404, OH331786, OH334942, OH334979 |
| Galion Wtr Wks | OH333021 | 35.8% | 1.3 years | OH331404, OH331786, OH332124, OH334865, OH334942, OH338539 |
| Kenton | OH334189 | 45.6% | 3.8 years | OH331404, OH331786, OH332124, OH333021, OH334942, OH334979, OH338539, OH338552 |
| Lancaster | OH334403 | 22.8% | 290 days | OH331592, OH331786, OH332090, OH332124 |
| Marion 2 N | OH334942 | 25.4% | 3.2 years | OH331404, OH331786, OH332124, OH333021, OH334189, OH334865, OH334979, OH338539 |
| Marysville | OH334979 | 23.4% | 243 days | OH331404, OH331786, OH332090, OH332124, OH333021, OH334189, OH334942, OH338552 |

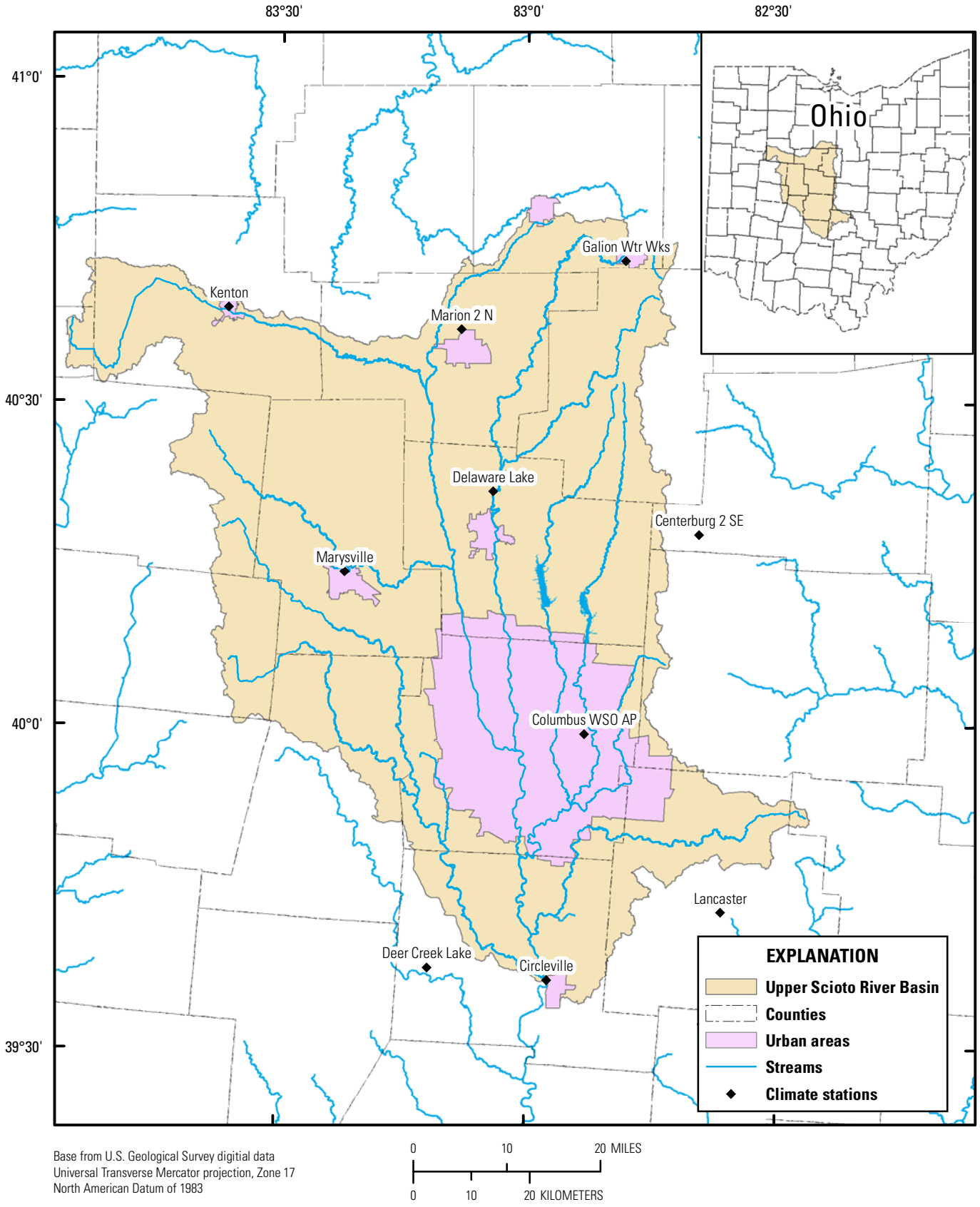


**Figure A1.** Locations of climate stations used in the HSPF model of the Upper Scioto River Basin, Ohio.

## Water Withdrawals

Surface-water withdrawals in this model were simulated for public water supply, agricultural/commercial/industrial use, and golf courses. Groundwater withdrawals are not directly accounted for in the model except in one instance where information was available to estimate the effective surface-water withdrawal associated with a groundwater withdrawal. Time series of monthly withdrawals were obtained from Ohio Department of Natural Resources (ODNR) Water Withdrawal Facilities Registration Program for the period 1990–2010 (Mike Hallfrisch, Ohio Department of Natural Resources, unpub. data, 2012). The time series provided by ODNR were in units of million gallons per day (Mgal/d) and were converted to cubic feet per second ($ft^3/s$). These monthly values were then disaggregated into daily values by assuming a constant rate of withdrawal. Daily values were then disaggregated into hourly values by assuming a constant rate of withdrawal for all withdrawals other than golf courses and agricultural withdrawals, which were disaggregated to have all the withdrawals only between the hours of 7:00 p.m. and 6:00 a.m. (when it was assumed that irrigation would occur).

A total of 84 surface-water withdrawal time series were used in the model (fig. A2). Surface-water withdrawals were simulated for public water supplies at 15 sites (table A2) and two additional surface-water withdrawals were estimated from the groundwater-withdrawal record for the Columbus City PWS Parsons Ave Plant in order to account for the effective withdrawal of surface water due to induced infiltration. For this time series, it was assumed that 15 percent of the groundwater pumped at the Parsons Avenue Plant came from surface-water sources. The 15-percent number was chosen on the basis of the range of infiltration percentages discussed in Childress and others (1991). Of that 15 percent, 75 percent was assumed to come from the Scioto River (because three of the four pumps were in its basin), and 25 percent was assumed to come from Big Walnut Creek (because one of the four pumps was in its basin). No other groundwater withdrawals were directly simulated in the model.

Nine surface-water withdrawals were simulated for industrial, commercial, or electric power generation use. Three surface-water withdrawals were simulated for managed wetlands or nature areas. If a subbasin contained more than one agricultural or landscaping withdrawal, those withdrawals were combined into a single time series in the model. Nineteen surface-water withdrawals were simulated for agricultural/landscaping use and were represented in the model by 11 withdrawal time series. If a subbasin contained more than one golf course withdrawal, those withdrawals were summed into a single time series in the model. Thirty-six surface-water withdrawals were simulated for golf course use and were represented in the model by 20 time series.

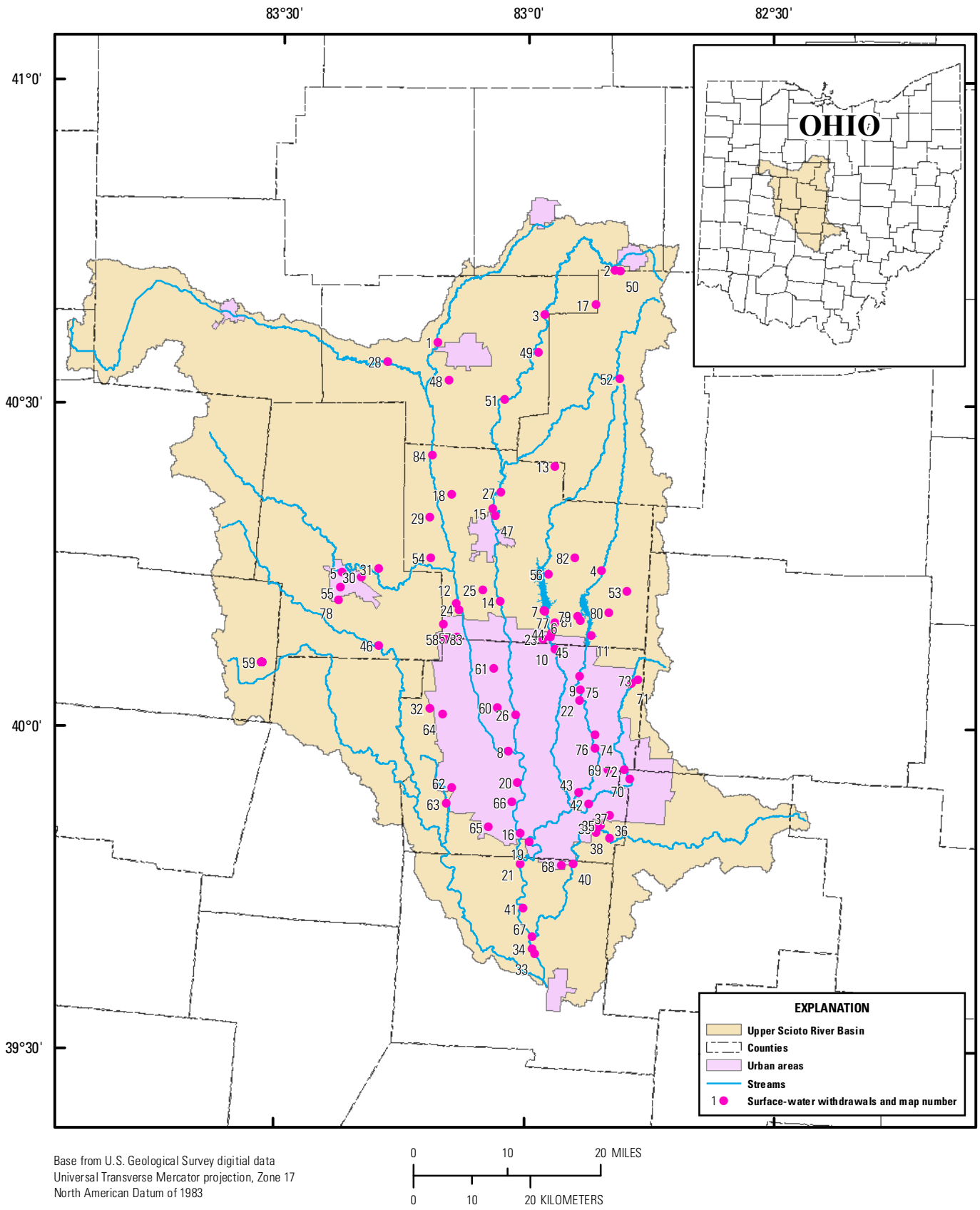


**Figure A2.** Surface-water withdrawal locations used in the HSPF model of the Upper Scioto River Basin, Ohio. (Map numbers are identified in table A2)

**Table A2. Surface-water withdrawals used in the HSPF model of the Upper Scioto River Basin, Ohio.**

[Map number, corresponds to numbers used in figure A2; DSN, dataset number used in HSPF model; ODNR, Ohio Department of Natural Resources; $ft^3/s$, cubic feet per second; na, not applicable]

| Map number | DSN | RCHRES number | ODNR facility registration number | ODNR facility identifier | Average 1990–2010 withdrawal rate ($ft^3/s$) | Maximum 1990–2010 withdrawal rate ($ft^3/s$) |
|---|---|---|---|---|---|---|
| | | | | Public water supply | | |
| 1 | 12 | 1 | 00605 | OAWC PWS - Marion | 5.86 | 8.83 |
| 2 | 22 | 2 | 01690 | Galion City PWS | 1.81 | 2.30 |
| 3 | 23 | 2 | 00607 | OAWC PWS - Caledonia | 0.093 | 0.127 |
| 4 | 62 | 6 | 00545 | Sunbury Village PWS | 0.642 | 1.91 |
| 5 | 72 | 7 | 00774 | Marysville City PWS | 1.70 | 18.9 |
| 6 | 92 | 9 | 00421 | Del-Co Water Company PWS - Alum Creek | 6.26 | 12.8 |
| 7 | 93 | 9 | 00785 | Columbus City PWS - Alum Creek Pump Station | 60.6 | 108 |
| 8 | 152 | 15 | 00788 | Columbus City PWS - Dublin Rd Plant | 81.607 | 114 |
| 9 | 332 | 33 | 00791 | Columbus City PWS - Hap Cremean Plant | 118 | 163 |
| 10 | 342 | 34 | 00032 | Westerville City PWS | 5.69 | 9.52 |
| 11 | 382 | 38 | 00446 | Lake of the Woods Water Company | 0.068 | 0.135 |
| 12 | 392 | 39 | 00135 | Scioto Village Riverview Complex | 0.104 | 0.181 |
| 13 | 402 | 40 | 00329 | Ashley Village PWS | 0.202 | 0.449 |
| 14 | 482 | 48 | 00420 | Del-Co Water Company PWS - Olentangy | 4.93 | 41.4 |
| 15 | 483 | 48 | 00432 | Delaware City PWS | 4.65 | 6.42 |
| 16 | 203 | 20 | 00790 | Columbus City PWS - Parsons Ave Plant; this is the SW-induced portion from Big Walnut Creek | 1.05 | 1.63 |
| 16 | 214 | 21 | 00790 | Columbus City PWS - Parsons Ave Plant; this is the SW-induced portion from Scioto River | 3.16 | 4.9 |
| | | | | Industrial/Construction/Commercial/Electric | | |
| 17 | 25 | 2 | 00902 | Glen Gery-Iberia | 0.026 | 0.043 |
| 18 | 52 | 5 | 00057 | National Lime & Stone - Radnor Plant | 0.237 | 0.309 |
| 19 | 202 | 20 | 01421 | Shelly Materials - Lockbourne Plant | 2.24 | 3.81 |
| 20 | 213 | 21 | 02092 | COE - Harmon Ave Pump Station | 1.33 | 1.78 |
| 21 | 292 | 29 | 00676 | CSP - Pickaway Electric Generation Station | 74.6 | 150 |
| 22 | 335 | 33 | 01931 | Dewatering - Columbus City (Stygler Rd) | 0.113 | 0.371 |
| 23 | 345 | 34 | 01907 | Banc One - Corporate Center | 0.089 | 0.219 |
| 24 | 394 | 39 | 01423 | Shelly Materials - Shawnee | 4.32 | 8.92 |
| 25 | 484 | 48 | 01553 | Land Tech Supply | 0.062 | 0.087 |
| | | | | Managed Wetlands/Nature Areas | | |
| 26 | 142 | 14 | 01764 | The Ohio State University - Olentangy River Wetland | 0.851 | 2.87 |
| 27 | 432 | 43 | 00765 | Delaware Wildlife Area | 1.46 | 3.43 |
| 28 | 452 | 45 | 00766 | Big Island Wildlife Area | 1.67 | 5.54 |
| | | | | Agricultural/Landscaping | | |
| 29 | 53 | 5 | 00846 | Delwood Nursery | 0.017 | 0.044 |
| | 74 | 7 | Agriculture (00331 + 01299) | Paul Florence Turfgrass + Greensward Landscaping | 0.226 | 0.898 |
| 30 | 74 | 7 | 00331 | Paul Florence Turfgrass | 0.230 | 0.898 |
| 31 | 74 | 7 | 01299 | Greensward Landscaping | 0.006 | 0.011 |

**Table A2. Surface-water withdrawals used in the HSPF model of the Upper Scioto River Basin, Ohio.—Continued**

[Map number, corresponds to numbers used in figure A2; DSN, dataset number used in HSPF model; ODNR, Ohio Department of Natural Resources; $ft^3/s$, cubic feet per second; na, not applicable]

| Map number | DSN | RCHRES number | ODNR facility registration number | ODNR facility identifier | Average 1990–2010 withdrawal rate ($ft^3/s$) | Maximum 1990–2010 withdrawal rate ($ft^3/s$) |
|---|---|---|---|---|---|---|
| | | | | Agricultural/Landscaping—continued | | |
| 32 | 173 | 17 | 02295 | Willoway Columbus WDC | 0.167 | 0.225 |
| | 242 | 24 | Agriculture (01957 + 02078) | Scherer Farm + Lamb's Farm | 0.732 | 2.94 |
| 33 | 242 | 24 | 01957 | Scherer Farm | 0.649 | 2.94 |
| 34 | 242 | 24 | 02078 | Lamb's Farm | 0.252 | 0.542 |
| | 263 | 26 | Agriculture (00804 + 01014 + 01560 + 01561 + 01562 + 01652) | Decker Nursery + Schacht Farm -1 + Eastside Nursery - 1 + Eastside Nursery - 2 + Eastside Nursery - 3 + Kizer Farm | 0.193 | 1.89 |
| 35 | 263 | 26 | 00804 | Decker Nursery | 0.173 | 0.449 |
| 36 | 263 | 26 | 01014 | Schacht Farm - 1 | 0.099 | 0.514 |
| 37 | 263 | 26 | 01560 | Eastside Nursery - 1 | 0.085 | 0.908 |
| 38 | 263 | 26 | 01561 | Eastside Nursery - 2 | 0.829 | 0.829 |
| 39 | 263 | 26 | 01562 | Eastside Nursery - 3 | 0.039 | 0.061 |
| 40 | 263 | 26 | 01652 | Kizer Farm | 0.002 | 0.003 |
| 41 | 282 | 28 | 00613 | Columbus Turf Nursery | 1.151 | 4.14 |
| 42 | 323 | 32 | 01564 | Eastside Nursey - 5 | 1.04 | 3.37 |
| 43 | 334 | 33 | 01555 | Greenscapes Landscape | 0.023 | 0.052 |
| | 344 | 34 | Agriculture (00735 + 01644) | Acorn Farms + Yarnell's Farm Market | 0.602 | 1.62 |
| 44 | 344 | 34 | 00735 | Acorn Farms | 0.601 | 1.62 |
| 45 | 344 | 34 | 01644 | Yarnell's Farm Market | 0.057 | 0.057 |
| 46 | 373 | 37 | 02161 | Gingerich Farm | 0.178 | 0.479 |
| 47 | 485 | 48 | 00309 | Case Farms | 0.291 | 0.565 |
| | | | | Golf courses | | |
| 48 | 13 | 1 | 01707 | Marion Country Club | 0.130 | 0.404 |
| | 24 | 2 | Golf courses (00467 + 00903) | Whetstone Country Club + Galion Country Club | 0.160 | 0.605 |
| 49 | 24 | 2 | | Whetstone Country Club | 0.055 | 0.144 |
| 50 | 24 | 2 | | Galion Country Club | 0.129 | 0.523 |
| 51 | 32 | 3 | 01759 | King's Mill Golf Course | 0.249 | 0.639 |
| 52 | 42 | 4 | 01440 | Pine Lakes Golf Course | 0.277 | 0.464 |
| 53 | 63 | 6 | 02071 | Rattlesnake Ridge Golf Club | 0.114 | 0.259 |
| | 73 | 7 | Golf courses (00330 + 01732) | Mill Creek Golf Course + Timberview Golf Club | 0.133 | 0.275 |
| 54 | 73 | 7 | 00330 | Mill Creek Golf Course | 0.046 | 0.083 |
| 55 | 73 | 7 | 01732 | Timberview Golf Club | 0.117 | 0.210 |
| 56 | 94 | 9 | 01686 | Double Eagle Club | 0.639 | 6.93 |
| | 112 | 11 | Golf courses (00615 + 01611 | Muirfield Village Golf Club + Riviera Country Club | 0.064 | 0.473 |

**Table A2. Surface-water withdrawals used in the HSPF model of the Upper Scioto River Basin, Ohio.—Continued**

[Map number, corresponds to numbers used in figure A2; DSN, dataset number used in HSPF model; ODNR, Ohio Department of Natural Resources; $ft^3/s$, cubic feet per second; na, not applicable]

| Map number | DSN | RCHRES number | ODNR facility registration number | ODNR facility identifier | Average 1990–2010 withdrawal rate ($ft^3/s$) | Maximum 1990–2010 withdrawal rate ($ft^3/s$) |
|---|---|---|---|---|---|---|
| | | | | Golf courses—continued | | |
| 57 | 112 | 11 | 00615 | Muirfield Village Golf Club | 0.035 | 0.230 |
| 58 | 112 | 11 | 01611 | Riviera Country Club | 0.141 | 0.345 |
| 59 | 122 | 12 | 00354 | Indian Springs Golf Club | 0.239 | 1.24 |
| | 143 | 14 | Golf courses (00557 + 01252) | The Ohio State University Golf Course + Brookside Golf & Country Club | 0.584 | 1.56 |
| 60 | 143 | 14 | 00557 | The Ohio State University - Golf Course | 0.462 | 1.25 |
| 61 | 143 | 14 | 01252 | Brookslide Golf & Country Club | 0.196 | 0.382 |
| | 172 | 17 | Golf courses (00031 + 01443 + 01813) | Bolton Field Golf Course + Oakhurst Country Club + Heritage Golf Club | 0.318 | 1.03 |
| 62 | 172 | 17 | 00031 | Bolton Field Golf Course | 0.074 | 0.119 |
| 63 | 172 | 17 | 01443 | Oakhurst Country Club | 0.302 | 0.619 |
| 64 | 172 | 17 | 01813 | Heritage Golf Club | 0.221 | 0.699 |
| | 212 | 21 | Golf courses (01088 + 02050) | Grovebrook Golf Club + Phoenix Golf Course | 0.312 | 1.36 |
| 65 | 212 | 21 | 01088 | Grovebrook Golf Club | 0.110 | 0.240 |
| 66 | 212 | 21 | 02050 | Phoenix Golf Course | 0.401 | 1.16 |
| 67 | 252 | 25 | 01670 | Cooks Creek Golf Club | 0.076 | 0.146 |
| 68 | 262 | 26 | 02054 | Rickenbacker Golf Club | 0.172 | 0.304 |
| | 322 | 32 | Golf courses (00434 + 00535+ 00748 + 00891 + 01660) | Walnut Hills Golf Course + Turnberry Golf Course + The New Albany Golf Club + Blacklick Woods Golf Club + Winding Hollow Country Club | 0.367 | 1.43 |
| 69 | 322 | 32 | 00434 | Walnut Hills Golf Course | 0.055 | 0.273 |
| 70 | 322 | 32 | 00535 | Turnberry Golf Course | 0.105 | 0.552 |
| 71 | 322 | 32 | 00748 | The New Albany Golf Club | 0.159 | 0.774 |
| 72 | 322 | 32 | 00891 | Blacklick Woods Golf Course | 0.055 | 0.287 |
| 73 | 322 | 32 | | Winding Hollow Country Club | 0.114 | 0.463 |
| | 333 | 33 | Golf courses (00636 + 00643 + 01408) | Airport Golf Course + Little Turtle Golf Club + Columbus Country Club | 0.392 | 1.25 |
| 74 | 333 | 33 | 00636 | Airport Golf Course | 0.204 | 0.649 |
| 75 | 333 | 33 | 00643 | Little Turtle Golf Club | 0.100 | 0.301 |
| 76 | 333 | 33 | 01408 | Columbus Country Club | 0.163 | 0.714 |
| 77 | 343 | 34 | 01339 | Lakes Golf & Country Club | 0.082 | 0.115 |
| 78 | 372 | 37 | 00801 | Marysville Golf Club | 0.182 | 0.429 |
| | 383 | 38 | Golf courses (00771 + 01334 + 01754 + 02108) | Arrowhead Lakes Golf Club + Royal American Golf Links + The Medallion Golf Club + Bent Tree Golf Club | 0.334 | 1.20 |
| 79 | 383 | 38 | 00771 | Arrowhead Lakes Golf Club | 0.031 | 0.136 |

**Table A2. Surface-water withdrawals used in the HSPF model of the Upper Scioto River Basin, Ohio.—Continued**

[Map number, corresponds to numbers used in figure A2; DSN, dataset number used in HSPF model; ODNR, Ohio Department of Natural Resources; $ft^3/s$, cubic feet per second; na, not applicable]

| Map number | DSN | RCHRES number | ODNR facility registration number | ODNR facility identifier | Average 1990–2010 withdrawal rate ($ft^3/s$) | Maximum 1990–2010 withdrawal rate ($ft^3/s$) |
|---|---|---|---|---|---|---|
| | | | | Golf courses—continued | | |
| 80 | 383 | 38 | 01334 | Royal American Golf Links | 0.101 | 0.619 |
| 81 | 383 | 38 | 01754 | The Medallion Club | 0.232 | 0.918 |
| 82 | 383 | 38 | 02108 | Bent Tree Golf Club | 0.102 | 0.431 |
| 83 | 393 | 39 | 00816 | Twin Oaks Golf Course | 0.035 | 0.052 |
| | | | | Miscellaneous | | |
| 84 | na | 45 | na | Columbus Upground Reservoir(s) | na | na |

## Return Flows

Return-flow data were obtained from two separate sources: return flows from water-withdrawal facilities registered in the ODNR Water Withdrawal Facilities Registration Program (Mike Hallfrisch, Ohio Department of Natural Resources, unpub. data, 2012) and wastewater-treatment plant (WWTP) return flows from the Ohio Environmental Protection Agency (OEPA National Pollutant Discharge Elimination System [NPDES]).

Monthly return-flow time series, from ODNR Water Withdrawal Facilities Registration Program for 1990–2010, were provided in units of million gallons per day and were converted to acre-feet per hour. These monthly values were then disaggregated into hourly values by assuming a constant rate of return. Table A3 and fig. A3 show the non-WWTP return flows included in the model.

**Table A3.** Surface-water return flows, excluding wastewater-treatment plants, used in the HSPF model of the Upper Scioto River Basin, Ohio.

[Map number, corresponds to numbers used in figure A4; DSN, dataset number used in HSPF model; ODNR, Ohio Department of Natural Resources; $ft^3/s$, cubic feet per second]

| Map number | DSN | RCHRES number | ODNR facility registration number | ODNR facility identifier | Average 1990–2010 return rate ($ft^3/s$) | Maximum 1990–2010 return rate ($ft^3/s$) |
|---|---|---|---|---|---|---|
| 1 | 113 | 11 | 00615 | Muirfield Village Golf Club | 0.013 | 0.013 |
| 2 | 114 | 11 | 01611 | Riviera Country Club | 0.011 | 0.026 |
| 3 | 123 | 12 | 00354 | Indian Springs Golf Club | 0.254 | 0.439 |
| 4 | 144 | 14 | 01252 | Brookside Golf & Country Club | 0.026 | 0.084 |
| 5 | 145 | 14 | 01764 | The Ohio State University - Olentangy River Wetland | 0.812 | 3.07 |
| 6 | 204 | 20 | 01421 | Shelly Materials - Lockbourne | 3.39 | 5.55 |
| 7 | 215 | 21 | 02092 | COE - Harmon Ave Pump Station | 1.86 | 2.52 |
| 8 | 264 | 26 | 01560 | Eastside Nursery - 1 | 0.026 | 0.043 |
| 9 | 265 | 26 | 01562 | Eastside Nursery - 3 | 0.020 | 0.026 |
| 10 | 283 | 28 | 00613 | Columbus Turf Nursery | 10.0 | 22.9 |
| 11 | 293 | 29 | 00676 | CSP - Picway Electric Generating Station | 74.7 | 150 |
| 12 | 324 | 32 | 00535 | Turnberry Golf Course | 0.092 | 0.175 |
| 13 | 325 | 32 | 00891 | Blacklick Woods Golf Course | 0.053 | 0.287 |
| 14 | 336 | 33 | 01555 | Greenscapes Landscape | 0.006 | 0.012 |
| 15 | 374 | 37 | 00801 | Marysville Golf Club | 0.163 | 0.392 |
| 16 | 395 | 39 | 00816 | Twin Oaks Golf Course | 0.012 | 0.012 |
| 17 | 396 | 39 | 01423 | Shelly Materials - Shawnee | 2.51 | 6.25 |
| 18 | 433 | 43 | 00765 | Delaware Wildlife Area | 1.28 | 3.67 |
| 19 | 453 | 45 | 00766 | Big Island Wildlife Area | 1.77 | 4.67 |

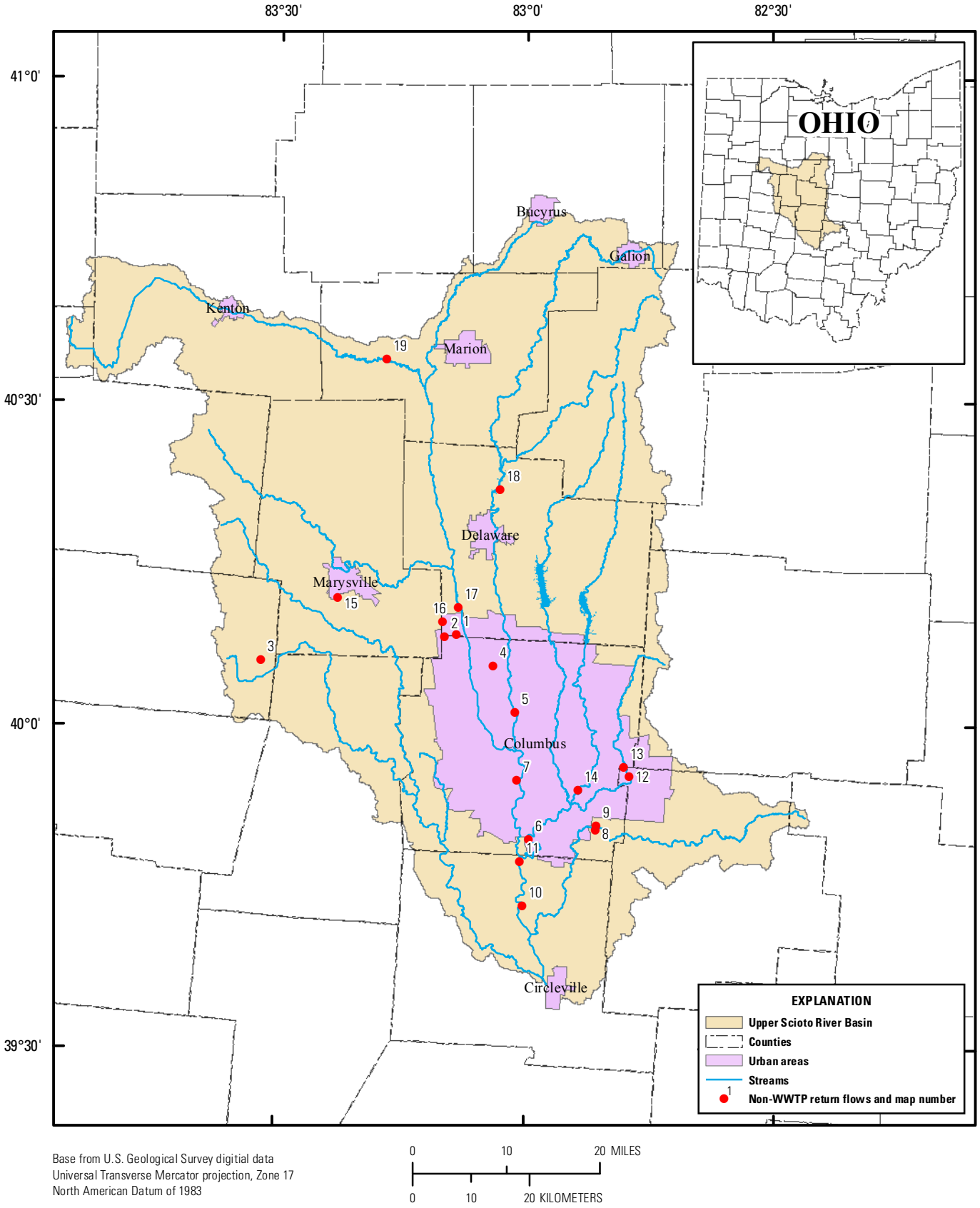


**Figure A3.** Locations of non-wastewater-treatment-plant (non-WWTP) return flows used in the HSPF model of the Upper Scioto River Basin, Ohio. (Map numbers are identified in table A3.)

WWTP discharge time series from OEPA NPDES data were provided as daily values in units of million gallons per day and were converted to acre-feet per hour. These daily values were then disaggregated into hourly values by assuming a constant flow rate. Only WWTPs that are designated as major facilities by NPDES were included in the model. A major facility has either a design flow of greater than 1 Mgal/d (1.547 $ft^3/s$) or an EPA/State approved industrial pretreatment program (U.S. Environmental Protection Agency [USEPA], 2013). Table A4 lists all the WWTPs included in the model. Note that table A4 reports average and maximum return flows, which may be smaller than the WWTP design flows.

**Table A4.** Wastewater-treatment-plant return flows used in the HSPF model of the Upper Scioto River Basin, Ohio.

[Map number corresponds to numbers used in figure A2; DSN is dataset number used in HSPF model; EPA, Environmental Protection Agency; $ft^3/s$, cubic feet per second

| Map number | DSN | RCHRES number | Ohio EPA identifier | Average 1990–2010 WWTP return rate ($ft^3/s$) | Maximum 1990–2010 WWTP return rate ($ft^3/s$) |
|---|---|---|---|---|---|
| 1 | 14 | 1 | Marion WPC | 14.4 | 126 |
| 2 | 26 | 2 | Galion WWTP | 4.17 | 18.6 |
| 3 | 33 | 3 | SD No 7 Water Reclamation Plant | 1.70 | 8.97 |
| 4 | 75 | 7 | Marysville WWTP | 5.71 | 26.3 |
| 5 | 76 | 7 | Marysville WRF | 4.40 | 14.8 |
| 6 | 162 | 16 | Jackson Pike WWTP | 115 | 333 |
| 7 | 216 | 21 | Columbus Southerly WWTP | 147 | 721 |
| 8 | 253 | 25 | Aleris Rolled Products Inc | 0.023 | 0.439 |
| 9 | 266 | 26 | Canal Winchester WWTP | 1.10 | 7.04 |
| 10 | 272 | 27 | Ohio Paperboard Corp | 0.932 | 2.54 |
| 11 | 273 | 27 | Pickerington WWTP | 1.67 | 7.14 |
| 12 | 312 | 31 | Pickaway Correctional Institute | 1.84 | 6.82 |
| 13 | 326 | 32 | Tussing Rd Water Reclamation Facility | 2.14 | 9.99 |
| 14 | 327 | 32 | Ohio American Water Company Blacklick Estates WWTP | 1.54 | 6.73 |
| 15 | 346 | 34 | Alum Creek WWTP | 5.64 | 14.9 |
| 16 | 362 | 36 | Olentangy Environmental Control | 4.14 | 20.2 |
| 17 | 462 | 46 | Kenton WWTP | 2.95 | 40.0 |
| 18 | 463 | 46 | Durez Corp | 0.612 | 3.2 |
| 19 | 486 | 48 | Upper Olentangy Water Reclamation Center | 5.98 | 30.1 |

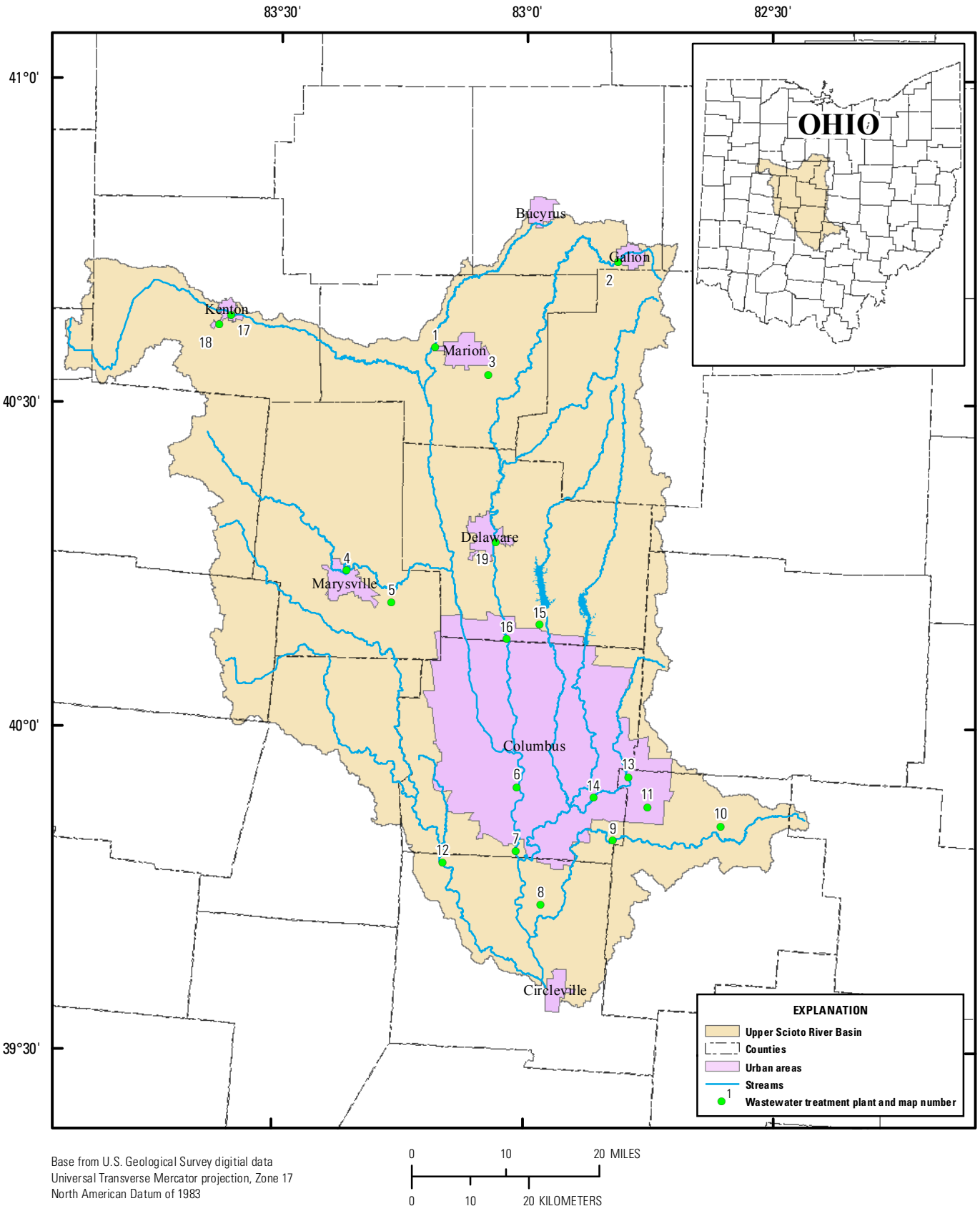


**Figure A4.** Locations of wastewater-treatment plants whose return flows were simulated in the HSPF model of the Upper Scioto River Basin, Ohio. (Map numbers are identified in table A4)

## Streamflow

Streamflow simulations were calibrated with and validated to daily measured streamflow data from 18 USGS continuous-record streamgages (fig. A5; table A5). The periods of record for streamgages in the Upper Scioto River Basin were not all the same. Given the different periods of record for each streamgage, calibration and validation periods were varied between reaches to maximize the use of measured streamflow record. In the calibration process, measured streamflow records were used as the upstream boundary condition whenever possible, the intent being that doing so would provide the most accurate model parameterization for the intervening drainage. If streamflow data for a given streamgage were available for the period 1989–2010[3], then the model was run for that entire period but model calibration was based only on results from the 12-year period 1991–2002, and the validation statistics were computed for the 8-year period 2003–2010. However, if streamflow data were not available for a streamgage for the entire 1989–2010 period, then the calibration and validation statistics were based on shorter periods. The minimum number of years used for calibration was 6 years, and the minimum number of years used to compute validation statistics was 8 years. Table A5 shows the calibration and validation periods (if applicable) for each USGS streamgage used in calibration of the model. The combined longest calibration/validation period extending from 1991 to 2010 will be referred to as the "reference period" in subsequent discussions.

[3] Hydrologic simulations for 1989 accounted for climatic variations but did not account for water uses. Simulations were started in 1989 to help establish a watershed water balance.

**Table A5.** USGS continuous-record streamgages used for calibration and (or) validation in the HSPF model of the Upper Scioto River Basin, Ohio.

[USGS, U.S. Geological Survey; n/a, not applicable]

| RCHRES number | USGS streamgage number | USGS streamgage name | Calibration period | Validation period |
|---|---|---|---|---|
| 2 | 03223000 | Olentangy River at Claridon | 1991–1998 | n/a |
| 6 | 03228300 | Big Walnut Creek at Sunbury | 1991–2002 | 2003–2010 |
| 7 | 03220000 | Mill Creek at Bellepoint | 1991–2002 | 2003–2010 |
| 8 | 03221000 | Scioto River below O'Shaughnessy Dam near Dublin | 1991–2002 | 2003–2010 |
| 10 | 03228805 | Alum Creek at Africa | 1991–1998 | n/a |
| 12 | 03230310 | Little Darby Creek at West Jefferson | 1992–2005 | n/a |
| 13 | 03228500 | Big Walnut Creek at Central College | 1991–2002 | 2003–2010 |
| 16 | 03227500 | Scioto River at Columbus | 1997–2005 | 2006–2010 |
| 26 | 03229796 | Walnut Creek at Ashville | 2005–2010 | n/a |
| 29 | 03229610 | Scioto River near Commercial Point | 2005–2010 | n/a |
| 30 | 03229500 | Big Walnut Creek at Rees | 1991–2002 | 2003–2010 |
| 31 | 03230500 | Big Darby Creek at Darbyville | 1991–2002 | 2003–2010 |
| 34 | 03229000 | Alum Creek at Columbus | 1991–1998 | n/a |
| 36 | 03226800 | Olentangy River near Worthington | 1996–2005 | 2006–2010 |
| 40 | 03228750 | Alum Creek near Kilbourne | 2000–2010 | n/a |
| 42 | 03225500 | Olentangy River near Delaware | 1996–2005 | 2006–2010 |
| 44 | 03223425 | Whetstone Creek at Mt. Gilead | 1996–2010 | n/a |
| 45 | 03219500 | Scioto River at Prospect | 1991–2002 | 2003–2010 |

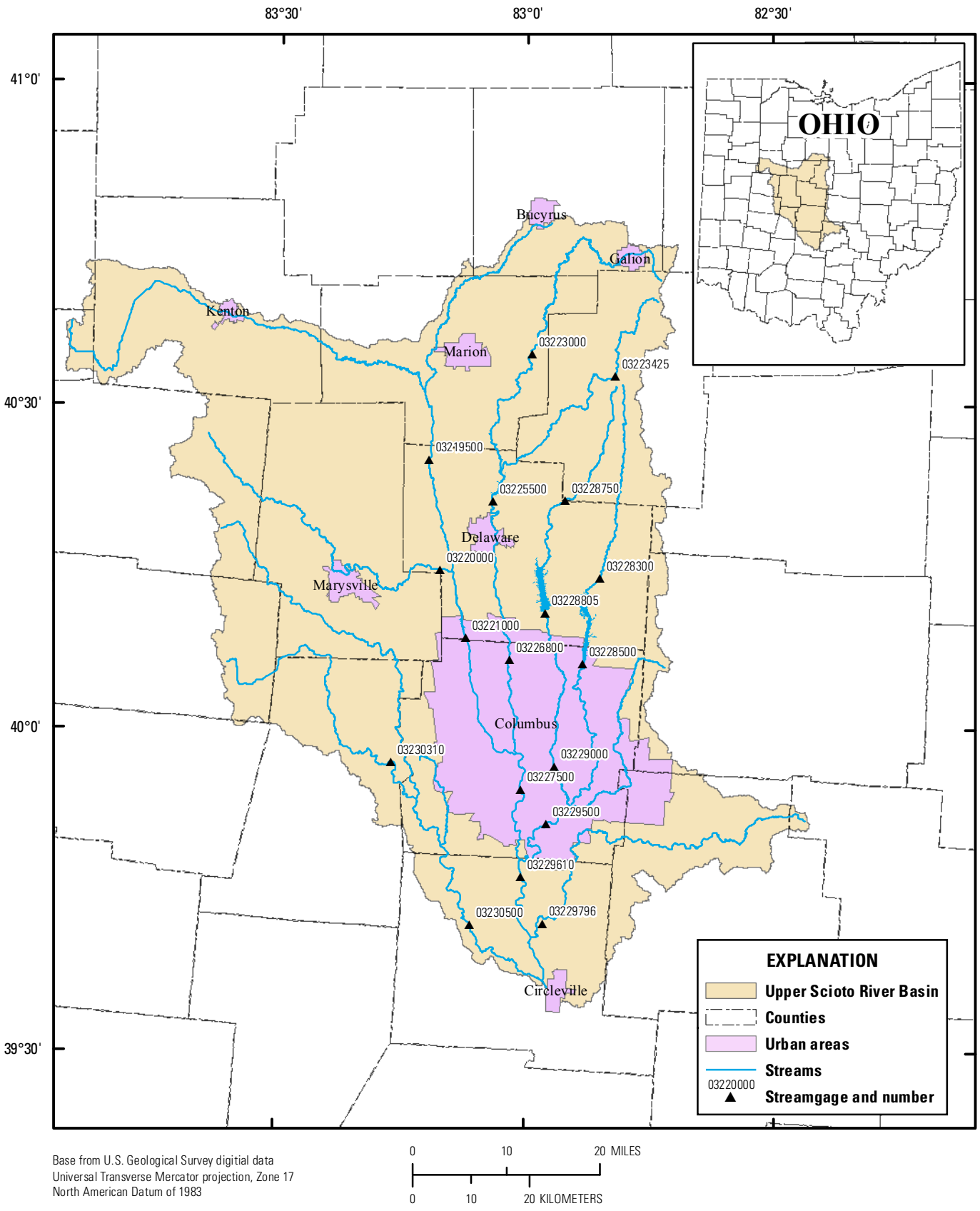


**Figure A5.** Locations of USGS continuous-record streamgages used for calibration and (or) validation in the HSPF model of the Upper Scioto River Basin, Ohio.

# Representation of the Basin

Discretization of the Upper Scioto River Basin—the process of defining HRUs, linkage of HRUs to reaches, and linkage of reaches to one another—was based on a variety of geographic-information system (GIS) layers. The GIS data used in the discretization include digital elevation model (DEM) data obtained from the USGS 300-meter-resolution, 1-degree DEM (USEPA, 2007), and 30-meter spatial resolution land-cover data obtained from the 2006 National Land Cover Database (NLCD) (Fry and others, 2011).

## Land Cover

The 2006 NLCD contains 20 land-cover classifications, 15 of which are found in the Upper Scioto River Basin. These land-cover classifications are (1) open water; (2) developed, open space; (3) developed, low intensity; (4) developed, medium intensity; (5) developed, high intensity; (6) barren land; (7) deciduous forest; (8) evergreen forest; (9) mixed forest; (10) shrub/scrub; (11) grassland/herbaceous; (12) pasture/hay; (13) cultivated crops; (14) woody wetlands; and (15) emergent herbaceous wetlands.

The 15 land-cover classifications present in the Upper Scioto River Basin were aggregated into 9 classifications to characterize reference-period land cover (table A6). These reclassified groups are (1) open water; (2) developed, open space (includes developed open space plus barren land); (3) developed, low intensity; (4) developed, medium intensity; (5) developed, high intensity; (6) forest (includes deciduous forest, evergreen forest, mixed forest, and shrub/scrub); (7) grassland/herbaceous; (8) agriculture (includes pasture/hay plus cultivated crops); and (9) wetlands (includes woody wetlands plus emergent herbaceous wetlands). Figure A6 shows the reclassified 2006 NLCD data for the entire Upper Scioto River Basin.

The Upper Scioto River Basin contains a mix of rural and urban landscapes, with a productive agricultural region surrounding most urban population centers. Agriculture land cover makes up 66.3 percent of the entire basin, whereas developed land cover makes up 20.2 percent. Table A6 shows the breakdown of land-cover classifications for the basin based on the 2006 NLCD data. Subbasins in the modeled area vary greatly with respect to land cover, with RCHRES 47 comprising 88.1 percent agriculture land use and RCHRES 15 comprising 94.8 percent developed land.

**Table A6.** Land-cover classifications used in the HSPF model of the Upper Scioto River Basin, Ohio.

| Land-cover classification | Area (acres) | Percentage of basin |
|---|---|---|
| Open water | 20,794 | 1.0% |
| Developed, open space | 181,261 | 8.8% |
| Developed, low intensity | 142,586 | 6.9% |
| Developed, medium intensity | 64,238 | 3.1% |
| Developed, high intensity | 28,139 | 1.4% |
| Forest | 238,817 | 11.6% |
| Grassland/Herbaceous | 14,029 | 0.7% |
| Agriculture | 1,364,786 | 66.3% |
| Wetlands | 5,366 | 0.3% |
| TOTAL | 2,060,017 | 100.0% |

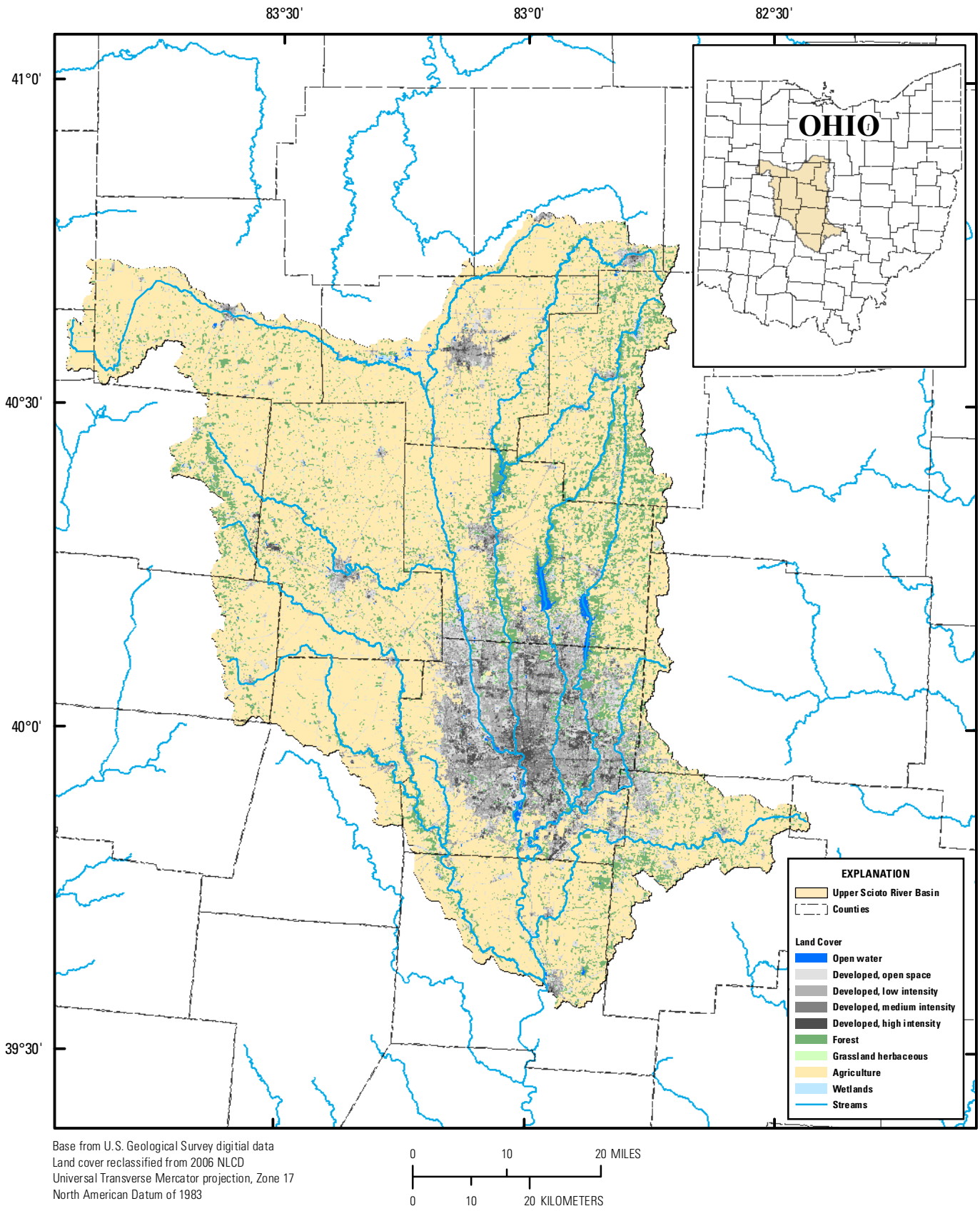


**Figure A6.** Reclassified 2006 National Land-Cover Dataset (NLCD) data used to characterize reference-period land cover of the Upper Scioto River Basin, Ohio, in the HSPF model.

## Hydrologic Response Units

HRUs were created on the basis of land-cover classification, stream reach, and the distribution of rain gages around the basin. Table A7 lists and describes the HRUs created for the model. A total of 348 HRUs were created for the model, comprising 240 pervious land segments (PERLNDs) and 108 impervious land segments (IMPLNDs).

**Table A7.** Hydrologic Response Units (HRUs) developed for the HSPF model of the Upper Scioto River Basin, Ohio.

[PE, potential evapotranspiration]

| HRU | Area (acres) | Land-cover classification | Precipitation station | Temperature station | PE station |
|---|---|---|---|---|---|
| PERLND 11 | 1,165.9 | Open water | OH331592 | 14821 | 14821 |
| PERLND 12 | 4,403.5 | Developed, open space | OH331592 | 14821 | 14821 |
| PERLND 13 | 1,502.4 | Developed, low intensity | OH331592 | 14821 | 14821 |
| PERLND 14 | 330.6 | Developed, medium intensity | OH331592 | 14821 | 14821 |
| PERLND 15 | 35.0 | Developed, high intensity | OH331592 | 14821 | 14821 |
| PERLND 16 | 6,039.9 | Forest | OH331592 | 14821 | 14821 |
| PERLND 17 | 215.7 | Grassland/Herbaceous | OH331592 | 14821 | 14821 |
| PERLND 18 | 57,308.9 | Agriculture | OH331592 | 14821 | 14821 |
| PERLND 19 | 387.5 | Wetlands | OH331592 | 14821 | 14821 |
| IMPLND 12 | 489.3 | Developed, open space | OH331592 | 14821 | 14821 |
| IMPLND 13 | 809.0 | Developed, low intensity | OH331592 | 14821 | 14821 |
| IMPLND 14 | 613.9 | Developed, medium intensity | OH331592 | 14821 | 14821 |
| IMPLND 15 | 314.7 | Developed, high intensity | OH331592 | 14821 | 14821 |
| PERLND 21 | 1,289.6 | Open water | OH331786 | 14821 | 14821 |
| PERLND 22 | 9,556.3 | Developed, open space | OH331786 | 14821 | 14821 |
| PERLND 23 | 9,387.2 | Developed, low intensity | OH331786 | 14821 | 14821 |
| PERLND 24 | 2,837.5 | Developed, medium intensity | OH331786 | 14821 | 14821 |
| PERLND 25 | 341.9 | Developed, high intensity | OH331786 | 14821 | 14821 |
| PERLND 26 | 3,405.7 | Forest | OH331786 | 14821 | 14821 |
| PERLND 27 | 164.6 | Grassland/Herbaceous | OH331786 | 14821 | 14821 |
| PERLND 28 | 16,355.6 | Agriculture | OH331786 | 14821 | 14821 |
| PERLND 29 | 28.0 | Wetlands | OH331786 | 14821 | 14821 |
| IMPLND 22 | 1,061.8 | Developed, open space | OH331786 | 14821 | 14821 |
| IMPLND 23 | 5,054.6 | Developed, low intensity | OH331786 | 14821 | 14821 |
| IMPLND 24 | 5,269.6 | Developed, medium intensity | OH331786 | 14821 | 14821 |
| IMPLND 25 | 3,077.2 | Developed, high intensity | OH331786 | 14821 | 14821 |
| PERLND 31 | 1,029.6 | Open water | OH331786 | 14821 | 14821 |
| PERLND 32 | 13,955.1 | Developed, open space | OH331786 | 14821 | 14821 |
| PERLND 33 | 11,355.1 | Developed, low intensity | OH331786 | 14821 | 14821 |
| PERLND 34 | 2,840.0 | Developed, medium intensity | OH331786 | 14821 | 14821 |
| PERLND 35 | 364.6 | Developed, high intensity | OH331786 | 14821 | 14821 |
| PERLND 36 | 1,720.9 | Forest | OH331786 | 14821 | 14821 |
| PERLND 37 | 295.0 | Grassland/Herbaceous | OH331786 | 14821 | 14821 |
| PERLND 38 | 9,253.1 | Agriculture | OH331786 | 14821 | 14821 |
| PERLND 39 | 28.0 | Wetlands | OH331786 | 14821 | 14821 |
| IMPLND 32 | 1,550.6 | Developed, open space | OH331786 | 14821 | 14821 |
| IMPLND 33 | 6,114.3 | Developed, low intensity | OH331786 | 14821 | 14821 |
| IMPLND 34 | 5,274.2 | Developed, medium intensity | OH331786 | 14821 | 14821 |
| IMPLND 35 | 3,281.8 | Developed, high intensity | OH331786 | 14821 | 14821 |
| PERLND 41 | 1,025.0 | Open water | OH332124 | 14821 | 14821 |
| PERLND 42 | 3,254.2 | Developed, open space | OH332124 | 14821 | 14821 |
| PERLND 43 | 808.7 | Developed, low intensity | OH332124 | 14821 | 14821 |
| PERLND 44 | 58.0 | Developed, medium intensity | OH332124 | 14821 | 14821 |

**Table A7.** Hydrologic Response Units (HRUs) developed for the HSPF model of the Upper Scioto River Basin, Ohio.—Continued

[PE, potential evapotranspiration]

| HRU | Area (acres) | Land-cover classification | Precipitation station | Temperature station | PE station |
|---|---|---|---|---|---|
| PERLND 45 | 4.4 | Developed, high intensity | OH332124 | 14821 | 14821 |
| PERLND 46 | 2,513.0 | Forest | OH332124 | 14821 | 14821 |
| PERLND 47 | 388.8 | Grassland/Herbaceous | OH332124 | 14821 | 14821 |
| PERLND 48 | 11,246.2 | Agriculture | OH332124 | 14821 | 14821 |
| PERLND 49 | 11.0 | Wetlands | OH332124 | 14821 | 14821 |
| IMPLND 42 | 361.6 | Developed, open space | OH332124 | 14821 | 14821 |
| IMPLND 43 | 435.5 | Developed, low intensity | OH332124 | 14821 | 14821 |
| IMPLND 44 | 107.7 | Developed, medium intensity | OH332124 | 14821 | 14821 |
| IMPLND 45 | 39.5 | Developed, high intensity | OH332124 | 14821 | 14821 |
| PERLND 51 | 559.5 | Open water | OH334979 | 04855 | 04855 |
| PERLND 52 | 4,921.0 | Developed, open space | OH334979 | 04855 | 04855 |
| PERLND 53 | 1,304.8 | Developed, low intensity | OH334979 | 04855 | 04855 |
| PERLND 54 | 63.6 | Developed, medium intensity | OH334979 | 04855 | 04855 |
| PERLND 55 | 3.9 | Developed, high intensity | OH334979 | 04855 | 04855 |
| PERLND 56 | 7,242.4 | Forest | OH334979 | 04855 | 04855 |
| PERLND 57 | 1,485.8 | Grassland/Herbaceous | OH334979 | 04855 | 04855 |
| PERLND 58 | 112,499.2 | Agriculture | OH334979 | 04855 | 04855 |
| PERLND 59 | 113.4 | Wetlands | OH334979 | 04855 | 04855 |
| IMPLND 52 | 546.8 | Developed, open space | OH334979 | 04855 | 04855 |
| IMPLND 53 | 702.6 | Developed, low intensity | OH334979 | 04855 | 04855 |
| IMPLND 54 | 118.0 | Developed, medium intensity | OH334979 | 04855 | 04855 |
| IMPLND 55 | 35.1 | Developed, high intensity | OH334979 | 04855 | 04855 |
| PERLND 61 | 1,274.2 | Open water | OH334942 | 04855 | 04855 |
| PERLND 62 | 8,304.4 | Developed, open space | OH334942 | 04855 | 04855 |
| PERLND 63 | 4,819.4 | Developed, low intensity | OH334942 | 04855 | 04855 |
| PERLND 64 | 705.7 | Developed, medium intensity | OH334942 | 04855 | 04855 |
| PERLND 65 | 88.4 | Developed, high intensity | OH334942 | 04855 | 04855 |
| PERLND 66 | 11,568.1 | Forest | OH334942 | 04855 | 04855 |
| PERLND 67 | 1,610.7 | Grassland/Herbaceous | OH334942 | 04855 | 04855 |
| PERLND 68 | 163,055.9 | Agriculture | OH334942 | 04855 | 04855 |
| PERLND 69 | 1,029.2 | Wetlands | OH334942 | 04855 | 04855 |
| IMPLND 62 | 922.7 | Developed, open space | OH334942 | 04855 | 04855 |
| IMPLND 63 | 2,595.1 | Developed, low intensity | OH334942 | 04855 | 04855 |
| IMPLND 64 | 1,310.5 | Developed, medium intensity | OH334942 | 04855 | 04855 |
| IMPLND 65 | 795.4 | Developed, high intensity | OH334942 | 04855 | 04855 |
| PERLND 71 | 230.2 | Open water | OH334189 | 04855 | 04855 |
| PERLND 72 | 7,778.9 | Developed, open space | OH334189 | 04855 | 04855 |
| PERLND 73 | 1,232.3 | Developed, low intensity | OH334189 | 04855 | 04855 |
| PERLND 74 | 155.1 | Developed, medium intensity | OH334189 | 04855 | 04855 |
| PERLND 75 | 31.2 | Developed, high intensity | OH334189 | 04855 | 04855 |
| PERLND 76 | 11,185.2 | Forest | OH334189 | 04855 | 04855 |
| PERLND 77 | 2,229.5 | Grassland/Herbaceous | OH334189 | 04855 | 04855 |
| PERLND 78 | 139,850.0 | Agriculture | OH334189 | 04855 | 04855 |

**Table A7.** Hydrologic Response Units (HRUs) developed for the HSPF model of the Upper Scioto River Basin, Ohio.—Continued

[PE, potential evapotranspiration]

| HRU | Area (acres) | Land-cover classification | Precipitation station | Temperature station | PE station |
|---|---|---|---|---|---|
| PERLND 79 | 366.4 | Wetlands | OH334189 | 04855 | 04855 |
| IMPLND 72 | 864.3 | Developed, open space | OH334189 | 04855 | 04855 |
| IMPLND 73 | 663.6 | Developed, low intensity | OH334189 | 04855 | 04855 |
| IMPLND 74 | 288.0 | Developed, medium intensity | OH334189 | 04855 | 04855 |
| IMPLND 75 | 280.8 | Developed, high intensity | OH334189 | 04855 | 04855 |
| PERLND 81 | 421.7 | Open water | OH334979 | 04855 | 04855 |
| PERLND 82 | 5,953.9 | Developed, open space | OH334979 | 04855 | 04855 |
| PERLND 83 | 2,640.4 | Developed, low intensity | OH334979 | 04855 | 04855 |
| PERLND 84 | 360.0 | Developed, medium intensity | OH334979 | 04855 | 04855 |
| PERLND 85 | 29.0 | Developed, high intensity | OH334979 | 04855 | 04855 |
| PERLND 86 | 13,942.6 | Forest | OH334979 | 04855 | 04855 |
| PERLND 87 | 723.9 | Grassland/Herbaceous | OH334979 | 04855 | 04855 |
| PERLND 88 | 86,744.9 | Agriculture | OH334979 | 04855 | 04855 |
| PERLND 89 | 169.4 | Wetlands | OH334979 | 04855 | 04855 |
| IMPLND 82 | 661.5 | Developed, open space | OH334979 | 04855 | 04855 |
| IMPLND 83 | 1,421.7 | Developed, low intensity | OH334979 | 04855 | 04855 |
| IMPLND 84 | 668.6 | Developed, medium intensity | OH334979 | 04855 | 04855 |
| IMPLND 85 | 261.1 | Developed, high intensity | OH334979 | 04855 | 04855 |
| PERLND 91 | 860.9 | Open water | OH331786 | 14821 | 14821 |
| PERLND 92 | 1,888.7 | Developed, open space | OH331786 | 14821 | 14821 |
| PERLND 93 | 1,426.0 | Developed, low intensity | OH331786 | 14821 | 14821 |
| PERLND 94 | 357.9 | Developed, medium intensity | OH331786 | 14821 | 14821 |
| PERLND 95 | 88.9 | Developed, high intensity | OH331786 | 14821 | 14821 |
| PERLND 96 | 1,335.4 | Forest | OH331786 | 14821 | 14821 |
| PERLND 97 | 114.5 | Grassland/Herbaceous | OH331786 | 14821 | 14821 |
| PERLND 98 | 3,577.4 | Agriculture | OH331786 | 14821 | 14821 |
| PERLND 99 | 148.6 | Wetlands | OH331786 | 14821 | 14821 |
| IMPLND 92 | 209.9 | Developed, open space | OH331786 | 14821 | 14821 |
| IMPLND 93 | 767.8 | Developed, low intensity | OH331786 | 14821 | 14821 |
| IMPLND 94 | 664.8 | Developed, medium intensity | OH331786 | 14821 | 14821 |
| IMPLND 95 | 799.8 | Developed, high intensity | OH331786 | 14821 | 14821 |
| PERLND 101 | 531.2 | Open water | OH331786 | 14821 | 14821 |
| PERLND 102 | 17,417.8 | Developed, open space | OH331786 | 14821 | 14821 |
| PERLND 103 | 12,989.1 | Developed, low intensity | OH331786 | 14821 | 14821 |
| PERLND 104 | 3,545.1 | Developed, medium intensity | OH331786 | 14821 | 14821 |
| PERLND 105 | 486.0 | Developed, high intensity | OH331786 | 14821 | 14821 |
| PERLND 106 | 16,335.1 | Forest | OH331786 | 14821 | 14821 |
| PERLND 107 | 740.8 | Grassland/Herbaceous | OH331786 | 14821 | 14821 |
| PERLND 108 | 20,861.5 | Agriculture | OH331786 | 14821 | 14821 |
| PERLND 109 | 418.1 | Wetlands | OH331786 | 14821 | 14821 |
| IMPLND 102 | 1,935.3 | Developed, open space | OH331786 | 14821 | 14821 |
| IMPLND 103 | 6,994.1 | Developed, low intensity | OH331786 | 14821 | 14821 |
| IMPLND 104 | 6,583.8 | Developed, medium intensity | OH331786 | 14821 | 14821 |

**Table A7.** Hydrologic Response Units (HRUs) developed for the HSPF model of the Upper Scioto River Basin, Ohio.—Continued

[PE, potential evapotranspiration]

| HRU | Area (acres) | Land-cover classification | Precipitation station | Temperature station | PE station |
|---|---|---|---|---|---|
| IMPLND 105 | 4,373.8 | Developed, high intensity | OH331786 | 14821 | 14821 |
| PERLND 111 | 2,983.1 | Open water | OH331404 | 14821 | 14821 |
| PERLND 112 | 4,503.1 | Developed, open space | OH331404 | 14821 | 14821 |
| PERLND 114 | 127.1 | Developed, medium intensity | OH331404 | 14821 | 14821 |
| PERLND 115 | 7.4 | Developed, high intensity | OH331404 | 14821 | 14821 |
| PERLND 116 | 13,203.2 | Forest | OH331404 | 14821 | 14821 |
| PERLND 117 | 453.3 | Grassland/Herbaceous | OH331404 | 14821 | 14821 |
| PERLND 118 | 32,901.5 | Agriculture | OH331404 | 14821 | 14821 |
| PERLND 119 | 187.7 | Wetlands | OH331404 | 14821 | 14821 |
| IMPLND 112 | 500.3 | Developed, open space | OH331404 | 14821 | 14821 |
| IMPLND 113 | 463.2 | Developed, low intensity | OH331404 | 14821 | 14821 |
| IMPLND 114 | 236.0 | Developed, medium intensity | OH331404 | 14821 | 14821 |
| IMPLND 115 | 66.9 | Developed, high intensity | OH331404 | 14821 | 14821 |
| PERLND 121 | 89.0 | Open water | OH331404 | 14821 | 14821 |
| PERLND 122 | 3,141.3 | Developed, open space | OH331404 | 14821 | 14821 |
| PERLND 123 | 266.2 | Developed, low intensity | OH331404 | 14821 | 14821 |
| PERLND 124 | 28.6 | Developed, medium intensity | OH331404 | 14821 | 14821 |
| PERLND 125 | 1.5 | Developed, high intensity | OH331404 | 14821 | 14821 |
| PERLND 126 | 17,569.8 | Forest | OH331404 | 14821 | 14821 |
| PERLND 127 | 355.9 | Grassland/Herbaceous | OH331404 | 14821 | 14821 |
| PERLND 128 | 42,512.8 | Agriculture | OH331404 | 14821 | 14821 |
| PERLND 129 | 308.3 | Wetlands | OH331404 | 14821 | 14821 |
| IMPLND 122 | 349.0 | Developed, open space | OH331404 | 14821 | 14821 |
| IMPLND 123 | 143.3 | Developed, low intensity | OH331404 | 14821 | 14821 |
| IMPLND 124 | 53.1 | Developed, medium intensity | OH331404 | 14821 | 14821 |
| IMPLND 125 | 13.2 | Developed, high intensity | OH331404 | 14821 | 14821 |
| PERLND 131 | 343.7 | Open water | OH331786 | 14821 | 14821 |
| PERLND 132 | 9,357.7 | Developed, open space | OH331786 | 14821 | 14821 |
| PERLND 133 | 11,091.0 | Developed, low intensity | OH331786 | 14821 | 14821 |
| PERLND 134 | 3,359.8 | Developed, medium intensity | OH331786 | 14821 | 14821 |
| PERLND 135 | 355.4 | Developed, high intensity | OH331786 | 14821 | 14821 |
| PERLND 136 | 5,120.2 | Forest | OH331786 | 14821 | 14821 |
| PERLND 137 | 287.6 | Grassland/Herbaceous | OH331786 | 14821 | 14821 |
| PERLND 138 | 2,760.0 | Agriculture | OH331786 | 14821 | 14821 |
| PERLND 139 | 73.1 | Wetlands | OH331786 | 14821 | 14821 |
| IMPLND 132 | 1,039.7 | Developed, open space | OH331786 | 14821 | 14821 |
| IMPLND 133 | 5,972.1 | Developed, low intensity | OH331786 | 14821 | 14821 |
| IMPLND 134 | 6,239.6 | Developed, medium intensity | OH331786 | 14821 | 14821 |
| IMPLND 135 | 3,199.0 | Developed, high intensity | OH331786 | 14821 | 14821 |
| PERLND 141 | 3,358.1 | Open water | OH332124 | 14821 | 14821 |
| PERLND 142 | 2,157.0 | Developed, open space | OH332124 | 14821 | 14821 |
| PERLND 143 | 700.5 | Developed, low intensity | OH332124 | 14821 | 14821 |
| PERLND 144 | 106.1 | Developed, medium intensity | OH332124 | 14821 | 14821 |

**Table A7.** Hydrologic Response Units (HRUs) developed for the HSPF model of the Upper Scioto River Basin, Ohio.—Continued

[PE, potential evapotranspiration]

| HRU | Area (acres) | Land-cover classification | Precipitation station | Temperature station | PE station |
|---|---|---|---|---|---|
| PERLND 145 | 3.8 | Developed, high intensity | OH332124 | 14821 | 14821 |
| PERLND 146 | 9,480.6 | Forest | OH332124 | 14821 | 14821 |
| PERLND 147 | 182.7 | Grassland/Herbaceous | OH332124 | 14821 | 14821 |
| PERLND 148 | 19,693.4 | Agriculture | OH332124 | 14821 | 14821 |
| IMPLND 142 | 239.7 | Developed, open space | OH332124 | 14821 | 14821 |
| IMPLND 143 | 377.2 | Developed, low intensity | OH332124 | 14821 | 14821 |
| IMPLND 144 | 197.1 | Developed, medium intensity | OH332124 | 14821 | 14821 |
| IMPLND 145 | 34.0 | Developed, high intensity | OH332124 | 14821 | 14821 |
| PERLND 151 | 95.1 | Open water | OH332124 | 04855 | 04855 |
| PERLND 152 | 1,869.0 | Developed, open space | OH332124 | 04855 | 04855 |
| PERLND 153 | 419.1 | Developed, low intensity | OH332124 | 04855 | 04855 |
| PERLND 154 | 26.9 | Developed, medium intensity | OH332124 | 04855 | 04855 |
| PERLND 155 | 0.5 | Developed, high intensity | OH332124 | 04855 | 04855 |
| PERLND 156 | 9,886.1 | Forest | OH332124 | 04855 | 04855 |
| PERLND 157 | 59.7 | Grassland/Herbaceous | OH332124 | 04855 | 04855 |
| PERLND 158 | 28,522.5 | Agriculture | OH332124 | 04855 | 04855 |
| PERLND 159 | 177.9 | Wetlands | OH332124 | 04855 | 04855 |
| IMPLND 152 | 207.7 | Developed, open space | OH332124 | 04855 | 04855 |
| IMPLND 153 | 225.6 | Developed, low intensity | OH332124 | 04855 | 04855 |
| IMPLND 154 | 49.9 | Developed, medium intensity | OH332124 | 04855 | 04855 |
| IMPLND 155 | 4.4 | Developed, high intensity | OH332124 | 04855 | 04855 |
| PERLND 161 | 547.6 | Open water | OH331786 | 14821 | 14821 |
| PERLND 162 | 4,934.0 | Developed, open space | OH331786 | 14821 | 14821 |
| PERLND 163 | 7,142.9 | Developed, low intensity | OH331786 | 14821 | 14821 |
| PERLND 164 | 3,631.8 | Developed, medium intensity | OH331786 | 14821 | 14821 |
| PERLND 165 | 524.7 | Developed, high intensity | OH331786 | 14821 | 14821 |
| PERLND 166 | 1,192.6 | Forest | OH331786 | 14821 | 14821 |
| PERLND 167 | 142.5 | Grassland/Herbaceous | OH331786 | 14821 | 14821 |
| PERLND 168 | 196.2 | Agriculture | OH331786 | 14821 | 14821 |
| PERLND 169 | 4.9 | Wetlands | OH331786 | 14821 | 14821 |
| IMPLND 162 | 548.2 | Developed, open space | OH331786 | 14821 | 14821 |
| IMPLND 163 | 3,846.2 | Developed, low intensity | OH331786 | 14821 | 14821 |
| IMPLND 164 | 6,744.9 | Developed, medium intensity | OH331786 | 14821 | 14821 |
| IMPLND 165 | 4,721.9 | Developed, high intensity | OH331786 | 14821 | 14821 |
| PERLND 171 | 548.9 | Open water | OH332124 | 14821 | 14821 |
| PERLND 172 | 13,650.9 | Developed, open space | OH332124 | 14821 | 14821 |
| PERLND 173 | 9,585.1 | Developed, low intensity | OH332124 | 14821 | 14821 |
| PERLND 174 | 1,940.7 | Developed, medium intensity | OH332124 | 14821 | 14821 |
| PERLND 175 | 196.7 | Developed, high intensity | OH332124 | 14821 | 14821 |
| PERLND 176 | 15,253.0 | Forest | OH332124 | 14821 | 14821 |
| PERLND 177 | 265.6 | Grassland/Herbaceous | OH332124 | 14821 | 14821 |
| PERLND 178 | 12,506.4 | Agriculture | OH332124 | 14821 | 14821 |
| PERLND 179 | 4.4 | Wetlands | OH332124 | 14821 | 14821 |

**Table A7.** Hydrologic Response Units (HRUs) developed for the HSPF model of the Upper Scioto River Basin, Ohio.—Continued

[PE, potential evapotranspiration]

| HRU | Area (acres) | Land-cover classification | Precipitation station | Temperature station | PE station |
|---|---|---|---|---|---|
| IMPLND 172 | 1,516.8 | Developed, open space | OH332124 | 14821 | 14821 |
| IMPLND 173 | 5,161.2 | Developed, low intensity | OH332124 | 14821 | 14821 |
| IMPLND 174 | 3,604.2 | Developed, medium intensity | OH332124 | 14821 | 14821 |
| IMPLND 175 | 1,770.1 | Developed, high intensity | OH332124 | 14821 | 14821 |
| PERLND 181 | 1,039.6 | Open water | OH332124 | 04855 | 04855 |
| PERLND 183 | 993.2 | Developed, low intensity | OH332124 | 04855 | 04855 |
| PERLND 184 | 116.4 | Developed, medium intensity | OH332124 | 04855 | 04855 |
| PERLND 185 | 8.2 | Developed, high intensity | OH332124 | 04855 | 04855 |
| PERLND 186 | 10,046.1 | Forest | OH332124 | 04855 | 04855 |
| PERLND 187 | 215.7 | Grassland/Herbaceous | OH332124 | 04855 | 04855 |
| PERLND 188 | 46,743.5 | Agriculture | OH332124 | 04855 | 04855 |
| PERLND 189 | 421.7 | Wetlands | OH332124 | 04855 | 04855 |
| IMPLND 182 | 303.3 | Developed, open space | OH332124 | 04855 | 04855 |
| IMPLND 183 | 534.8 | Developed, low intensity | OH332124 | 04855 | 04855 |
| IMPLND 184 | 216.3 | Developed, medium intensity | OH332124 | 04855 | 04855 |
| IMPLND 185 | 73.5 | Developed, high intensity | OH332124 | 04855 | 04855 |
| PERLND 191 | 510.6 | Open water | OH334942 | 04855 | 04855 |
| PERLND 192 | 4,057.2 | Developed, open space | OH334942 | 04855 | 04855 |
| PERLND 193 | 1,876.6 | Developed, low intensity | OH334942 | 04855 | 04855 |
| PERLND 194 | 266.6 | Developed, medium intensity | OH334942 | 04855 | 04855 |
| PERLND 195 | 43.1 | Developed, high intensity | OH334942 | 04855 | 04855 |
| PERLND 196 | 6,203.3 | Forest | OH334942 | 04855 | 04855 |
| PERLND 197 | 277.9 | Grassland/Herbaceous | OH334942 | 04855 | 04855 |
| PERLND 198 | 48,025.0 | Agriculture | OH334942 | 04855 | 04855 |
| PERLND 199 | 80.4 | Wetlands | OH334942 | 04855 | 04855 |
| IMPLND 192 | 450.8 | Developed, open space | OH334942 | 04855 | 04855 |
| IMPLND 193 | 1,010.5 | Developed, low intensity | OH334942 | 04855 | 04855 |
| IMPLND 194 | 495.1 | Developed, medium intensity | OH334942 | 04855 | 04855 |
| IMPLND 195 | 388.3 | Developed, high intensity | OH334942 | 04855 | 04855 |
| PERLND 201 | 195.6 | Open water | OH333021 | 04855 | 04855 |
| PERLND 202 | 5,220.8 | Developed, open space | OH333021 | 04855 | 04855 |
| PERLND 203 | 1,778.4 | Developed, low intensity | OH333021 | 04855 | 04855 |
| PERLND 204 | 180.6 | Developed, medium intensity | OH333021 | 04855 | 04855 |
| PERLND 205 | 23.1 | Developed, high intensity | OH333021 | 04855 | 04855 |
| PERLND 206 | 12,748.5 | Forest | OH333021 | 04855 | 04855 |
| PERLND 207 | 253.1 | Grassland/Herbaceous | OH333021 | 04855 | 04855 |
| PERLND 208 | 77,587.3 | Agriculture | OH333021 | 04855 | 04855 |
| PERLND 209 | 357.0 | Wetlands | OH333021 | 04855 | 04855 |
| IMPLND 202 | 580.1 | Developed, open space | OH333021 | 04855 | 04855 |
| IMPLND 203 | 957.6 | Developed, low intensity | OH333021 | 04855 | 04855 |
| IMPLND 204 | 335.3 | Developed, medium intensity | OH333021 | 04855 | 04855 |
| IMPLND 205 | 208.0 | Developed, high intensity | OH333021 | 04855 | 04855 |
| PERLND 211 | 292.6 | Open water | OH333021 | 04855 | 04855 |

**Table A7.** Hydrologic Response Units (HRUs) developed for the HSPF model of the Upper Scioto River Basin, Ohio.—Continued

[PE, potential evapotranspiration]

| HRU | Area (acres) | Land-cover classification | Precipitation station | Temperature station | PE station |
|---|---|---|---|---|---|
| PERLND 212 | 1,730.1 | Developed, open space | OH333021 | 04855 | 04855 |
| PERLND 213 | 132.9 | Developed, low intensity | OH333021 | 04855 | 04855 |
| PERLND 214 | 9.4 | Developed, medium intensity | OH333021 | 04855 | 04855 |
| PERLND 215 | 0.4 | Developed, high intensity | OH333021 | 04855 | 04855 |
| PERLND 216 | 8,056.7 | Forest | OH333021 | 04855 | 04855 |
| PERLND 217 | 68.6 | Grassland/Herbaceous | OH333021 | 04855 | 04855 |
| PERLND 218 | 13,600.9 | Agriculture | OH333021 | 04855 | 04855 |
| PERLND 219 | 11.0 | Wetlands | OH333021 | 04855 | 04855 |
| IMPLND 212 | 192.2 | Developed, open space | OH333021 | 04855 | 04855 |
| IMPLND 213 | 71.6 | Developed, low intensity | OH333021 | 04855 | 04855 |
| IMPLND 214 | 17.5 | Developed, medium intensity | OH333021 | 04855 | 04855 |
| IMPLND 215 | 3.3 | Developed, high intensity | OH333021 | 04855 | 04855 |
| PERLND 221 | 426.3 | Open water | OH331592 | 14821 | 14821 |
| PERLND 222 | 8,739.0 | Developed, open space | OH331592 | 14821 | 14821 |
| PERLND 223 | 3,088.5 | Developed, low intensity | OH331592 | 14821 | 14821 |
| PERLND 224 | 497.3 | Developed, medium intensity | OH331592 | 14821 | 14821 |
| PERLND 225 | 95.2 | Developed, high intensity | OH331592 | 14821 | 14821 |
| PERLND 226 | 10,596.3 | Forest | OH331592 | 14821 | 14821 |
| PERLND 227 | 283.4 | Grassland/Herbaceous | OH331592 | 14821 | 14821 |
| PERLND 228 | 60,324.8 | Agriculture | OH331592 | 14821 | 14821 |
| PERLND 229 | 80.6 | Wetlands | OH331592 | 14821 | 14821 |
| IMPLND 222 | 971.0 | Developed, open space | OH331592 | 14821 | 14821 |
| IMPLND 223 | 1,663.1 | Developed, low intensity | OH331592 | 14821 | 14821 |
| IMPLND 224 | 923.5 | Developed, medium intensity | OH331592 | 14821 | 14821 |
| IMPLND 225 | 856.6 | Developed, high intensity | OH331592 | 14821 | 14821 |
| PERLND 231 | 141.5 | Open water | OH334403 | 14821 | 14821 |
| PERLND 232 | 7,181.1 | Developed, open space | OH334403 | 14821 | 14821 |
| PERLND 233 | 1,702.1 | Developed, low intensity | OH334403 | 14821 | 14821 |
| PERLND 234 | 213.0 | Developed, medium intensity | OH334403 | 14821 | 14821 |
| PERLND 235 | 10.0 | Developed, high intensity | OH334403 | 14821 | 14821 |
| PERLND 236 | 14,716.3 | Forest | OH334403 | 14821 | 14821 |
| PERLND 237 | 374.4 | Grassland/Herbaceous | OH334403 | 14821 | 14821 |
| PERLND 238 | 67,371.2 | Agriculture | OH334403 | 14821 | 14821 |
| PERLND 239 | 290.3 | Wetlands | OH334403 | 14821 | 14821 |
| IMPLND 232 | 797.9 | Developed, open space | OH334403 | 14821 | 14821 |
| IMPLND 233 | 916.5 | Developed, low intensity | OH334403 | 14821 | 14821 |
| IMPLND 234 | 395.6 | Developed, medium intensity | OH334403 | 14821 | 14821 |
| IMPLND 235 | 90.0 | Developed, high intensity | OH334403 | 14821 | 14821 |
| PERLND 241 | 302.4 | Open water | OH331592 | 14821 | 14821 |
| PERLND 242 | 391.8 | Developed, open space | OH331592 | 14821 | 14821 |
| PERLND 243 | 36.5 | Developed, low intensity | OH331592 | 14821 | 14821 |
| PERLND 244 | 2.1 | Developed, medium intensity | OH331592 | 14821 | 14821 |
| PERLND 245 | 0.2 | Developed, high intensity | OH331592 | 14821 | 14821 |

**Table A7.** Hydrologic Response Units (HRUs) developed for the HSPF model of the Upper Scioto River Basin, Ohio.—Continued

[PE, potential evapotranspiration]

| HRU | Area (acres) | Land-cover classification | Precipitation station | Temperature station | PE station |
|---|---|---|---|---|---|
| PERLND 246 | 1,254.8 | Forest | OH331592 | 14821 | 14821 |
| PERLND 247 | 25.6 | Grassland/Herbaceous | OH331592 | 14821 | 14821 |
| PERLND 248 | 11,922.8 | Agriculture | OH331592 | 14821 | 14821 |
| PERLND 249 | 23.2 | Wetlands | OH331592 | 14821 | 14821 |
| IMPLND 242 | 43.5 | Developed, open space | OH331592 | 14821 | 14821 |
| IMPLND 243 | 19.6 | Developed, low intensity | OH331592 | 14821 | 14821 |
| IMPLND 244 | 4.0 | Developed, medium intensity | OH331592 | 14821 | 14821 |
| IMPLND 245 | 2.2 | Developed, high intensity | OH331592 | 14821 | 14821 |
| PERLND 251 | 483.9 | Open water | OH332090 | 14821 | 14821 |
| PERLND 252 | 2,660.1 | Developed, open space | OH332090 | 14821 | 14821 |
| PERLND 253 | 1,015.4 | Developed, low intensity | OH332090 | 14821 | 14821 |
| PERLND 254 | 91.7 | Developed, medium intensity | OH332090 | 14821 | 14821 |
| PERLND 255 | 3.0 | Developed, high intensity | OH332090 | 14821 | 14821 |
| PERLND 256 | 7,706.3 | Forest | OH332090 | 14821 | 14821 |
| PERLND 257 | 474.1 | Grassland/Herbaceous | OH332090 | 14821 | 14821 |
| PERLND 258 | 38,956.9 | Agriculture | OH332090 | 14821 | 14821 |
| PERLND 259 | 109.7 | Wetlands | OH332090 | 14821 | 14821 |
| IMPLND 252 | 295.6 | Developed, open space | OH332090 | 14821 | 14821 |
| IMPLND 253 | 546.8 | Developed, low intensity | OH332090 | 14821 | 14821 |
| IMPLND 254 | 170.3 | Developed, medium intensity | OH332090 | 14821 | 14821 |
| IMPLND 255 | 27.4 | Developed, high intensity | OH332090 | 14821 | 14821 |
| PERLND 261 | 915.2 | Open water | OH334979 | 14821 | 14821 |
| PERLND 262 | 9,291.9 | Developed, open space | OH334979 | 14821 | 14821 |
| PERLND 263 | 3,766.8 | Developed, low intensity | OH334979 | 14821 | 14821 |
| PERLND 264 | 521.1 | Developed, medium intensity | OH334979 | 14821 | 14821 |
| PERLND 265 | 60.2 | Developed, high intensity | OH334979 | 14821 | 14821 |
| PERLND 266 | 14,903.2 | Forest | OH334979 | 14821 | 14821 |
| PERLND 267 | 1,693.8 | Grassland/Herbaceous | OH334979 | 14821 | 14821 |
| PERLND 268 | 149,009.0 | Agriculture | OH334979 | 14821 | 14821 |
| PERLND 269 | 294.9 | Wetlands | OH334979 | 14821 | 14821 |
| IMPLND 262 | 1,032.4 | Developed, open space | OH334979 | 14821 | 14821 |
| IMPLND 263 | 2,028.3 | Developed, low intensity | OH334979 | 14821 | 14821 |
| IMPLND 264 | 967.7 | Developed, medium intensity | OH334979 | 14821 | 14821 |
| IMPLND 265 | 541.8 | Developed, high intensity | OH334979 | 14821 | 14821 |
| PERLND 271 | 132.9 | Open water | OH334979 | 14821 | 14821 |
| PERLND 272 | 4,086.8 | Developed, open space | OH334979 | 14821 | 14821 |
| PERLND 273 | 760.1 | Developed, low intensity | OH334979 | 14821 | 14821 |
| PERLND 274 | 110.5 | Developed, medium intensity | OH334979 | 14821 | 14821 |
| PERLND 275 | 7.3 | Developed, high intensity | OH334979 | 14821 | 14821 |
| PERLND 276 | 5,592.0 | Forest | OH334979 | 14821 | 14821 |
| PERLND 277 | 646.3 | Grassland/Herbaceous | OH334979 | 14821 | 14821 |
| PERLND 278 | 91,399.1 | Agriculture | OH334979 | 14821 | 14821 |
| PERLND 279 | 207.3 | Wetlands | OH334979 | 14821 | 14821 |

**Table A7.** Hydrologic Response Units (HRUs) developed for the HSPF model of the Upper Scioto River Basin, Ohio.—Continued

[PE, potential evapotranspiration]

| HRU | Area (acres) | Land-cover classification | Precipitation station | Temperature station | PE station |
|---|---|---|---|---|---|
| IMPLND 272 | 454.1 | Developed, open space | OH334979 | 14821 | 14821 |
| IMPLND 273 | 409.3 | Developed, low intensity | OH334979 | 14821 | 14821 |
| IMPLND 274 | 205.3 | Developed, medium intensity | OH334979 | 14821 | 14821 |
| IMPLND 275 | 65.8 | Developed, high intensity | OH334979 | 14821 | 14821 |

## Pervious Land Segments (PERLNDs)

Pervious surfaces are represented in the model as land segments called PERLNDs, which were segmented on the basis of land cover, stream reach, and associated climate stations. In the model, the different PERLNDs associated with different land covers are identified by the last digit in their identification numbers (IDs), as follows:

| Last digit in PERLND ID | Land-cover type |
|---|---|
| 1 | Open water |
| 2 | Developed, open space |
| 3 | Developed, low intensity |
| 4 | Developed, medium intensity |
| 5 | Developed, high intensity |
| 6 | Forest |
| 7 | Grassland/Herbaceous |
| 8 | Agriculture |
| 9 | Wetlands |

The first digit (or two digits of three digit numbers) of the PERLND ID in part indexes the combination of precipitation and temperature stations associated with a given PERLND, as shown below:

| Precipitation site | PERLND index for indicated combination of precipitation and temperature sites | |
|---|---|---|
| | Temperature site | |
| | 14821 | 04855 |
| OH331404 | 11,12 | - |
| OH331592 | 1,22,24 | - |
| OH331786 | 2,3,10,13,16 | - |
| OH332090 | 25 | - |
| OH332124 | 4,14,17 | 15,18 |
| OH333021 | 9 | 20,21 |
| OH334189 | - | 7 |
| OH334403 | 23 | |
| OH334942 | - | 6,19 |
| OH334979 | 26,27 | 5,8 |

Consequently, for example, PERLND number 116 corresponds to a forested area (indicated by the last digit being 6) that uses precipitation from site OH331404 and temperature from site 14821 (indicated by the first two digits being 11). More than one index number is associated with some combinations of precipitation and temperature stations for a given land-cover type. That approach was necessary because of the need to regionally adjust some model parameters associated with the PERLNDs to improve calibration.

## Impervious Land Segments (IMPLNDs)

Impervious surfaces are represented in the model as land segments called IMPLNDs, whose areas were computed as a percentage of the areas of PERLNDs. The 2006 NLCD classification (NLCD, 2013) stated that impervious surfaces account for less than 20 percent of the land surface in land covers classified as "developed, open space"; 20–49 percent in "developed, low intensity"; 50–79 percent in "developed, medium intensity"; and 80–100 percent in "developed, high intensity." On the basis of these ranges, the following percentages of impervious area were used to compute the areas of IMPLNDS:

| Impervious area, in percent | Land-cover type |
|---|---|
| 10 | Developed, open space |
| 35 | Developed, low intensity |
| 65 | Developed, medium intensity |
| 90 | Developed, high intensity |

All land-cover classifications other than those listed above were assumed to have no effective impervious area. Impervious areas make up less than 7 percent of the Upper Scioto River Basin; however, the amount of impervious area associated with a given subbasin ranged from more than 60 percent to less than 1 percent (table A8).

In the model, the IMPLNDs associated with different land covers are identified by the last digit in their identification numbers (IDs), as follows:

| Last digit in IMPLND ID | Land-cover type |
|---|---|
| 2 | Developed, open space |
| 3 | Developed, low intensity |
| 4 | Developed, medium intensity |
| 5 | Developed, high intensity |

**Table A8.** Total and impervious areas by land-cover classification for each RCHRES in the HSPF model of the Upper Scioto River Basin, Ohio.

| RCHRES number | Land-cover classification | Area (acres) | Impervious area (acres) | Percent impervious area |
|---|---|---|---|---|
| 1 | Open water | 303.5 | 0.0 | 0% |
| | Developed, open space | 4,317.5 | 431.7 | 1% |
| | Developed, low intensity | 5,510.8 | 1,928.8 | 3% |
| | Developed, medium intensity | 1,865.0 | 1,212.2 | 2% |
| | Developed, high intensity | 825.2 | 742.7 | 1% |
| | Forest | 2,603.7 | 0.0 | 0% |
| | Grassland/Herbaceous | 594.8 | 0.0 | 0% |
| | Agriculture | 56,212.6 | 0.0 | 0% |
| | Wetlands | 118.2 | 0.0 | 0% |
| | TOTAL | 72,351.4 | 4,315.5 | 6% |
| 2 | Open water | 195.6 | 0.0 | 0% |
| | Developed, open space | 5,800.9 | 580.1 | 1% |
| | Developed, low intensity | 2,736.0 | 957.6 | 1% |
| | Developed, medium intensity | 515.9 | 335.3 | 0% |
| | Developed, high intensity | 231.1 | 208.0 | 0% |
| | Forest | 12,748.5 | 0.0 | 0% |
| | Grassland/Herbaceous | 253.1 | 0.0 | 0% |
| | Agriculture | 77,587.3 | 0.0 | 0% |
| | Wetlands | 357.0 | 0.0 | 0% |
| | TOTAL | 100,425.3 | 2,081.0 | 2% |
| 3 | Open water | 510.6 | 0.0 | 0% |
| | Developed, open space | 4,508.1 | 450.8 | 1% |
| | Developed, low intensity | 2,887.2 | 1,010.5 | 2% |
| | Developed, medium intensity | 761.7 | 495.1 | 1% |
| | Developed, high intensity | 431.4 | 388.3 | 1% |
| | Forest | 6,203.3 | 0.0 | 0% |
| | Grassland/Herbaceous | 277.9 | 0.0 | 0% |
| | Agriculture | 48,025.0 | 0.0 | 0% |
| | Wetlands | 80.4 | 0.0 | 0% |
| | TOTAL | 63,685.5 | 2,344.7 | 4% |
| 4 | Open water | 262.0 | 0.0 | 0% |
| | Developed, open space | 2,734.9 | 273.5 | 1% |
| | Developed, low intensity | 1,265.1 | 442.8 | 1% |
| | Developed, medium intensity | 229.1 | 148.9 | 0% |
| | Developed, high intensity | 78.0 | 70.2 | 0% |
| | Forest | 7,016.4 | 0.0 | 0% |
| | Grassland/Herbaceous | 113.3 | 0.0 | 0% |
| | Agriculture | 37,011.0 | 0.0 | 0% |
| | Wetlands | 390.0 | 0.0 | 0% |
| | TOTAL | 49,099.8 | 935.4 | 2% |

**Table A8.** Total and impervious areas by land-cover classification for each RCHRES in the HSPF model of the Upper Scioto River Basin, Ohio.—Continued

| RCHRES number | Land-cover classification | Area (acres) | Impervious area (acres) | Percent impervious area |
|---|---|---|---|---|
| 5 | Open water | 559.5 | 0.0 | 0% |
| | Developed, open space | 5,467.8 | 546.8 | 0% |
| | Developed, low intensity | 2,007.5 | 702.6 | 1% |
| | Developed, medium intensity | 181.6 | 118.0 | 0% |
| | Developed, high intensity | 39.0 | 35.1 | 0% |
| | Forest | 7,242.4 | 0.0 | 0% |
| | Grassland/Herbaceous | 1,485.8 | 0.0 | 0% |
| | Agriculture | 112,499.2 | 0.0 | 0% |
| | Wetlands | 113.4 | 0.0 | 0% |
| | TOTAL | 129,596.1 | 1,402.5 | 1% |
| 6 | Open water | 89.0 | 0.0 | 0% |
| | Developed, open space | 3,490.3 | 349.0 | 1% |
| | Developed, low intensity | 409.5 | 143.3 | 0% |
| | Developed, medium intensity | 81.7 | 53.1 | 0% |
| | Developed, high intensity | 14.6 | 13.2 | 0% |
| | Forest | 17,569.8 | 0.0 | 0% |
| | Grassland/Herbaceous | 355.9 | 0.0 | 0% |
| | Agriculture | 42,512.8 | 0.0 | 0% |
| | Wetlands | 308.3 | 0.0 | 0% |
| | TOTAL | 64,831.8 | 558.6 | 1% |
| 7 | Open water | 421.7 | 0.0 | 0% |
| | Developed, open space | 6,615.4 | 661.5 | 1% |
| | Developed, low intensity | 4,062.1 | 1,421.7 | 1% |
| | Developed, medium intensity | 1,028.6 | 668.6 | 1% |
| | Developed, high intensity | 290.1 | 261.1 | 0% |
| | Forest | 13,942.6 | 0.0 | 0% |
| | Grassland/Herbaceous | 723.9 | 0.0 | 0% |
| | Agriculture | 86,744.9 | 0.0 | 0% |
| | Wetlands | 169.4 | 0.0 | 0% |
| | TOTAL | 113,998.8 | 3,012.9 | 3% |
| 8 | Open water | 20.6 | 0.0 | 0% |
| | Developed, open space | 112.7 | 11.3 | 5% |
| | Developed, low intensity | 44.8 | 15.7 | 7% |
| | Developed, medium intensity | 4.8 | 3.2 | 1% |
| | Developed, high intensity | 2.4 | 2.2 | 1% |
| | Forest | 46.0 | 0.0 | 0% |
| | Grassland/Herbaceous | 0.0 | 0.0 | 0% |
| | Agriculture | 0.0 | 0.0 | 0% |
| | Wetlands | 2.4 | 0.0 | 0% |
| | TOTAL | 233.8 | 32.3 | 14% |

**Table A8.** Total and impervious areas by land-cover classification for each RCHRES in the HSPF model of the Upper Scioto River Basin, Ohio.—Continued

| RCHRES number | Land-cover classification | Area (acres) | Impervious area (acres) | Percent impervious area |
|---|---|---|---|---|
| 9 | Open water | 3,356.8 | 0.0 | 0% |
| | Developed, open space | 2,367.8 | 236.8 | 1% |
| | Developed, low intensity | 1,059.7 | 370.9 | 1% |
| | Developed, medium intensity | 298.4 | 194.0 | 1% |
| | Developed, high intensity | 37.8 | 34.0 | 0% |
| | Forest | 9,446.9 | 0.0 | 0% |
| | Grassland/Herbaceous | 182.7 | 0.0 | 0% |
| | Agriculture | 19,640.5 | 0.0 | 0% |
| | Wetlands | 34.1 | 0.0 | 0% |
| | TOTAL | 36,424.7 | 835.6 | 2% |
| 10 | Open water | 1.2 | 0.0 | 0% |
| | Developed, open space | 28.8 | 2.9 | 2% |
| | Developed, low intensity | 18.0 | 6.3 | 5% |
| | Developed, medium intensity | 4.8 | 3.1 | 2% |
| | Developed, high intensity | 0.0 | 0.0 | 0% |
| | Forest | 33.6 | 0.0 | 0% |
| | Grassland/Herbaceous | 0.0 | 0.0 | 0% |
| | Agriculture | 52.9 | 0.0 | 0% |
| | Wetlands | 0.0 | 0.0 | 0% |
| | TOTAL | 139.4 | 12.3 | 9% |
| 11 | Open water | 561.9 | 0.0 | 0% |
| | Developed, open space | 11,620.3 | 1,162.0 | 3% |
| | Developed, low intensity | 12,111.5 | 4,239.0 | 10% |
| | Developed, medium intensity | 4,604.0 | 2,992.6 | 7% |
| | Developed, high intensity | 1,233.6 | 1,110.2 | 3% |
| | Forest | 1,382.3 | 0.0 | 0% |
| | Grassland/Herbaceous | 293.8 | 0.0 | 0% |
| | Agriculture | 9,253.1 | 0.0 | 0% |
| | Wetlands | 3.7 | 0.0 | 0% |
| | TOTAL | 41,064.1 | 9,503.9 | 23% |
| 12 | Open water | 132.9 | 0.0 | 0% |
| | Developed, open space | 4,540.9 | 454.1 | 0% |
| | Developed, low intensity | 1,169.4 | 409.3 | 0% |
| | Developed, medium intensity | 315.8 | 205.3 | 0% |
| | Developed, high intensity | 73.2 | 65.8 | 0% |
| | Forest | 5,592.0 | 0.0 | 0% |
| | Grassland/Herbaceous | 646.3 | 0.0 | 0% |
| | Agriculture | 91,399.1 | 0.0 | 0% |
| | Wetlands | 207.3 | 0.0 | 0% |
| | TOTAL | 104,076.8 | 1,134.5 | 1% |

**Table A8.** Total and impervious areas by land-cover classification for each RCHRES in the HSPF model of the Upper Scioto River Basin, Ohio.—Continued

| RCHRES number | Land-cover classification | Area (acres) | Impervious area (acres) | Percent impervious area |
|---|---|---|---|---|
| 13 | Open water | 10.8 | 0.0 | 0% |
| | Developed, open space | 42.0 | 4.2 | 1% |
| | Developed, low intensity | 20.4 | 7.1 | 2% |
| | Developed, medium intensity | 13.2 | 8.6 | 2% |
| | Developed, high intensity | 0.0 | 0.0 | 0% |
| | Forest | 181.0 | 0.0 | 0% |
| | Grassland/Herbaceous | 9.6 | 0.0 | 0% |
| | Agriculture | 117.5 | 0.0 | 0% |
| | Wetlands | 0.0 | 0.0 | 0% |
| | TOTAL | 394.4 | 19.9 | 5% |
| 14 | Open water | 249.8 | 0.0 | 0% |
| | Developed, open space | 5,307.1 | 530.7 | 2% |
| | Developed, low intensity | 10,299.9 | 3,605.0 | 12% |
| | Developed, medium intensity | 8,304.3 | 5,397.8 | 18% |
| | Developed, high intensity | 3,822.0 | 3,439.8 | 12% |
| | Forest | 1,112.4 | 0.0 | 0% |
| | Grassland/Herbaceous | 140.1 | 0.0 | 0% |
| | Agriculture | 196.2 | 0.0 | 0% |
| | Wetlands | 0.0 | 0.0 | 0% |
| | TOTAL | 29,431.7 | 12,973.2 | 44% |
| 15 | Open water | 467.7 | 0.0 | 0% |
| | Developed, open space | 3,885.3 | 388.5 | 2% |
| | Developed, low intensity | 5,357.9 | 1,875.3 | 12% |
| | Developed, medium intensity | 3,510.2 | 2,281.6 | 14% |
| | Developed, high intensity | 2,412.8 | 2,171.5 | 14% |
| | Forest | 338.6 | 0.0 | 0% |
| | Grassland/Herbaceous | 1.2 | 0.0 | 0% |
| | Agriculture | 0.0 | 0.0 | 0% |
| | Wetlands | 24.4 | 0.0 | 0% |
| | TOTAL | 15,998.1 | 6,716.9 | 42% |
| 16 | Open water | 297.8 | 0.0 | 0% |
| | Developed, open space | 175.0 | 17.5 | 0% |
| | Developed, low intensity | 689.2 | 241.2 | 2% |
| | Developed, medium intensity | 2,072.4 | 1,347.1 | 8% |
| | Developed, high intensity | 1,424.6 | 1,282.1 | 8% |
| | Forest | 80.2 | 0.0 | 0% |
| | Grassland/Herbaceous | 2.4 | 0.0 | 0% |
| | Agriculture | 0.0 | 0.0 | 0% |
| | Wetlands | 4.9 | 0.0 | 0% |
| | TOTAL | 4,746.5 | 2,887.9 | 18% |

**Table A8.** Total and impervious areas by land-cover classification for each RCHRES in the HSPF model of the Upper Scioto River Basin, Ohio.—Continued

| RCHRES number | Land-cover classification | Area (acres) | Impervious area (acres) | Percent impervious area |
|---|---|---|---|---|
| 17 | Open water | 47.5 | 0.0 | 0% |
| | Developed, open space | 2,382.8 | 238.3 | 1% |
| | Developed, low intensity | 2,597.1 | 909.0 | 4% |
| | Developed, medium intensity | 597.8 | 388.6 | 2% |
| | Developed, high intensity | 20.7 | 18.6 | 0% |
| | Forest | 1,071.5 | 0.0 | 0% |
| | Grassland/Herbaceous | 334.8 | 0.0 | 0% |
| | Agriculture | 15,876.1 | 0.0 | 0% |
| | Wetlands | 9.7 | 0.0 | 0% |
| | TOTAL | 22,938.1 | 1,554.5 | 7% |
| 18 | Open water | 117.0 | 0.0 | 0% |
| | Developed, open space | 876.6 | 87.7 | 2% |
| | Developed, low intensity | 2,230.0 | 780.5 | 14% |
| | Developed, medium intensity | 996.1 | 647.5 | 12% |
| | Developed, high intensity | 392.6 | 353.3 | 6% |
| | Forest | 558.4 | 0.0 | 0% |
| | Grassland/Herbaceous | 63.4 | 0.0 | 0% |
| | Agriculture | 326.8 | 0.0 | 0% |
| | Wetlands | 50.0 | 0.0 | 0% |
| | TOTAL | 5,611.0 | 1,869.0 | 33% |
| 19 | Open water | 13.4 | 0.0 | 0% |
| | Developed, open space | 49.8 | 5.0 | 0% |
| | Developed, low intensity | 90.0 | 31.5 | 3% |
| | Developed, medium intensity | 1.2 | 0.8 | 0% |
| | Developed, high intensity | 0.0 | 0.0 | 0% |
| | Forest | 238.3 | 0.0 | 0% |
| | Grassland/Herbaceous | 4.9 | 0.0 | 0% |
| | Agriculture | 846.1 | 0.0 | 0% |
| | Wetlands | 0.0 | 0.0 | 0% |
| | TOTAL | 1,243.6 | 37.3 | 3% |
| 20 | Open water | 688.9 | 0.0 | 0% |
| | Developed, open space | 634.2 | 63.4 | 1% |
| | Developed, low intensity | 575.7 | 201.5 | 3% |
| | Developed, medium intensity | 182.6 | 118.7 | 2% |
| | Developed, high intensity | 157.0 | 141.3 | 2% |
| | Forest | 564.8 | 0.0 | 0% |
| | Grassland/Herbaceous | 64.5 | 0.0 | 0% |
| | Agriculture | 2,805.6 | 0.0 | 0% |
| | Wetlands | 90.1 | 0.0 | 0% |
| | TOTAL | 5,763.4 | 524.9 | 9% |

**Table A8.** Total and impervious areas by land-cover classification for each RCHRES in the HSPF model of the Upper Scioto River Basin, Ohio.—Continued

| RCHRES number | Land-cover classification | Area (acres) | Impervious area (acres) | Percent impervious area |
|---|---|---|---|---|
| 21 | Open water | 1,289.6 | 0.0 | 0% |
| | Developed, open space | 10,618.1 | 1,061.8 | 2% |
| | Developed, low intensity | 14,441.8 | 5,054.6 | 9% |
| | Developed, medium intensity | 8,107.1 | 5,269.6 | 9% |
| | Developed, high intensity | 3,419.1 | 3,077.2 | 5% |
| | Forest | 3,405.7 | 0.0 | 0% |
| | Grassland/Herbaceous | 164.6 | 0.0 | 0% |
| | Agriculture | 16,355.6 | 0.0 | 0% |
| | Wetlands | 28.0 | 0.0 | 0% |
| | TOTAL | 57,829.5 | 14,463.2 | 25% |
| 22 | Open water | 302.4 | 0.0 | 0% |
| | Developed, open space | 435.4 | 43.5 | 0% |
| | Developed, low intensity | 56.1 | 19.6 | 0% |
| | Developed, medium intensity | 6.1 | 4.0 | 0% |
| | Developed, high intensity | 2.4 | 2.2 | 0% |
| | Forest | 1,254.8 | 0.0 | 0% |
| | Grassland/Herbaceous | 25.6 | 0.0 | 0% |
| | Agriculture | 11,922.8 | 0.0 | 0% |
| | Wetlands | 23.2 | 0.0 | 0% |
| | TOTAL | 14,028.8 | 69.3 | 0% |
| 23 | Open water | 225.5 | 0.0 | 0% |
| | Developed, open space | 1,315.4 | 131.5 | 1% |
| | Developed, low intensity | 926.5 | 324.3 | 2% |
| | Developed, medium intensity | 575.4 | 374.0 | 3% |
| | Developed, high intensity | 57.3 | 51.6 | 0% |
| | Forest | 2,174.8 | 0.0 | 0% |
| | Grassland/Herbaceous | 92.6 | 0.0 | 0% |
| | Agriculture | 8,723.7 | 0.0 | 0% |
| | Wetlands | 32.9 | 0.0 | 0% |
| | TOTAL | 14,124.2 | 881.4 | 6% |
| 24 | Open water | 427.7 | 0.0 | 0% |
| | Developed, open space | 1,059.0 | 105.9 | 1% |
| | Developed, low intensity | 475.2 | 166.3 | 1% |
| | Developed, medium intensity | 141.4 | 91.9 | 0% |
| | Developed, high intensity | 26.8 | 24.1 | 0% |
| | Forest | 1,759.6 | 0.0 | 0% |
| | Grassland/Herbaceous | 59.7 | 0.0 | 0% |
| | Agriculture | 16,224.2 | 0.0 | 0% |
| | Wetlands | 287.6 | 0.0 | 0% |
| | TOTAL | 20,461.3 | 388.2 | 2% |

**Table A8.** Total and impervious areas by land-cover classification for each RCHRES in the HSPF model of the Upper Scioto River Basin, Ohio.—Continued

| RCHRES number | Land-cover classification | Area (acres) | Impervious area (acres) | Percent impervious area |
|---|---|---|---|---|
| 25 | Open water | 42.6 | 0.0 | 0% |
| | Developed, open space | 690.3 | 69.0 | 1% |
| | Developed, low intensity | 393.2 | 137.6 | 2% |
| | Developed, medium intensity | 58.4 | 38.0 | 0% |
| | Developed, high intensity | 18.3 | 16.4 | 0% |
| | Forest | 564.9 | 0.0 | 0% |
| | Grassland/Herbaceous | 11.0 | 0.0 | 0% |
| | Agriculture | 6,189.3 | 0.0 | 0% |
| | Wetlands | 2.4 | 0.0 | 0% |
| | TOTAL | 7,970.4 | 261.1 | 3% |
| 26 | Open water | 383.7 | 0.0 | 0% |
| | Developed, open space | 9,019.7 | 902.0 | 1% |
| | Developed, low intensity | 4,358.4 | 1,525.4 | 2% |
| | Developed, medium intensity | 1,362.4 | 885.5 | 1% |
| | Developed, high intensity | 933.5 | 840.1 | 1% |
| | Forest | 10,031.4 | 0.0 | 0% |
| | Grassland/Herbaceous | 272.5 | 0.0 | 0% |
| | Agriculture | 54,135.5 | 0.0 | 0% |
| | Wetlands | 78.2 | 0.0 | 0% |
| | TOTAL | 80,575.2 | 4,153.1 | 5% |
| 27 | Open water | 141.5 | 0.0 | 0% |
| | Developed, open space | 7,979.0 | 797.9 | 1% |
| | Developed, low intensity | 2,618.6 | 916.5 | 1% |
| | Developed, medium intensity | 608.6 | 395.6 | 0% |
| | Developed, high intensity | 100.0 | 90.0 | 0% |
| | Forest | 14,716.3 | 0.0 | 0% |
| | Grassland/Herbaceous | 374.4 | 0.0 | 0% |
| | Agriculture | 67,371.2 | 0.0 | 0% |
| | Wetlands | 290.3 | 0.0 | 0% |
| | TOTAL | 94,200.0 | 2,200.0 | 2% |
| 28 | Open water | 411.7 | 0.0 | 0% |
| | Developed, open space | 2,216.7 | 221.7 | 1% |
| | Developed, low intensity | 738.1 | 258.3 | 1% |
| | Developed, medium intensity | 173.0 | 112.4 | 0% |
| | Developed, high intensity | 265.5 | 239.0 | 1% |
| | Forest | 1,738.0 | 0.0 | 0% |
| | Grassland/Herbaceous | 47.5 | 0.0 | 0% |
| | Agriculture | 26,948.8 | 0.0 | 0% |
| | Wetlands | 65.8 | 0.0 | 0% |
| | TOTAL | 32,605.1 | 831.4 | 3% |

**Table A8.** Total and impervious areas by land-cover classification for each RCHRES in the HSPF model of the Upper Scioto River Basin, Ohio.—Continued

| RCHRES number | Land-cover classification | Area (acres) | Impervious area (acres) | Percent impervious area |
|---|---|---|---|---|
| 29 | Open water | 101.0 | 0.0 | 0% |
| | Developed, open space | 301.7 | 30.2 | 0% |
| | Developed, low intensity | 171.5 | 60.0 | 1% |
| | Developed, medium intensity | 54.7 | 35.6 | 1% |
| | Developed, high intensity | 0.0 | 0.0 | 0% |
| | Forest | 367.4 | 0.0 | 0% |
| | Grassland/Herbaceous | 15.8 | 0.0 | 0% |
| | Agriculture | 5,412.1 | 0.0 | 0% |
| | Wetlands | 1.2 | 0.0 | 0% |
| | TOTAL | 6,425.4 | 125.8 | 2% |
| 30 | Open water | 171.9 | 0.0 | 0% |
| | Developed, open space | 1,464.4 | 146.4 | 2% |
| | Developed, low intensity | 1,618.0 | 566.3 | 9% |
| | Developed, medium intensity | 840.1 | 546.1 | 8% |
| | Developed, high intensity | 731.6 | 658.4 | 10% |
| | Forest | 770.6 | 0.0 | 0% |
| | Grassland/Herbaceous | 50.0 | 0.0 | 0% |
| | Agriculture | 771.8 | 0.0 | 0% |
| | Wetlands | 58.5 | 0.0 | 0% |
| | TOTAL | 6,477.1 | 1,917.3 | 30% |
| 31 | Open water | 438.8 | 0.0 | 0% |
| | Developed, open space | 2,563.6 | 256.4 | 1% |
| | Developed, low intensity | 1,099.5 | 384.8 | 1% |
| | Developed, medium intensity | 181.6 | 118.1 | 0% |
| | Developed, high intensity | 9.8 | 8.8 | 0% |
| | Forest | 6,457.1 | 0.0 | 0% |
| | Grassland/Herbaceous | 386.4 | 0.0 | 0% |
| | Agriculture | 29,957.0 | 0.0 | 0% |
| | Wetlands | 61.0 | 0.0 | 0% |
| | TOTAL | 41,154.8 | 768.0 | 2% |
| 32 | Open water | 174.3 | 0.0 | 0% |
| | Developed, open space | 7,609.0 | 760.9 | 2% |
| | Developed, low intensity | 7,193.3 | 2,517.7 | 6% |
| | Developed, medium intensity | 2,973.1 | 1,932.5 | 5% |
| | Developed, high intensity | 1,166.6 | 1,049.9 | 3% |
| | Forest | 7,690.7 | 0.0 | 0% |
| | Grassland/Herbaceous | 343.8 | 0.0 | 0% |
| | Agriculture | 13,142.0 | 0.0 | 0% |
| | Wetlands | 281.6 | 0.0 | 0% |
| | TOTAL | 40,574.4 | 6,261.0 | 15% |

**Table A8.** Total and impervious areas by land-cover classification for each RCHRES in the HSPF model of the Upper Scioto River Basin, Ohio.—Continued

| RCHRES number | Land-cover classification | Area (acres) | Impervious area (acres) | Percent impervious area |
|---|---|---|---|---|
| 33 | Open water | 346.0 | 0.0 | 0% |
| | Developed, open space | 11,702.1 | 1,170.2 | 2% |
| | Developed, low intensity | 12,769.5 | 4,469.3 | 9% |
| | Developed, medium intensity | 7,142.6 | 4,642.7 | 9% |
| | Developed, high intensity | 3,693.2 | 3,323.8 | 6% |
| | Forest | 8,463.5 | 0.0 | 0% |
| | Grassland/Herbaceous | 387.5 | 0.0 | 0% |
| | Agriculture | 7,602.0 | 0.0 | 0% |
| | Wetlands | 136.5 | 0.0 | 0% |
| | TOTAL | 52,242.9 | 13,606.1 | 26% |
| 34 | Open water | 226.6 | 0.0 | 0% |
| | Developed, open space | 9,520.8 | 952.1 | 2% |
| | Developed, low intensity | 14,833.1 | 5,191.6 | 12% |
| | Developed, medium intensity | 8,603.3 | 5,592.1 | 13% |
| | Developed, high intensity | 3,161.8 | 2,845.6 | 7% |
| | Forest | 4,561.8 | 0.0 | 0% |
| | Grassland/Herbaceous | 224.2 | 0.0 | 0% |
| | Agriculture | 2,433.2 | 0.0 | 0% |
| | Wetlands | 23.2 | 0.0 | 0% |
| | TOTAL | 43,588.0 | 14,581.4 | 33% |
| 35 | Open water | 31.7 | 0.0 | 0% |
| | Developed, open space | 342.3 | 34.2 | 0% |
| | Developed, low intensity | 372.7 | 130.5 | 1% |
| | Developed, medium intensity | 79.2 | 51.5 | 1% |
| | Developed, high intensity | 20.7 | 18.6 | 0% |
| | Forest | 1,011.0 | 0.0 | 0% |
| | Grassland/Herbaceous | 82.8 | 0.0 | 0% |
| | Agriculture | 8,153.8 | 0.0 | 0% |
| | Wetlands | 48.7 | 0.0 | 0% |
| | TOTAL | 10,142.9 | 234.8 | 2% |
| 36 | Open water | 151.1 | 0.0 | 0% |
| | Developed, open space | 4,175.7 | 417.6 | 2% |
| | Developed, low intensity | 4,062.4 | 1,421.8 | 8% |
| | Developed, medium intensity | 1,528.0 | 993.2 | 5% |
| | Developed, high intensity | 542.2 | 488.0 | 3% |
| | Forest | 4,200.1 | 0.0 | 0% |
| | Grassland/Herbaceous | 73.1 | 0.0 | 0% |
| | Agriculture | 3,445.9 | 0.0 | 0% |
| | Wetlands | 1.2 | 0.0 | 0% |
| | TOTAL | 18,179.7 | 3,320.6 | 18% |

**Table A8.** Total and impervious areas by land-cover classification for each RCHRES in the HSPF model of the Upper Scioto River Basin, Ohio.—Continued

| RCHRES number | Land-cover classification | Area (acres) | Impervious area (acres) | Percent impervious area |
|---|---|---|---|---|
| 37 | Open water | 867.8 | 0.0 | 0% |
| | Developed, open space | 7,941.5 | 794.1 | 0% |
| | Developed, low intensity | 3,198.0 | 1,119.3 | 1% |
| | Developed, medium intensity | 890.9 | 579.1 | 0% |
| | Developed, high intensity | 581.4 | 523.2 | 0% |
| | Forest | 13,831.8 | 0.0 | 0% |
| | Grassland/Herbaceous | 1,358.9 | 0.0 | 0% |
| | Agriculture | 133,133.0 | 0.0 | 0% |
| | Wetlands | 285.2 | 0.0 | 0% |
| | TOTAL | 162,088.4 | 3,015.8 | 2% |
| 38 | Open water | 2,983.1 | 0.0 | 0% |
| | Developed, open space | 5,003.5 | 500.3 | 1% |
| | Developed, low intensity | 1,323.4 | 463.2 | 1% |
| | Developed, medium intensity | 363.1 | 236.0 | 0% |
| | Developed, high intensity | 74.3 | 66.9 | 0% |
| | Forest | 13,203.2 | 0.0 | 0% |
| | Grassland/Herbaceous | 453.3 | 0.0 | 0% |
| | Agriculture | 32,901.5 | 0.0 | 0% |
| | Wetlands | 187.7 | 0.0 | 0% |
| | TOTAL | 56,493.0 | 1,266.5 | 2% |
| 39 | Open water | 992.2 | 0.0 | 0% |
| | Developed, open space | 3,459.3 | 345.9 | 2% |
| | Developed, low intensity | 1,182.4 | 413.8 | 2% |
| | Developed, medium intensity | 159.7 | 103.8 | 1% |
| | Developed, high intensity | 41.4 | 37.3 | 0% |
| | Forest | 2,353.7 | 0.0 | 0% |
| | Grassland/Herbaceous | 370.6 | 0.0 | 0% |
| | Agriculture | 10,758.2 | 0.0 | 0% |
| | Wetlands | 8.5 | 0.0 | 0% |
| | TOTAL | 19,326.0 | 900.8 | 5% |
| 40 | Open water | 95.1 | 0.0 | 0% |
| | Developed, open space | 2,076.7 | 207.7 | 0% |
| | Developed, low intensity | 644.7 | 225.6 | 1% |
| | Developed, medium intensity | 76.8 | 49.9 | 0% |
| | Developed, high intensity | 4.9 | 4.4 | 0% |
| | Forest | 9,886.1 | 0.0 | 0% |
| | Grassland/Herbaceous | 59.7 | 0.0 | 0% |
| | Agriculture | 28,522.5 | 0.0 | 0% |
| | Wetlands | 177.9 | 0.0 | 0% |
| | TOTAL | 41,544.3 | 487.6 | 1% |

**Table A8.** Total and impervious areas by land-cover classification for each RCHRES in the HSPF model of the Upper Scioto River Basin, Ohio.—Continued

| RCHRES number | Land-cover classification | Area (acres) | Impervious area (acres) | Percent impervious area |
|---|---|---|---|---|
| 41 | Open water | 12.2 | 0.0 | 0% |
| | Developed, open space | 43.8 | 4.4 | 1% |
| | Developed, low intensity | 17.0 | 6.0 | 1% |
| | Developed, medium intensity | 1.2 | 0.8 | 0% |
| | Developed, high intensity | 0.0 | 0.0 | 0% |
| | Forest | 113.2 | 0.0 | 0% |
| | Grassland/Herbaceous | 18.3 | 0.0 | 0% |
| | Agriculture | 488.0 | 0.0 | 0% |
| | Wetlands | 0.0 | 0.0 | 0% |
| | TOTAL | 693.7 | 11.1 | 2% |
| 42 | Open water | 4.9 | 0.0 | 0% |
| | Developed, open space | 114.2 | 11.4 | 0% |
| | Developed, low intensity | 117.9 | 41.3 | 1% |
| | Developed, medium intensity | 8.5 | 5.5 | 0% |
| | Developed, high intensity | 0.0 | 0.0 | 0% |
| | Forest | 435.1 | 0.0 | 0% |
| | Grassland/Herbaceous | 20.7 | 0.0 | 0% |
| | Agriculture | 4,064.1 | 0.0 | 0% |
| | Wetlands | 0.0 | 0.0 | 0% |
| | TOTAL | 4,765.3 | 58.2 | 1% |
| 43 | Open water | 772.7 | 0.0 | 0% |
| | Developed, open space | 184.0 | 18.4 | 0% |
| | Developed, low intensity | 145.0 | 50.8 | 1% |
| | Developed, medium intensity | 95.1 | 61.8 | 1% |
| | Developed, high intensity | 3.7 | 3.3 | 0% |
| | Forest | 2,594.7 | 0.0 | 0% |
| | Grassland/Herbaceous | 81.7 | 0.0 | 0% |
| | Agriculture | 5,668.3 | 0.0 | 0% |
| | Wetlands | 31.7 | 0.0 | 0% |
| | TOTAL | 8,804.1 | 134.2 | 2% |
| 44 | Open water | 292.6 | 0.0 | 0% |
| | Developed, open space | 1,922.3 | 192.2 | 1% |
| | Developed, low intensity | 204.5 | 71.6 | 0% |
| | Developed, medium intensity | 26.9 | 17.5 | 0% |
| | Developed, high intensity | 3.7 | 3.3 | 0% |
| | Forest | 8,056.7 | 0.0 | 0% |
| | Grassland/Herbaceous | 68.6 | 0.0 | 0% |
| | Agriculture | 13,600.9 | 0.0 | 0% |
| | Wetlands | 11.0 | 0.0 | 0% |
| | TOTAL | 24,187.3 | 284.6 | 1% |

**Table A8.** Total and impervious areas by land-cover classification for each RCHRES in the HSPF model of the Upper Scioto River Basin, Ohio.—Continued

| RCHRES number | Land-cover classification | Area (acres) | Impervious area (acres) | Percent impervious area |
|---|---|---|---|---|
| 45 | Open water | 970.7 | 0.0 | 0% |
| | Developed, open space | 4,909.7 | 491.0 | 0% |
| | Developed, low intensity | 1,903.6 | 666.3 | 1% |
| | Developed, medium intensity | 151.2 | 98.3 | 0% |
| | Developed, high intensity | 58.5 | 52.7 | 0% |
| | Forest | 8,964.5 | 0.0 | 0% |
| | Grassland/Herbaceous | 1,015.8 | 0.0 | 0% |
| | Agriculture | 106,843.3 | 0.0 | 0% |
| | Wetlands | 911.0 | 0.0 | 0% |
| | TOTAL | 125,728.3 | 1,308.2 | 1% |
| 46 | Open water | 177.3 | 0.0 | 0% |
| | Developed, open space | 4,727.4 | 472.7 | 1% |
| | Developed, low intensity | 1,380.6 | 483.2 | 1% |
| | Developed, medium intensity | 379.1 | 246.4 | 0% |
| | Developed, high intensity | 281.2 | 253.1 | 0% |
| | Forest | 7,107.0 | 0.0 | 0% |
| | Grassland/Herbaceous | 1,111.5 | 0.0 | 0% |
| | Agriculture | 66,302.2 | 0.0 | 0% |
| | Wetlands | 225.0 | 0.0 | 0% |
| | TOTAL | 81,691.4 | 1,455.5 | 2% |
| 47 | Open water | 52.9 | 0.0 | 0% |
| | Developed, open space | 3,915.9 | 391.6 | 0% |
| | Developed, low intensity | 515.3 | 180.4 | 0% |
| | Developed, medium intensity | 64.0 | 41.6 | 0% |
| | Developed, high intensity | 30.7 | 27.7 | 0% |
| | Forest | 4,078.2 | 0.0 | 0% |
| | Grassland/Herbaceous | 1,117.9 | 0.0 | 0% |
| | Agriculture | 73,547.7 | 0.0 | 0% |
| | Wetlands | 141.4 | 0.0 | 0% |
| | TOTAL | 83,464.1 | 641.2 | 1% |
| 48 | Open water | 397.8 | 0.0 | 0% |
| | Developed, open space | 10,992.0 | 1,099.2 | 2% |
| | Developed, low intensity | 10,683.9 | 3,739.4 | 8% |
| | Developed, medium intensity | 4,016.9 | 2,611.0 | 5% |
| | Developed, high intensity | 1,424.5 | 1,282.1 | 3% |
| | Forest | 11,052.9 | 0.0 | 0% |
| | Grassland/Herbaceous | 192.5 | 0.0 | 0% |
| | Agriculture | 9,060.5 | 0.0 | 0% |
| | Wetlands | 3.2 | 0.0 | 0% |
| | TOTAL | 47,824.3 | 8,731.6 | 18% |

**Table A8.** Total and impervious areas by land-cover classification for each RCHRES in the HSPF model of the Upper Scioto River Basin, Ohio.—Continued

| RCHRES number | Land-cover classification | Area (acres) | Impervious area (acres) | Percent impervious area |
|---|---|---|---|---|
| TOTALS | Open water | 20,793.7 | 0.0 | 0% |
| | Developed, open space | 181,261.4 | 18,126.1 | 1% |
| | Developed, low intensity | 142,586.2 | 49,905.2 | 2% |
| | Developed, medium intensity | 64,237.7 | 41,754.5 | 2% |
| | Developed, high intensity | 28,139.1 | 25,325.2 | 1% |
| | Forest | 238,817.4 | 0.0 | 0% |
| | Grassland/Herbaceous | 14,029.3 | 0.0 | 0% |
| | Agriculture | 1,364,785.8 | 0.0 | 0% |
| | Wetlands | 5,366.1 | 0.0 | 0% |
| | TOTAL | 2,060,016.7 | 135,111.0 | 7% |

## River Reach and Reservoir Segments (RCHRESs)

The Scioto River and its main tributaries were divided into 48 subbasins with corresponding RCHRESs (fig. A7). RCHRES boundaries were located at streamgages used for calibration, above all reservoirs, at or near major water withdrawals, and at the confluences of major tributaries. Additional RCHRES boundaries were added to control the size of contributing drainage areas. The primary streams in the Upper Scioto River Basin and their associated RCHRES numbers are listed below:

| Stream | Associated RCHRES numbers |
|---|---|
| Scioto River | 5, 8, 11, 15, 16, 21, 23, 24, 28, 29, 39, 45, 46, 47 |
| Big Darby Creek | 22, 31, 37 |
| Little Darby Creek | 12, 15 |
| Hellbranch Run | 17, 19 |
| Walnut Creek | 25, 26, 27 |
| Big Walnut Creek | 6, 13, 20, 30, 33, 38 |
| Blacklick Creek | 21 |
| Alum Creek | 9, 10, 18, 34, 40 |
| Olentangy River | 2, 3, 14, 36, 42, 43, 48 |
| Whetstone Creek | 4, 44 |
| Mill Creek | 7, 41 |
| Little Scioto River | 1 |

Table A9 shows the local subbasin area contributing to each RCHRES and the reason for its delineation. In addition, table A9 lists the RCHRESs that flow directly into each reach. The total area associated with each HRU directly contributing to each reach was determined by intersecting the HRU data layer with the subbasin delineation data layer (table A10).

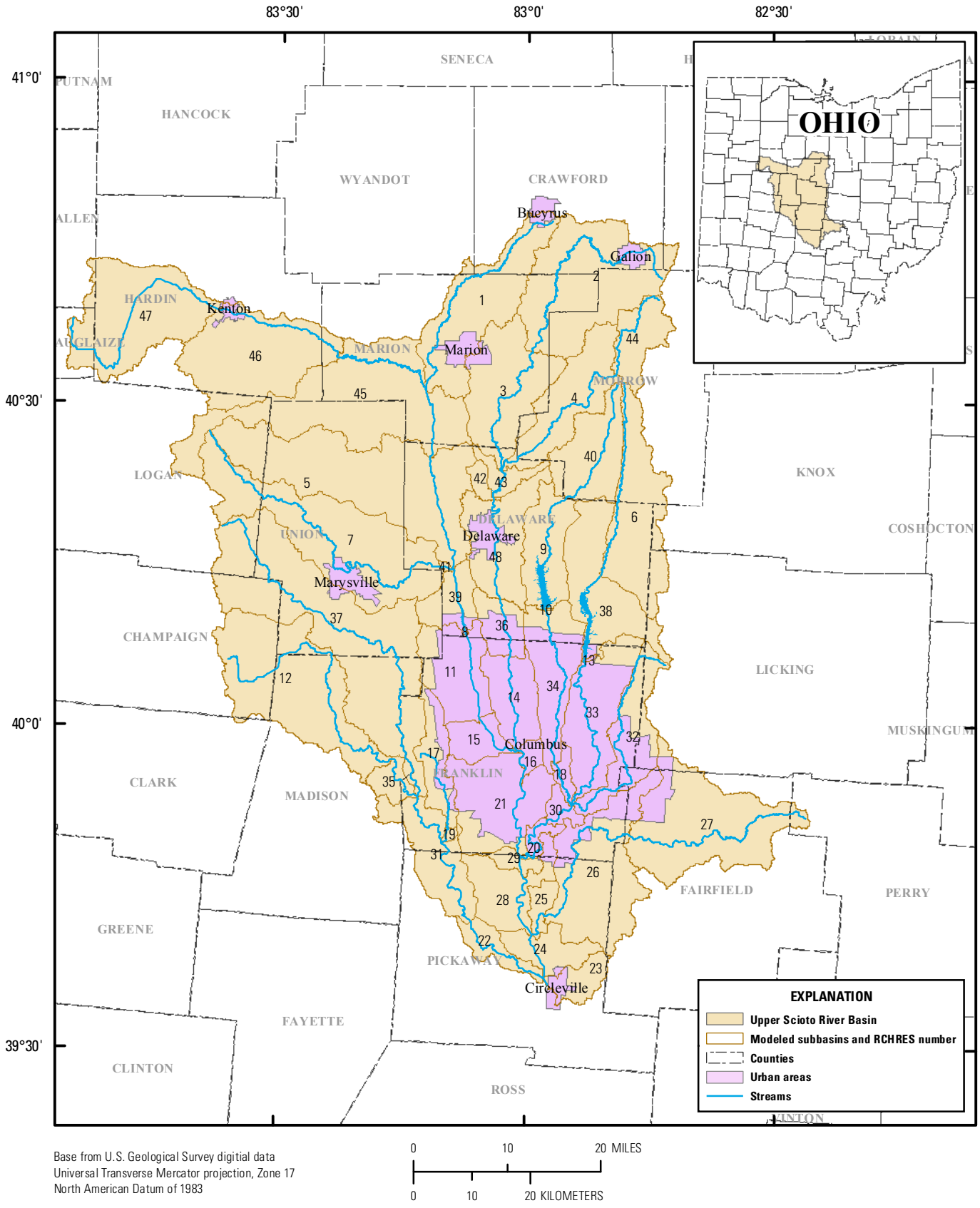


**Figure A7.** Subbasins and corresponding reach-reservoirs (RCHRESs) used in the HSPF model of the Upper Scioto River Basin, Ohio.

**Table A9.** RCHRES numbers, descriptions, areas, and directly contributing RCHRESs in the HSPF model of the Upper Scioto River Basin, Ohio.

[n/a, not applicable]

| RCHRES no | Stream name | Description / Reason for delineation | RCHRES area (acres) | Contributing RCHRES numbers |
|---|---|---|---|---|
| 1 | Little Scioto River | Mouth of stream | 72,351 | n/a |
| 2 | Olentangy River | USGS streamgage 03223000 (Olentangy River at Claridon) | 100,425 | n/a |
| 3 | Olentangy River | Above confluence with Whetstone Creek | 63,686 | 2 |
| 4 | Whetstone Creek | Mouth of stream | 49,100 | 44 |
| 5 | Scioto River | Above confluence with Mill Creek | 129,596 | 45 |
| 6 | Big Walnut Creek | USGS streamgage 03228300 (Big Walnut Creek at Sunbury) | 64,832 | n/a |
| 7 | Mill Creek | USGS streamgage 03220000 (Mill Creek at Bellepoint) | 113,999 | n/a |
| 8 | Scioto River | USGS streamgage 03221000 (Scioto River below O'Shaughnessy Dam near Dublin) | 234 | 39 |
| 9 | Alum Creek | Above Alum Creek Lake Dam | 36,425 | 40 |
| 10 | Alum Creek | USGS streamgage 03228805 (Alum Creek at Africa) | 139 | 9 |
| 11 | Scioto River | Above Griggs Reservoir Dam | 41,064 | 8 |
| 12 | Little Darby Creek | USGS streamgage 03230310 (Little Darby Creek at West Jefferson) | 104,077 | n/a |
| 13 | Big Walnut Creek | USGS streamgage 03228500 (Big Walnut Creek at Central College) | 394 | 38 |
| 14 | Olentangy River | Mouth of stream | 29,432 | 36 |
| 15 | Scioto River | Above the confluence with Olentangy River | 15,998 | 11 |
| 16 | Scioto River | USGS streamgage 03227500 (Scioto River at Columbus) | 4,747 | 14, 15 |
| 17 | Hellbranch Run | USGS streamgage 03230450 (Hellbranch Run near Harrisburg) | 22,938 | n/a |
| 18 | Alum Creek | Mouth of stream | 5,611 | 34 |
| 19 | Hellbranch Run | Mouth of stream | 1,244 | 17 |
| 20 | Big Walnut Creek | Mouth of stream | 5,763 | 30 |
| 21 | Scioto River | Above the confluence with Big Walnut Creek | 57,830 | 16 |
| 22 | Big Darby Creek | Mouth of stream | 14,029 | 31 |
| 23 | Scioto River | USGS streamgage 03230700 (Scioto River at Circleville) | 14,124 | 22, 24 |
| 24 | Scioto River | Above the confluence with Big Darby Creek | 20,461 | 25, 28 |
| 25 | Walnut Creek | Mouth of stream | 7,970 | 26 |
| 26 | Walnut Creek | USGS streamgage 03229796 (Walnut Creek at Ashville) | 80,575 | 27 |
| 27 | Walnut Creek | Walnut Creek near downstream end of canals | 94,200 | n/a |
| 28 | Scioto River | Above the confluence with Walnut Creek | 32,605 | 29 |
| 29 | Scioto River | USGS streamgage 03229610 (Scioto River near Commercial Point) | 6,425 | 20, 21 |
| 30 | Big Walnut Creek | USGS streamgage 03229500 (Big Walnut at Rees) | 6,477 | 18, 32, 33 |
| 31 | Big Darby Creek | USGS streamgage 03230500 (Big Darby Creek at Darbyville) | 41,155 | 19, 35, 37 |
| 32 | Blacklick Creek | Mouth of stream | 40,574 | n/a |
| 33 | Big Walnut Creek | Above the confluence with Alum Creek | 52,243 | 13 |
| 34 | Alum Creek | USGS streamgage 03229000 (Alum Creek at Columbus) | 43,588 | 10 |
| 35 | Little Darby Creek | Mouth of stream | 10,143 | 12 |
| 36 | Olentangy River | USGS streamgage 03226800 (Olentangy River near Worthington) | 18,180 | 48 |
| 37 | Big Darby Creek | Above the confluence with Little Darby Creek | 162,088 | n/a |
| 38 | Big Walnut Creek | Above Hoover Reservoir Dam | 56,493 | 6 |
| 39 | Scioto River | Above O'Shaughnessy Reservoir Dam | 19,326 | 5, 41 |
| 40 | Alum Creek | USGS streamgage 03228750 (Alum Creek near Kilbourne) | 41,544 | n/a |

**Table A9.** RCHRES numbers, descriptions, areas, and directly contributing RCHRESs in the HSPF model of the Upper Scioto River Basin, Ohio.—Continued

[n/a, not applicable]

| RCHRES no | Stream name | Description / Reason for delineation | RCHRES area (acres) | Contributing RCHRES numbers |
|---|---|---|---|---|
| 41 | Mill Creek | Mouth of stream | 694 | 7 |
| 42 | Olentangy River | USGS streamgage 03225500 (Olentangy River near Delaware) | 4,765 | 43 |
| 43 | Olentangy River | Above the Delaware Lake Dam | 9,577 | 3, 4 |
| 44 | Whetstone Creek | USGS streamgage 03223425 (Whetstone Creek at Mt Gilead) | 24,187 | n/a |
| 45 | Scioto River | USGS streamgage 03219500 (Scioto River at Prospect) | 125,728 | 1, 46 |
| 46 | Scioto River | USGS streamgage 03217500 (Scioto River at La Rue) | 81,691 | 47 |
| 47 | Scioto River | Above confluence with Silver Creek | 83,464 | n/a |
| 48 | Olentangy River | Above Del-Co Company PWS - Olentangy withdrawal site | 47,824 | 42 |

**Table A10.** Makeup of each reach by Hydrologic Response Unit (HRU) for the Upper Scioto River Basin HSPF model.

| RCHRES number | HRU | Land-cover classification | Area (acres) | Percent |
|---|---|---|---|---|
| 1 | PERLND 61 | Open water | 303.5 | 0.4% |
| | PERLND 62 | Developed, open space | 3,885.7 | 5.4% |
| | IMPLND 62 | Developed, open space | 431.7 | 0.6% |
| | PERLND 63 | Developed, low intensity | 3,582.0 | 5.0% |
| | IMPLND 63 | Developed, low intensity | 1,928.8 | 2.7% |
| | PERLND 64 | Developed, medium intensity | 652.7 | 0.9% |
| | IMPLND 64 | Developed, medium intensity | 1,212.2 | 1.7% |
| | PERLND 65 | Developed, high intensity | 82.5 | 0.1% |
| | IMPLND 65 | Developed, high intensity | 742.7 | 1.0% |
| | PERLND 66 | Forest | 2,603.7 | 3.6% |
| | PERLND 67 | Grassland/Herbaceous | 594.8 | 0.8% |
| | PERLND 68 | Agriculture | 56,212.6 | 77.7% |
| | PERLND 69 | Wetlands | 118.2 | 0.2% |
| | 1 TOTAL | | 72,351.1 | 100.0% |
| 2 | PERLND 201 | Open water | 195.6 | 0.2% |
| | PERLND 202 | Developed, open space | 5,220.8 | 5.2% |
| | IMPLND 202 | Developed, open space | 580.1 | 0.6% |
| | PERLND 203 | Developed, low intensity | 1,778.4 | 1.8% |
| | IMPLND 203 | Developed, low intensity | 957.6 | 1.0% |
| | PERLND 204 | Developed, medium intensity | 180.6 | 0.2% |
| | IMPLND 204 | Developed, medium intensity | 335.3 | 0.3% |
| | PERLND 205 | Developed, high intensity | 23.1 | 0.0% |
| | IMPLND 205 | Developed, high intensity | 208.0 | 0.2% |
| | PERLND 206 | Forest | 12,748.5 | 12.7% |
| | PERLND 207 | Grassland/Herbaceous | 253.1 | 0.3% |
| | PERLND 208 | Agriculture | 77,587.3 | 77.3% |
| | PERLND 209 | Wetlands | 357.0 | 0.4% |
| | 2 TOTAL | | 100,425.4 | 100.0% |
| 3 | PERLND 191 | Open water | 510.6 | 0.8% |
| | PERLND 192 | Developed, open space | 4,057.2 | 6.4% |
| | IMPLND 192 | Developed, open space | 450.8 | 0.7% |
| | PERLND 193 | Developed, low intensity | 1,876.6 | 2.9% |
| | IMPLND 193 | Developed, low intensity | 1,010.5 | 1.6% |
| | PERLND 194 | Developed, medium intensity | 266.6 | 0.4% |
| | IMPLND 194 | Developed, medium intensity | 495.1 | 0.8% |
| | PERLND 195 | Developed, high intensity | 43.1 | 0.1% |
| | IMPLND 195 | Developed, high intensity | 388.3 | 0.6% |
| | PERLND 196 | Forest | 6,203.3 | 9.7% |
| | PERLND 197 | Grassland/Herbaceous | 277.9 | 0.4% |
| | PERLND 198 | Agriculture | 48,025.0 | 75.4% |
| | PERLND 199 | Wetlands | 80.4 | 0.1% |
| | 3 TOTAL | | 63,685.4 | 100.0% |

**Table A10.** Makeup of each reach by Hydrologic Response Unit (HRU) for the Upper Scioto River Basin HSPF model.—Continued

| RCHRES number | HRU | Land-cover classification | Area (acres) | Percent |
|---|---|---|---|---|
| | PERLND 181 | Open water | 262.0 | 0.5% |
| | PERLND 182 | Developed, open space | 2,461.4 | 5.0% |
| | IMPLND 182 | Developed, open space | 273.5 | 0.6% |
| | PERLND 183 | Developed, low intensity | 822.3 | 1.7% |
| | IMPLND 183 | Developed, low intensity | 442.8 | 0.9% |
| | PERLND 184 | Developed, medium intensity | 80.2 | 0.2% |
| 4 | IMPLND 184 | Developed, medium intensity | 148.9 | 0.3% |
| | PERLND 185 | Developed, high intensity | 7.8 | 0.0% |
| | IMPLND 185 | Developed, high intensity | 70.2 | 0.1% |
| | PERLND 186 | Forest | 7,016.4 | 14.3% |
| | PERLND 187 | Grassland/Herbaceous | 113.3 | 0.2% |
| | PERLND 188 | Agriculture | 37,011.0 | 75.4% |
| | PERLND 189 | Wetlands | 390.0 | 0.8% |
| | 4 TOTAL | | 49,099.8 | 100.0% |
| | PERLND 51 | Open water | 559.5 | 0.4% |
| | PERLND 52 | Developed, open space | 4,921.0 | 3.8% |
| | IMPLND 52 | Developed, open space | 546.8 | 0.4% |
| | PERLND 53 | Developed, low intensity | 1,304.8 | 1.0% |
| | IMPLND 53 | Developed, low intensity | 702.6 | 0.5% |
| | PERLND 54 | Developed, medium intensity | 63.6 | 0.0% |
| 5 | IMPLND 54 | Developed, medium intensity | 118.0 | 0.1% |
| | PERLND 55 | Developed, high intensity | 3.9 | 0.0% |
| | IMPLND 55 | Developed, high intensity | 35.1 | 0.0% |
| | PERLND 56 | Forest | 7,242.4 | 5.6% |
| | PERLND 57 | Grassland/Herbaceous | 1,485.8 | 1.1% |
| | PERLND 58 | Agriculture | 112,499.2 | 86.8% |
| | PERLND 59 | Wetlands | 113.4 | 0.1% |
| | 5 TOTAL | | 129,596.1 | 100.0% |
| | PERLND 121 | Open water | 89.0 | 0.1% |
| | PERLND 122 | Developed, open space | 3,141.3 | 4.8% |
| | IMPLND 122 | Developed, open space | 349.0 | 0.5% |
| | PERLND 123 | Developed, low intensity | 266.2 | 0.4% |
| | IMPLND 123 | Developed, low intensity | 143.3 | 0.2% |
| | PERLND 124 | Developed, medium intensity | 28.6 | 0.0% |
| 6 | IMPLND 124 | Developed, medium intensity | 53.1 | 0.1% |
| | PERLND 125 | Developed, high intensity | 1.5 | 0.0% |
| | IMPLND 125 | Developed, high intensity | 13.2 | 0.0% |
| | PERLND 126 | Forest | 17,569.8 | 27.1% |
| | PERLND 127 | Grassland/Herbaceous | 355.9 | 0.5% |
| | PERLND 128 | Agriculture | 42,512.8 | 65.6% |
| | PERLND 129 | Wetlands | 308.3 | 0.5% |
| | 6 TOTAL | | 64,832.0 | 100.0% |

**Table A10.** Makeup of each reach by Hydrologic Response Unit (HRU) for the Upper Scioto River Basin HSPF model.—Continued

| RCHRES number | HRU | Land-cover classification | Area (acres) | Percent |
|---|---|---|---|---|
| | PERLND 81 | Open water | 421.7 | 0.4% |
| | PERLND 82 | Developed, open space | 5,953.9 | 5.2% |
| | IMPLND 82 | Developed, open space | 661.5 | 0.6% |
| | PERLND 83 | Developed, low intensity | 2,640.4 | 2.3% |
| | IMPLND 83 | Developed, low intensity | 1,421.7 | 1.2% |
| | PERLND 84 | Developed, medium intensity | 360.0 | 0.3% |
| 7 | IMPLND 84 | Developed, medium intensity | 668.6 | 0.6% |
| | PERLND 85 | Developed, high intensity | 29.0 | 0.0% |
| | IMPLND 85 | Developed, high intensity | 261.1 | 0.2% |
| | PERLND 86 | Forest | 13,942.6 | 12.2% |
| | PERLND 87 | Grassland/Herbaceous | 723.9 | 0.6% |
| | PERLND 88 | Agriculture | 86,744.9 | 76.1% |
| | PERLND 89 | Wetlands | 169.4 | 0.1% |
| | 7 TOTAL | | 113,998.7 | 100.0% |
| | PERLND 41 | Open water | 20.6 | 8.8% |
| | PERLND 42 | Developed, open space | 101.4 | 43.4% |
| | IMPLND 42 | Developed, open space | 11.3 | 4.8% |
| | PERLND 43 | Developed, low intensity | 29.1 | 12.4% |
| | IMPLND 43 | Developed, low intensity | 15.7 | 6.7% |
| | PERLND 44 | Developed, medium intensity | 1.7 | 0.7% |
| 8 | IMPLND 44 | Developed, medium intensity | 3.2 | 1.4% |
| | PERLND 45 | Developed, high intensity | 0.2 | 0.1% |
| | IMPLND 45 | Developed, high intensity | 2.2 | 0.9% |
| | PERLND 46 | Forest | 46.0 | 19.7% |
| | PERLND 47 | Grassland/Herbaceous | 0.0 | 0.0% |
| | PERLND 48 | Agriculture | 0.0 | 0.0% |
| | PERLND 49 | Wetlands | 2.4 | 1.0% |
| | 8 TOTAL | | 233.8 | 100.0% |
| | PERLND 141 | Open water | 3,356.8 | 9.2% |
| | PERLND 142 | Developed, open space | 2,131.0 | 5.9% |
| | IMPLND 142 | Developed, open space | 236.8 | 0.7% |
| | PERLND 143 | Developed, low intensity | 688.8 | 1.9% |
| | IMPLND 143 | Developed, low intensity | 370.9 | 1.0% |
| | PERLND 144 | Developed, medium intensity | 104.4 | 0.3% |
| 9 | IMPLND 144 | Developed, medium intensity | 194.0 | 0.5% |
| | PERLND 145 | Developed, high intensity | 3.8 | 0.0% |
| | IMPLND 145 | Developed, high intensity | 34.0 | 0.1% |
| | PERLND 146 | Forest | 9,446.9 | 25.9% |
| | PERLND 147 | Grassland/Herbaceous | 182.7 | 0.5% |
| | PERLND 148 | Agriculture | 19,640.5 | 53.9% |
| | PERLND 149 | Wetlands | 34.1 | 0.1% |
| | 9 TOTAL | | 36,424.7 | 100.0% |

**Table A10.** Makeup of each reach by Hydrologic Response Unit (HRU) for the Upper Scioto River Basin HSPF model.—Continued

| RCHRES number | HRU | Land-cover classification | Area (acres) | Percent |
|---|---|---|---|---|
| | PERLND 141 | Open water | 1.2 | 0.9% |
| | PERLND 142 | Developed, open space | 26.0 | 18.7% |
| | IMPLND 142 | Developed, open space | 2.9 | 2.1% |
| | PERLND 143 | Developed, low intensity | 11.7 | 8.4% |
| | IMPLND 143 | Developed, low intensity | 6.3 | 4.5% |
| | PERLND 144 | Developed, medium intensity | 1.7 | 1.2% |
| 10 | IMPLND 144 | Developed, medium intensity | 3.1 | 2.2% |
| | PERLND 145 | Developed, high intensity | 0.0 | 0.0% |
| | IMPLND 145 | Developed, high intensity | 0.0 | 0.0% |
| | PERLND 146 | Forest | 33.6 | 24.1% |
| | PERLND 147 | Grassland/Herbaceous | 0.0 | 0.0% |
| | PERLND 148 | Agriculture | 52.9 | 37.9% |
| | PERLND 149 | Wetlands | 0.0 | 0.0% |
| | 10 TOTAL | | 139.4 | 100.0% |
| | PERLND 31 | Open water | 561.9 | 1.4% |
| | PERLND 32 | Developed, open space | 10,458.3 | 25.5% |
| | IMPLND 32 | Developed, open space | 1,162.0 | 2.8% |
| | PERLND 33 | Developed, low intensity | 7,872.5 | 19.2% |
| | IMPLND 33 | Developed, low intensity | 4,239.0 | 10.3% |
| | PERLND 34 | Developed, medium intensity | 1,611.4 | 3.9% |
| 11 | IMPLND 34 | Developed, medium intensity | 2,992.6 | 7.3% |
| | PERLND 35 | Developed, high intensity | 123.4 | 0.3% |
| | IMPLND 35 | Developed, high intensity | 1,110.2 | 2.7% |
| | PERLND 36 | Forest | 1,382.3 | 3.4% |
| | PERLND 37 | Grassland/Herbaceous | 293.8 | 0.7% |
| | PERLND 38 | Agriculture | 9,253.1 | 22.5% |
| | PERLND 39 | Wetlands | 3.7 | 0.0% |
| | 11 TOTAL | | 41,064.2 | 100.0% |
| | PERLND 271 | Open water | 132.9 | 0.1% |
| | PERLND 272 | Developed, open space | 4,086.8 | 3.9% |
| | IMPLND 272 | Developed, open space | 454.1 | 0.4% |
| | PERLND 273 | Developed, low intensity | 760.1 | 0.7% |
| | IMPLND 273 | Developed, low intensity | 409.3 | 0.4% |
| | PERLND 274 | Developed, medium intensity | 110.5 | 0.1% |
| 12 | IMPLND 274 | Developed, medium intensity | 205.3 | 0.2% |
| | PERLND 275 | Developed, high intensity | 7.3 | 0.0% |
| | IMPLND 275 | Developed, high intensity | 65.8 | 0.1% |
| | PERLND 276 | Forest | 5,592.0 | 5.4% |
| | PERLND 277 | Grassland/Herbaceous | 646.3 | 0.6% |
| | PERLND 278 | Agriculture | 91,399.1 | 87.8% |
| | PERLND 279 | Wetlands | 207.3 | 0.2% |
| | 12 TOTAL | | 104,076.8 | 100.0% |

**Table A10.** Makeup of each reach by Hydrologic Response Unit (HRU) for the Upper Scioto River Basin HSPF model.—Continued

| RCHRES number | HRU | Land-cover classification | Area (acres) | Percent |
|---|---|---|---|---|
| 13 | PERLND 102 | Developed, open space | 37.8 | 9.9% |
| | IMPLND 102 | Developed, open space | 4.2 | 1.1% |
| | PERLND 103 | Developed, low intensity | 13.2 | 3.4% |
| | IMPLND 103 | Developed, low intensity | 7.1 | 1.9% |
| | PERLND 104 | Developed, medium intensity | 4.6 | 1.2% |
| | IMPLND 104 | Developed, medium intensity | 8.6 | 2.2% |
| | PERLND 105 | Developed, high intensity | 0.0 | 0.0% |
| | IMPLND 105 | Developed, high intensity | 0.0 | 0.0% |
| | PERLND 106 | Forest | 181.0 | 47.2% |
| | PERLND 107 | Grassland/Herbaceous | 9.6 | 2.5% |
| | PERLND 108 | Agriculture | 117.5 | 30.6% |
| | PERLND 109 | Wetlands | 0.0 | 0.0% |
| | 13 TOTAL | | 383.6 | 100.0% |
| 14 | PERLND 161 | Open water | 249.8 | 0.8% |
| | PERLND 162 | Developed, open space | 4,776.4 | 16.2% |
| | IMPLND 162 | Developed, open space | 530.7 | 1.8% |
| | PERLND 163 | Developed, low intensity | 6,695.0 | 22.7% |
| | IMPLND 163 | Developed, low intensity | 3,605.0 | 12.2% |
| | PERLND 164 | Developed, medium intensity | 2,906.5 | 9.9% |
| | IMPLND 164 | Developed, medium intensity | 5,397.8 | 18.3% |
| | PERLND 165 | Developed, high intensity | 382.2 | 1.3% |
| | IMPLND 165 | Developed, high intensity | 3,439.8 | 11.7% |
| | PERLND 166 | Forest | 1,112.4 | 3.8% |
| | PERLND 167 | Grassland/Herbaceous | 140.1 | 0.5% |
| | PERLND 168 | Agriculture | 196.2 | 0.7% |
| | PERLND 169 | Wetlands | 0.0 | 0.0% |
| | 14 TOTAL | | 29,431.9 | 100.0% |
| 15 | PERLND 31 | Open water | 467.7 | 2.9% |
| | PERLND 32 | Developed, open space | 3,496.8 | 21.9% |
| | IMPLND 32 | Developed, open space | 388.5 | 2.4% |
| | PERLND 33 | Developed, low intensity | 3,482.6 | 21.8% |
| | IMPLND 33 | Developed, low intensity | 1,875.3 | 11.7% |
| | PERLND 34 | Developed, medium intensity | 1,228.6 | 7.7% |
| | IMPLND 34 | Developed, medium intensity | 2,281.6 | 14.3% |
| | PERLND 35 | Developed, high intensity | 241.3 | 1.5% |
| | IMPLND 35 | Developed, high intensity | 2,171.5 | 13.6% |
| | PERLND 36 | Forest | 338.6 | 2.1% |
| | PERLND 37 | Grassland/Herbaceous | 1.2 | 0.0% |
| | PERLND 38 | Agriculture | 0.0 | 0.0% |
| | PERLND 39 | Wetlands | 24.4 | 0.2% |
| | 15 TOTAL | | 15,998.1 | 100.0% |

**Table A10.** Makeup of each reach by Hydrologic Response Unit (HRU) for the Upper Scioto River Basin HSPF model.—Continued

| RCHRES number | HRU | Land-cover classification | Area (acres) | Percent |
|---|---|---|---|---|
| 16 | PERLND 161 | Open water | 297.8 | 6.3% |
| | PERLND 162 | Developed, open space | 157.5 | 3.3% |
| | IMPLND 162 | Developed, open space | 17.5 | 0.4% |
| | PERLND 163 | Developed, low intensity | 448.0 | 9.4% |
| | IMPLND 163 | Developed, low intensity | 241.2 | 5.1% |
| | PERLND 164 | Developed, medium intensity | 725.4 | 15.3% |
| | IMPLND 164 | Developed, medium intensity | 1,347.1 | 28.4% |
| | PERLND 165 | Developed, high intensity | 142.5 | 3.0% |
| | IMPLND 165 | Developed, high intensity | 1,282.1 | 27.0% |
| | PERLND 166 | Forest | 80.2 | 1.7% |
| | PERLND 167 | Grassland/Herbaceous | 2.4 | 0.1% |
| | PERLND 168 | Agriculture | 0.0 | 0.0% |
| | PERLND 169 | Wetlands | 4.9 | 0.1% |
| | 16 TOTAL | | 4,746.6 | 100.0% |
| 17 | PERLND 261 | Open water | 47.5 | 0.2% |
| | PERLND 262 | Developed, open space | 2,144.5 | 9.3% |
| | IMPLND 262 | Developed, open space | 238.3 | 1.0% |
| | PERLND 263 | Developed, low intensity | 1,688.1 | 7.4% |
| | IMPLND 263 | Developed, low intensity | 909.0 | 4.0% |
| | PERLND 264 | Developed, medium intensity | 209.2 | 0.9% |
| | IMPLND 264 | Developed, medium intensity | 388.6 | 1.7% |
| | PERLND 265 | Developed, high intensity | 2.1 | 0.0% |
| | IMPLND 265 | Developed, high intensity | 18.6 | 0.1% |
| | PERLND 266 | Forest | 1,071.5 | 4.7% |
| | PERLND 267 | Grassland/Herbaceous | 334.8 | 1.5% |
| | PERLND 268 | Agriculture | 15,876.1 | 69.2% |
| | PERLND 269 | Wetlands | 9.7 | 0.0% |
| | 17 TOTAL | | 22,938.0 | 100.0% |
| 18 | PERLND 131 | Open water | 117.0 | 2.1% |
| | PERLND 132 | Developed, open space | 789.0 | 14.1% |
| | IMPLND 132 | Developed, open space | 87.7 | 1.6% |
| | PERLND 133 | Developed, low intensity | 1,449.5 | 25.8% |
| | IMPLND 133 | Developed, low intensity | 780.5 | 13.9% |
| | PERLND 134 | Developed, medium intensity | 348.6 | 6.2% |
| | IMPLND 134 | Developed, medium intensity | 647.5 | 11.5% |
| | PERLND 135 | Developed, high intensity | 39.3 | 0.7% |
| | IMPLND 135 | Developed, high intensity | 353.3 | 6.3% |
| | PERLND 136 | Forest | 558.4 | 10.0% |
| | PERLND 137 | Grassland/Herbaceous | 63.4 | 1.1% |
| | PERLND 138 | Agriculture | 326.8 | 5.8% |
| | PERLND 139 | Wetlands | 50.0 | 0.9% |
| | 18 TOTAL | | 5,611.0 | 100.0% |

**Table A10.** Makeup of each reach by Hydrologic Response Unit (HRU) for the Upper Scioto River Basin HSPF model.—Continued

| RCHRES number | HRU | Land-cover classification | Area (acres) | Percent |
|---|---|---|---|---|
| 19 | PERLND 251 | Open water | 13.4 | 1.1% |
| | PERLND 252 | Developed, open space | 44.9 | 3.6% |
| | IMPLND 252 | Developed, open space | 5.0 | 0.4% |
| | PERLND 253 | Developed, low intensity | 58.5 | 4.7% |
| | IMPLND 253 | Developed, low intensity | 31.5 | 2.5% |
| | PERLND 254 | Developed, medium intensity | 0.4 | 0.0% |
| | IMPLND 254 | Developed, medium intensity | 0.8 | 0.1% |
| | PERLND 255 | Developed, high intensity | 0.0 | 0.0% |
| | IMPLND 255 | Developed, high intensity | 0.0 | 0.0% |
| | PERLND 256 | Forest | 238.3 | 19.2% |
| | PERLND 257 | Grassland/Herbaceous | 4.9 | 0.4% |
| | PERLND 258 | Agriculture | 846.1 | 68.0% |
| | PERLND 259 | Wetlands | 0.0 | 0.0% |
| | 19 TOTAL | | 1,243.8 | 100.0% |
| 20 | PERLND 91 | Open water | 688.9 | 12.0% |
| | PERLND 92 | Developed, open space | 570.7 | 9.9% |
| | IMPLND 92 | Developed, open space | 63.4 | 1.1% |
| | PERLND 93 | Developed, low intensity | 374.2 | 6.5% |
| | IMPLND 93 | Developed, low intensity | 201.5 | 3.5% |
| | PERLND 94 | Developed, medium intensity | 63.9 | 1.1% |
| | IMPLND 94 | Developed, medium intensity | 118.7 | 2.1% |
| | PERLND 95 | Developed, high intensity | 15.7 | 0.3% |
| | IMPLND 95 | Developed, high intensity | 141.3 | 2.5% |
| | PERLND 96 | Forest | 564.8 | 9.8% |
| | PERLND 97 | Grassland/Herbaceous | 64.5 | 1.1% |
| | PERLND 98 | Agriculture | 2,805.6 | 48.7% |
| | PERLND 99 | Wetlands | 90.1 | 1.6% |
| | 20 TOTAL | | 5,763.3 | 100.0% |
| 21 | PERLND 21 | Open water | 1,289.6 | 2.2% |
| | PERLND 22 | Developed, open space | 9,556.3 | 16.5% |
| | IMPLND 22 | Developed, open space | 1,061.8 | 1.8% |
| | PERLND 23 | Developed, low intensity | 9,387.2 | 16.2% |
| | IMPLND 23 | Developed, low intensity | 5,054.6 | 8.7% |
| | PERLND 24 | Developed, medium intensity | 2,837.5 | 4.9% |
| | IMPLND 24 | Developed, medium intensity | 5,269.6 | 9.1% |
| | PERLND 25 | Developed, high intensity | 341.9 | 0.6% |
| | IMPLND 25 | Developed, high intensity | 3,077.2 | 5.3% |
| | PERLND 26 | Forest | 3,405.7 | 5.9% |
| | PERLND 27 | Grassland/Herbaceous | 164.6 | 0.3% |
| | PERLND 28 | Agriculture | 16,355.6 | 28.3% |
| | PERLND 29 | Wetlands | 28.0 | 0.0% |
| | 21 TOTAL | | 57,829.6 | 100.0% |

**Table A10.** Makeup of each reach by Hydrologic Response Unit (HRU) for the Upper Scioto River Basin HSPF model.—Continued

| RCHRES number | HRU | Land-cover classification | Area (acres) | Percent |
|---|---|---|---|---|
| | PERLND 241 | Open water | 302.4 | 2.2% |
| | PERLND 242 | Developed, open space | 391.8 | 2.8% |
| | IMPLND 242 | Developed, open space | 43.5 | 0.3% |
| | PERLND 243 | Developed, low intensity | 36.5 | 0.3% |
| | IMPLND 243 | Developed, low intensity | 19.6 | 0.1% |
| | PERLND 244 | Developed, medium intensity | 2.1 | 0.0% |
| 22 | IMPLND 244 | Developed, medium intensity | 4.0 | 0.0% |
| | PERLND 245 | Developed, high intensity | 0.2 | 0.0% |
| | IMPLND 245 | Developed, high intensity | 2.2 | 0.0% |
| | PERLND 246 | Forest | 1,254.8 | 8.9% |
| | PERLND 247 | Grassland/Herbaceous | 25.6 | 0.2% |
| | PERLND 248 | Agriculture | 11,922.8 | 85.0% |
| | PERLND 249 | Wetlands | 23.2 | 0.2% |
| | 22 TOTAL | | 14,028.7 | 100.0% |
| | PERLND 11 | Open water | 225.5 | 1.6% |
| | PERLND 12 | Developed, open space | 1,183.8 | 8.4% |
| | IMPLND 12 | Developed, open space | 131.5 | 0.9% |
| | PERLND 13 | Developed, low intensity | 602.2 | 4.3% |
| | IMPLND 13 | Developed, low intensity | 324.3 | 2.3% |
| | PERLND 14 | Developed, medium intensity | 201.4 | 1.4% |
| 23 | IMPLND 14 | Developed, medium intensity | 374.0 | 2.6% |
| | PERLND 15 | Developed, high intensity | 5.7 | 0.0% |
| | IMPLND 15 | Developed, high intensity | 51.6 | 0.4% |
| | PERLND 16 | Forest | 2,174.8 | 15.4% |
| | PERLND 17 | Grassland/Herbaceous | 92.6 | 0.7% |
| | PERLND 18 | Agriculture | 8,723.7 | 61.8% |
| | PERLND 19 | Wetlands | 32.9 | 0.2% |
| | 23 TOTAL | | 14,124.0 | 100.0% |
| | PERLND 11 | Open water | 427.7 | 2.1% |
| | PERLND 12 | Developed, open space | 953.1 | 4.7% |
| | IMPLND 12 | Developed, open space | 105.9 | 0.5% |
| | PERLND 13 | Developed, low intensity | 308.9 | 1.5% |
| | IMPLND 13 | Developed, low intensity | 166.3 | 0.8% |
| | PERLND 14 | Developed, medium intensity | 49.5 | 0.2% |
| 24 | IMPLND 14 | Developed, medium intensity | 91.9 | 0.4% |
| | PERLND 15 | Developed, high intensity | 2.7 | 0.0% |
| | IMPLND 15 | Developed, high intensity | 24.1 | 0.1% |
| | PERLND 16 | Forest | 1,759.6 | 8.6% |
| | PERLND 17 | Grassland/Herbaceous | 59.7 | 0.3% |
| | PERLND 18 | Agriculture | 16,224.2 | 79.3% |
| | PERLND 19 | Wetlands | 287.6 | 1.4% |
| | 24 TOTAL | | 20,461.2 | 100.0% |

**Table A10.** Makeup of each reach by Hydrologic Response Unit (HRU) for the Upper Scioto River Basin HSPF model.—Continued

| RCHRES number | HRU | Land-cover classification | Area (acres) | Percent |
|---|---|---|---|---|
| 25 | PERLND 221 | Open water | 42.6 | 0.5% |
| | PERLND 222 | Developed, open space | 621.2 | 7.8% |
| | IMPLND 222 | Developed, open space | 69.0 | 0.9% |
| | PERLND 223 | Developed, low intensity | 255.6 | 3.2% |
| | IMPLND 223 | Developed, low intensity | 137.6 | 1.7% |
| | PERLND 224 | Developed, medium intensity | 20.5 | 0.3% |
| | IMPLND 224 | Developed, medium intensity | 38.0 | 0.5% |
| | PERLND 225 | Developed, high intensity | 1.8 | 0.0% |
| | IMPLND 225 | Developed, high intensity | 16.4 | 0.2% |
| | PERLND 226 | Forest | 564.9 | 7.1% |
| | PERLND 227 | Grassland/Herbaceous | 11.0 | 0.1% |
| | PERLND 228 | Agriculture | 6,189.3 | 77.7% |
| | PERLND 229 | Wetlands | 2.4 | 0.0% |
| | 25 TOTAL | | 7,970.3 | 100.0% |
| 26 | PERLND 221 | Open water | 383.7 | 0.5% |
| | PERLND 222 | Developed, open space | 8,117.8 | 10.1% |
| | IMPLND 222 | Developed, open space | 902.0 | 1.1% |
| | PERLND 223 | Developed, low intensity | 2,832.9 | 3.5% |
| | IMPLND 223 | Developed, low intensity | 1,525.4 | 1.9% |
| | PERLND 224 | Developed, medium intensity | 476.8 | 0.6% |
| | IMPLND 224 | Developed, medium intensity | 885.5 | 1.1% |
| | PERLND 225 | Developed, high intensity | 93.3 | 0.1% |
| | IMPLND 225 | Developed, high intensity | 840.1 | 1.0% |
| | PERLND 226 | Forest | 10,031.4 | 12.4% |
| | PERLND 227 | Grassland/Herbaceous | 272.5 | 0.3% |
| | PERLND 228 | Agriculture | 54,135.5 | 67.2% |
| | PERLND 229 | Wetlands | 78.2 | 0.1% |
| | 26 TOTAL | | 80,575.1 | 100.0% |
| 27 | PERLND 231 | Open water | 141.5 | 0.2% |
| | PERLND 232 | Developed, open space | 7,181.1 | 7.6% |
| | IMPLND 232 | Developed, open space | 797.9 | 0.8% |
| | PERLND 233 | Developed, low intensity | 1,702.1 | 1.8% |
| | IMPLND 233 | Developed, low intensity | 916.5 | 1.0% |
| | PERLND 234 | Developed, medium intensity | 213.0 | 0.2% |
| | IMPLND 234 | Developed, medium intensity | 395.6 | 0.4% |
| | PERLND 235 | Developed, high intensity | 10.0 | 0.0% |
| | IMPLND 235 | Developed, high intensity | 90.0 | 0.1% |
| | PERLND 236 | Forest | 14,716.3 | 15.6% |
| | PERLND 237 | Grassland/Herbaceous | 374.4 | 0.4% |
| | PERLND 238 | Agriculture | 67,371.2 | 71.5% |
| | PERLND 239 | Wetlands | 290.3 | 0.3% |
| | 27 TOTAL | | 94,199.9 | 100.0% |

**Table A10.** Makeup of each reach by Hydrologic Response Unit (HRU) for the Upper Scioto River Basin HSPF model.—Continued

| RCHRES number | HRU | Land-cover classification | Area (acres) | Percent |
|---|---|---|---|---|
| 28 | PERLND 11 | Open water | 411.7 | 1.3% |
| | PERLND 12 | Developed, open space | 1,995.0 | 6.1% |
| | IMPLND 12 | Developed, open space | 221.7 | 0.7% |
| | PERLND 13 | Developed, low intensity | 479.8 | 1.5% |
| | IMPLND 13 | Developed, low intensity | 258.3 | 0.8% |
| | PERLND 14 | Developed, medium intensity | 60.5 | 0.2% |
| | IMPLND 14 | Developed, medium intensity | 112.4 | 0.3% |
| | PERLND 15 | Developed, high intensity | 26.6 | 0.1% |
| | IMPLND 15 | Developed, high intensity | 239.0 | 0.7% |
| | PERLND 16 | Forest | 1,738.0 | 5.3% |
| | PERLND 17 | Grassland/Herbaceous | 47.5 | 0.1% |
| | PERLND 18 | Agriculture | 26,948.8 | 82.7% |
| | PERLND 19 | Wetlands | 65.8 | 0.2% |
| | 28 TOTAL | | 32,605.1 | 100.0% |
| 29 | PERLND 11 | Open water | 101.0 | 1.6% |
| | PERLND 12 | Developed, open space | 271.5 | 4.2% |
| | IMPLND 12 | Developed, open space | 30.2 | 0.5% |
| | PERLND 13 | Developed, low intensity | 111.5 | 1.7% |
| | IMPLND 13 | Developed, low intensity | 60.0 | 0.9% |
| | PERLND 14 | Developed, medium intensity | 19.2 | 0.3% |
| | IMPLND 14 | Developed, medium intensity | 35.6 | 0.6% |
| | PERLND 15 | Developed, high intensity | 0.0 | 0.0% |
| | IMPLND 15 | Developed, high intensity | 0.0 | 0.0% |
| | PERLND 16 | Forest | 367.4 | 5.7% |
| | PERLND 17 | Grassland/Herbaceous | 15.8 | 0.2% |
| | PERLND 18 | Agriculture | 5,412.1 | 84.2% |
| | PERLND 19 | Wetlands | 1.2 | 0.0% |
| | 29 TOTAL | | 6,425.5 | 100.0% |
| 30 | PERLND 91 | Open water | 171.9 | 2.7% |
| | PERLND 92 | Developed, open space | 1,318.0 | 20.3% |
| | IMPLND 92 | Developed, open space | 146.4 | 2.3% |
| | PERLND 93 | Developed, low intensity | 1,051.7 | 16.2% |
| | IMPLND 93 | Developed, low intensity | 566.3 | 8.7% |
| | PERLND 94 | Developed, medium intensity | 294.0 | 4.5% |
| | IMPLND 94 | Developed, medium intensity | 546.1 | 8.4% |
| | PERLND 95 | Developed, high intensity | 73.2 | 1.1% |
| | IMPLND 95 | Developed, high intensity | 658.4 | 10.2% |
| | PERLND 96 | Forest | 770.6 | 11.9% |
| | PERLND 97 | Grassland/Herbaceous | 50.0 | 0.8% |
| | PERLND 98 | Agriculture | 771.8 | 11.9% |
| | PERLND 99 | Wetlands | 58.5 | 0.9% |
| | 30 TOTAL | | 6,476.9 | 100.0% |

**Table A10.** Makeup of each reach by Hydrologic Response Unit (HRU) for the Upper Scioto River Basin HSPF model.—Continued

| RCHRES number | HRU | Land-cover classification | Area (acres) | Percent |
|---|---|---|---|---|
| 31 | PERLND 251 | Open water | 438.8 | 1.1% |
| | PERLND 252 | Developed, open space | 2,307.2 | 5.6% |
| | IMPLND 252 | Developed, open space | 256.4 | 0.6% |
| | PERLND 253 | Developed, low intensity | 714.7 | 1.7% |
| | IMPLND 253 | Developed, low intensity | 384.8 | 0.9% |
| | PERLND 254 | Developed, medium intensity | 63.6 | 0.2% |
| | IMPLND 254 | Developed, medium intensity | 118.1 | 0.3% |
| | PERLND 255 | Developed, high intensity | 1.0 | 0.0% |
| | IMPLND 255 | Developed, high intensity | 8.8 | 0.0% |
| | PERLND 256 | Forest | 6,457.1 | 15.7% |
| | PERLND 257 | Grassland/Herbaceous | 386.4 | 0.9% |
| | PERLND 258 | Agriculture | 29,957.0 | 72.8% |
| | PERLND 259 | Wetlands | 61.0 | 0.1% |
| | 31 TOTAL | | 41,154.9 | 100.0% |
| 32 | PERLND 101 | Open water | 174.3 | 0.4% |
| | PERLND 102 | Developed, open space | 6,848.1 | 16.9% |
| | IMPLND 102 | Developed, open space | 760.9 | 1.9% |
| | PERLND 103 | Developed, low intensity | 4,675.7 | 11.5% |
| | IMPLND 103 | Developed, low intensity | 2,517.7 | 6.2% |
| | PERLND 104 | Developed, medium intensity | 1,040.6 | 2.6% |
| | IMPLND 104 | Developed, medium intensity | 1,932.5 | 4.8% |
| | PERLND 105 | Developed, high intensity | 116.7 | 0.3% |
| | IMPLND 105 | Developed, high intensity | 1,049.9 | 2.6% |
| | PERLND 106 | Forest | 7,690.7 | 19.0% |
| | PERLND 107 | Grassland/Herbaceous | 343.8 | 0.8% |
| | PERLND 108 | Agriculture | 13,142.0 | 32.4% |
| | PERLND 109 | Wetlands | 281.6 | 0.7% |
| | 32 TOTAL | | 40,574.5 | 100.0% |
| 33 | PERLND 101 | Open water | 346.0 | 0.7% |
| | PERLND 102 | Developed, open space | 10,531.9 | 20.2% |
| | IMPLND 102 | Developed, open space | 1,170.2 | 2.2% |
| | PERLND 103 | Developed, low intensity | 8,300.2 | 15.9% |
| | IMPLND 103 | Developed, low intensity | 4,469.3 | 8.6% |
| | PERLND 104 | Developed, medium intensity | 2,499.9 | 4.8% |
| | IMPLND 104 | Developed, medium intensity | 4,642.7 | 8.9% |
| | PERLND 105 | Developed, high intensity | 369.3 | 0.7% |
| | IMPLND 105 | Developed, high intensity | 3,323.8 | 6.4% |
| | PERLND 106 | Forest | 8,463.5 | 16.2% |
| | PERLND 107 | Grassland/Herbaceous | 387.5 | 0.7% |
| | PERLND 108 | Agriculture | 7,602.0 | 14.6% |
| | PERLND 109 | Wetlands | 136.5 | 0.3% |
| | 33 TOTAL | | 52,242.8 | 100.0% |

**Table A10.** Makeup of each reach by Hydrologic Response Unit (HRU) for the Upper Scioto River Basin HSPF model.—Continued

| RCHRES number | HRU | Land-cover classification | Area (acres) | Percent |
|---|---|---|---|---|
| | PERLND 131 | Open water | 226.6 | 0.5% |
| | PERLND 132 | Developed, open space | 8,568.7 | 19.7% |
| | IMPLND 132 | Developed, open space | 952.1 | 2.2% |
| | PERLND 133 | Developed, low intensity | 9,641.5 | 22.1% |
| | IMPLND 133 | Developed, low intensity | 5,191.6 | 11.9% |
| | PERLND 134 | Developed, medium intensity | 3,011.2 | 6.9% |
| 34 | IMPLND 134 | Developed, medium intensity | 5,592.1 | 12.8% |
| | PERLND 135 | Developed, high intensity | 316.2 | 0.7% |
| | IMPLND 135 | Developed, high intensity | 2,845.6 | 6.5% |
| | PERLND 136 | Forest | 4,561.8 | 10.5% |
| | PERLND 137 | Grassland/Herbaceous | 224.2 | 0.5% |
| | PERLND 138 | Agriculture | 2,433.2 | 5.6% |
| | PERLND 139 | Wetlands | 23.2 | 0.1% |
| | 34 TOTAL | | 43,588.0 | 100.0% |
| | PERLND 251 | Open water | 31.7 | 0.3% |
| | PERLND 252 | Developed, open space | 308.1 | 3.0% |
| | IMPLND 252 | Developed, open space | 34.2 | 0.3% |
| | PERLND 253 | Developed, low intensity | 242.3 | 2.4% |
| | IMPLND 253 | Developed, low intensity | 130.5 | 1.3% |
| | PERLND 254 | Developed, medium intensity | 27.7 | 0.3% |
| 35 | IMPLND 254 | Developed, medium intensity | 51.5 | 0.5% |
| | PERLND 255 | Developed, high intensity | 2.1 | 0.0% |
| | IMPLND 255 | Developed, high intensity | 18.6 | 0.2% |
| | PERLND 256 | Forest | 1,011.0 | 10.0% |
| | PERLND 257 | Grassland/Herbaceous | 82.8 | 0.8% |
| | PERLND 258 | Agriculture | 8,153.8 | 80.4% |
| | PERLND 259 | Wetlands | 48.7 | 0.5% |
| | 35 TOTAL | | 10,143.0 | 100.0% |
| | PERLND 171 | Open water | 151.1 | 0.8% |
| | PERLND 172 | Developed, open space | 3,758.2 | 20.7% |
| | IMPLND 172 | Developed, open space | 417.6 | 2.3% |
| | PERLND 173 | Developed, low intensity | 2,640.6 | 14.5% |
| | IMPLND 173 | Developed, low intensity | 1,421.8 | 7.8% |
| | PERLND 174 | Developed, medium intensity | 534.8 | 2.9% |
| 36 | IMPLND 174 | Developed, medium intensity | 993.2 | 5.5% |
| | PERLND 175 | Developed, high intensity | 54.2 | 0.3% |
| | IMPLND 175 | Developed, high intensity | 488.0 | 2.7% |
| | PERLND 176 | Forest | 4,200.1 | 23.1% |
| | PERLND 177 | Grassland/Herbaceous | 73.1 | 0.4% |
| | PERLND 178 | Agriculture | 3,445.9 | 19.0% |
| | PERLND 179 | Wetlands | 1.2 | 0.0% |
| | 36 TOTAL | | 18,179.8 | 100.0% |

**Table A10.** Makeup of each reach by Hydrologic Response Unit (HRU) for the Upper Scioto River Basin HSPF model.—Continued

| RCHRES number | HRU | Land-cover classification | Area (acres) | Percent |
|---|---|---|---|---|
| 37 | PERLND 261 | Open water | 867.8 | 0.5% |
| | PERLND 262 | Developed, open space | 7,147.3 | 4.4% |
| | IMPLND 262 | Developed, open space | 794.1 | 0.5% |
| | PERLND 263 | Developed, low intensity | 2,078.7 | 1.3% |
| | IMPLND 263 | Developed, low intensity | 1,119.3 | 0.7% |
| | PERLND 264 | Developed, medium intensity | 311.8 | 0.2% |
| | IMPLND 264 | Developed, medium intensity | 579.1 | 0.4% |
| | PERLND 265 | Developed, high intensity | 58.1 | 0.0% |
| | IMPLND 265 | Developed, high intensity | 523.2 | 0.3% |
| | PERLND 266 | Forest | 13,831.8 | 8.5% |
| | PERLND 267 | Grassland/Herbaceous | 1,358.9 | 0.8% |
| | PERLND 268 | Agriculture | 133,133.0 | 82.1% |
| | PERLND 269 | Wetlands | 285.2 | 0.2% |
| | 37 TOTAL | | 162,088.3 | 100.0% |
| 38 | PERLND 111 | Open water | 2,983.1 | 5.3% |
| | PERLND 112 | Developed, open space | 4,503.1 | 8.0% |
| | IMPLND 112 | Developed, open space | 500.3 | 0.9% |
| | PERLND 113 | Developed, low intensity | 860.2 | 1.5% |
| | IMPLND 113 | Developed, low intensity | 463.2 | 0.8% |
| | PERLND 114 | Developed, medium intensity | 127.1 | 0.2% |
| | IMPLND 114 | Developed, medium intensity | 236.0 | 0.4% |
| | PERLND 115 | Developed, high intensity | 7.4 | 0.0% |
| | IMPLND 115 | Developed, high intensity | 66.9 | 0.1% |
| | PERLND 116 | Forest | 13,203.2 | 23.4% |
| | PERLND 117 | Grassland/Herbaceous | 453.3 | 0.8% |
| | PERLND 118 | Agriculture | 32,901.5 | 58.2% |
| | PERLND 119 | Wetlands | 187.7 | 0.3% |
| | 38 TOTAL | | 56,493.0 | 100.0% |
| 39 | PERLND 41 | Open water | 992.2 | 5.1% |
| | PERLND 42 | Developed, open space | 3,113.4 | 16.1% |
| | IMPLND 42 | Developed, open space | 345.9 | 1.8% |
| | PERLND 43 | Developed, low intensity | 768.5 | 4.0% |
| | IMPLND 43 | Developed, low intensity | 413.8 | 2.1% |
| | PERLND 44 | Developed, medium intensity | 55.9 | 0.3% |
| | IMPLND 44 | Developed, medium intensity | 103.8 | 0.5% |
| | PERLND 45 | Developed, high intensity | 4.1 | 0.0% |
| | IMPLND 45 | Developed, high intensity | 37.3 | 0.2% |
| | PERLND 46 | Forest | 2,353.7 | 12.2% |
| | PERLND 47 | Grassland/Herbaceous | 370.6 | 1.9% |
| | PERLND 48 | Agriculture | 10,758.2 | 55.7% |
| | PERLND 49 | Wetlands | 8.5 | 0.0% |
| | 39 TOTAL | | 19,325.9 | 100.0% |

**Table A10.** Makeup of each reach by Hydrologic Response Unit (HRU) for the Upper Scioto River Basin HSPF model.—Continued

| RCHRES number | HRU | Land-cover classification | Area (acres) | Percent |
|---|---|---|---|---|
| | PERLND 151 | Open water | 95.1 | 0.2% |
| | PERLND 152 | Developed, open space | 1,869.0 | 4.5% |
| | IMPLND 152 | Developed, open space | 207.7 | 0.5% |
| | PERLND 153 | Developed, low intensity | 419.1 | 1.0% |
| | IMPLND 153 | Developed, low intensity | 225.6 | 0.5% |
| | PERLND 154 | Developed, medium intensity | 26.9 | 0.1% |
| 40 | IMPLND 154 | Developed, medium intensity | 49.9 | 0.1% |
| | PERLND 155 | Developed, high intensity | 0.5 | 0.0% |
| | IMPLND 155 | Developed, high intensity | 4.4 | 0.0% |
| | PERLND 156 | Forest | 9,886.1 | 23.8% |
| | PERLND 157 | Grassland/Herbaceous | 59.7 | 0.1% |
| | PERLND 158 | Agriculture | 28,522.5 | 68.7% |
| | PERLND 159 | Wetlands | 177.9 | 0.4% |
| | 40 TOTAL | | 41,544.4 | 100.0% |
| | PERLND 41 | Open water | 12.2 | 1.8% |
| | PERLND 42 | Developed, open space | 39.4 | 5.7% |
| | IMPLND 42 | Developed, open space | 4.4 | 0.6% |
| | PERLND 43 | Developed, low intensity | 11.1 | 1.6% |
| | IMPLND 43 | Developed, low intensity | 6.0 | 0.9% |
| | PERLND 44 | Developed, medium intensity | 0.4 | 0.1% |
| 41 | IMPLND 44 | Developed, medium intensity | 0.8 | 0.1% |
| | PERLND 45 | Developed, high intensity | 0.0 | 0.0% |
| | IMPLND 45 | Developed, high intensity | 0.0 | 0.0% |
| | PERLND 46 | Forest | 113.2 | 16.3% |
| | PERLND 47 | Grassland/Herbaceous | 18.3 | 2.6% |
| | PERLND 48 | Agriculture | 488.0 | 70.3% |
| | PERLND 49 | Wetlands | 0.0 | 0.0% |
| | 41 TOTAL | | 693.8 | 100.0% |
| | PERLND 181 | Open water | 4.9 | 0.1% |
| | PERLND 182 | Developed, open space | 102.8 | 2.2% |
| | IMPLND 182 | Developed, open space | 11.4 | 0.2% |
| | PERLND 183 | Developed, low intensity | 76.6 | 1.6% |
| | IMPLND 183 | Developed, low intensity | 41.3 | 0.9% |
| | PERLND 184 | Developed, medium intensity | 3.0 | 0.1% |
| 42 | IMPLND 184 | Developed, medium intensity | 5.5 | 0.1% |
| | PERLND 185 | Developed, high intensity | 0.0 | 0.0% |
| | IMPLND 185 | Developed, high intensity | 0.0 | 0.0% |
| | PERLND 186 | Forest | 435.1 | 9.1% |
| | PERLND 187 | Grassland/Herbaceous | 20.7 | 0.4% |
| | PERLND 188 | Agriculture | 4,064.1 | 85.3% |
| | PERLND 189 | Wetlands | 0.0 | 0.0% |
| | 42 TOTAL | | 4,765.4 | 100.0% |

**Table A10.** Makeup of each reach by Hydrologic Response Unit (HRU) for the Upper Scioto River Basin HSPF model.—Continued

| RCHRES number | HRU | Land-cover classification | Area (acres) | Percent |
|---|---|---|---|---|
| | PERLND 181 | Open water | 772.7 | 8.1% |
| | PERLND 182 | Developed, open space | 165.6 | 1.7% |
| | IMPLND 182 | Developed, open space | 18.4 | 0.2% |
| | PERLND 183 | Developed, low intensity | 94.3 | 1.0% |
| | IMPLND 183 | Developed, low intensity | 50.8 | 0.5% |
| | PERLND 184 | Developed, medium intensity | 33.3 | 0.3% |
| 43 | IMPLND 184 | Developed, medium intensity | 61.8 | 0.6% |
| | PERLND 185 | Developed, high intensity | 0.4 | 0.0% |
| | IMPLND 185 | Developed, high intensity | 3.3 | 0.0% |
| | PERLND 186 | Forest | 2,594.7 | 27.1% |
| | PERLND 187 | Grassland/Herbaceous | 81.7 | 0.9% |
| | PERLND 188 | Agriculture | 5,668.3 | 59.2% |
| | PERLND 189 | Wetlands | 31.7 | 0.3% |
| | 43 TOTAL | | 9,577.0 | 100.0% |
| | PERLND 211 | Open water | 292.6 | 1.2% |
| | PERLND 212 | Developed, open space | 1,730.1 | 7.2% |
| | IMPLND 212 | Developed, open space | 192.2 | 0.8% |
| | PERLND 213 | Developed, low intensity | 132.9 | 0.5% |
| | IMPLND 213 | Developed, low intensity | 71.6 | 0.3% |
| | PERLND 214 | Developed, medium intensity | 9.4 | 0.0% |
| 44 | IMPLND 214 | Developed, medium intensity | 17.5 | 0.1% |
| | PERLND 215 | Developed, high intensity | 0.4 | 0.0% |
| | IMPLND 215 | Developed, high intensity | 3.3 | 0.0% |
| | PERLND 216 | Forest | 8,056.7 | 33.3% |
| | PERLND 217 | Grassland/Herbaceous | 68.6 | 0.3% |
| | PERLND 218 | Agriculture | 13,600.9 | 56.2% |
| | PERLND 219 | Wetlands | 11.0 | 0.0% |
| | 44 TOTAL | | 24,187.2 | 100.0% |
| | PERLND 61 | Open water | 970.7 | 0.8% |
| | PERLND 62 | Developed, open space | 4,418.7 | 3.5% |
| | IMPLND 62 | Developed, open space | 491.0 | 0.4% |
| | PERLND 63 | Developed, low intensity | 1,237.4 | 1.0% |
| | IMPLND 63 | Developed, low intensity | 666.3 | 0.5% |
| | PERLND 64 | Developed, medium intensity | 52.9 | 0.0% |
| 45 | IMPLND 64 | Developed, medium intensity | 98.3 | 0.1% |
| | PERLND 65 | Developed, high intensity | 5.9 | 0.0% |
| | IMPLND 65 | Developed, high intensity | 52.7 | 0.0% |
| | PERLND 66 | Forest | 8,964.5 | 7.1% |
| | PERLND 67 | Grassland/Herbaceous | 1,015.8 | 0.8% |
| | PERLND 68 | Agriculture | 106,843.3 | 85.0% |
| | PERLND 69 | Wetlands | 911.0 | 0.7% |
| | 45 TOTAL | | 125,728.5 | 100.0% |

**Table A10.** Makeup of each reach by Hydrologic Response Unit (HRU) for the Upper Scioto River Basin HSPF model.—Continued

| RCHRES number | HRU | Land-cover classification | Area (acres) | Percent |
|---|---|---|---|---|
| | PERLND 71 | Open water | 177.3 | 0.2% |
| | PERLND 72 | Developed, open space | 4,254.7 | 5.2% |
| | IMPLND 72 | Developed, open space | 472.7 | 0.6% |
| | PERLND 73 | Developed, low intensity | 897.4 | 1.1% |
| | IMPLND 73 | Developed, low intensity | 483.2 | 0.6% |
| | PERLND 74 | Developed, medium intensity | 132.7 | 0.2% |
| 46 | IMPLND 74 | Developed, medium intensity | 246.4 | 0.3% |
| | PERLND 75 | Developed, high intensity | 28.1 | 0.0% |
| | IMPLND 75 | Developed, high intensity | 253.1 | 0.3% |
| | PERLND 76 | Forest | 7,107.0 | 8.7% |
| | PERLND 77 | Grassland/Herbaceous | 1,111.5 | 1.4% |
| | PERLND 78 | Agriculture | 66,302.2 | 81.2% |
| | PERLND 79 | Wetlands | 225.0 | 0.3% |
| | 46 TOTAL | | 81,691.3 | 100.0% |
| | PERLND 71 | Open water | 52.9 | 0.1% |
| | PERLND 72 | Developed, open space | 3,524.3 | 4.2% |
| | IMPLND 72 | Developed, open space | 391.6 | 0.5% |
| | PERLND 73 | Developed, low intensity | 335.0 | 0.4% |
| | IMPLND 73 | Developed, low intensity | 180.4 | 0.2% |
| | PERLND 74 | Developed, medium intensity | 22.4 | 0.0% |
| 47 | IMPLND 74 | Developed, medium intensity | 41.6 | 0.0% |
| | PERLND 75 | Developed, high intensity | 3.1 | 0.0% |
| | IMPLND 75 | Developed, high intensity | 27.7 | 0.0% |
| | PERLND 76 | Forest | 4,078.2 | 4.9% |
| | PERLND 77 | Grassland/Herbaceous | 1,117.9 | 1.3% |
| | PERLND 78 | Agriculture | 73,547.7 | 88.1% |
| | PERLND 79 | Wetlands | 141.4 | 0.2% |
| | 47 TOTAL | | 83,464.2 | 100.0% |
| | PERLND 171 | Open water | 397.8 | 0.8% |
| | PERLND 172 | Developed, open space | 9,892.8 | 20.7% |
| | IMPLND 172 | Developed, open space | 1,099.2 | 2.3% |
| | PERLND 173 | Developed, low intensity | 6,944.6 | 14.5% |
| | IMPLND 173 | Developed, low intensity | 3,739.4 | 7.8% |
| | PERLND 174 | Developed, medium intensity | 1,405.9 | 2.9% |
| 48 | IMPLND 174 | Developed, medium intensity | 2,611.0 | 5.5% |
| | PERLND 175 | Developed, high intensity | 142.5 | 0.3% |
| | IMPLND 175 | Developed, high intensity | 1,282.1 | 2.7% |
| | PERLND 176 | Forest | 11,052.9 | 23.1% |
| | PERLND 177 | Grassland/Herbaceous | 192.5 | 0.4% |
| | PERLND 178 | Agriculture | 9,060.5 | 18.9% |
| | PERLND 179 | Wetlands | 3.2 | 0.0% |
| | 48 TOTAL | | 47,824.4 | 100.0% |

## Hydraulic Characteristics of RCHRESs (FTABLEs)

Relationships between depth, surface area, volume, and outflow for stream reaches and some reservoirs are input into HSPF as hydraulic function tables (FTABLEs), which are used to route water through reaches by means of kinematic-wave routing. FTABLEs representing RCHRESs 1, 2, 6, 7, 8, 10, 12, 13 16, 17, 23, 26, 29, 30, 31, 34, 36, 40, 42, 44, 45, and 46 were developed by using streamflow-measurement data from USGS streamgages. Streamflow-measurement data collected by the USGS include stage, stream width, cross-sectional area, and streamflow. These data were used along with the reach length to estimate the surface area (the product of stream width and reach length) and volume (the product of cross-sectional area and reach length) of the reach during each measurement. Surface area, volume, and streamflow were then tabulated as a function of stage, and FTABLEs were constructed on the basis of those tables.

For reaches that do not have an associated USGS streamgage, the stage, width, cross-sectional area and streamflow data from the nearest streamgage on the same stream were used to develop the FTABLE. Surface areas and volumes were determined as stated above, and streamflows were adjusted as a function of the ratio of drainage areas at the two locations. This approach was used for RCHRESs 3, 4, 5, 14, 15, 18, 19, 20, 21, 22, 24, 25, 27, 28, 33, 35, 37, 41, 43, 47, and 48. For RCHRES 32 (Blacklick Creek), no streamflow data were available, and so data from Alum Creek near Kilbourne (streamgage 03228750, RCHRES 40) were used to construct its FTABLE because of its similar drainage area.

FTABLEs for reservoirs were created from storage-capacity and spillway-rating curves supplied by the City of Columbus and U.S. Army Corps of Engineers (USACE). Outflows from two of the reservoirs (Alum Creek Lake and Delaware Lake) do not use FTABLEs but instead are computed in HSPF by use of algorithms referred to as “Special Actions” (Jobes and others, 2000).

The depth-area-volume relationship for Griggs Reservoir (RCHRES 11) was constructed from information contained in documents titled “Topographic Survey of Griggs Reservoir Water Surface / Elevation / Area / Capacity Relationship” and “Griggs Reservoir Spillway Rating Curve” supplied by the City of Columbus (Lynn Kelly, City of Columbus, written commun., 2011). Likewise, the depth-area-volume relationship for O’Shaughnessy Reservoir (RCHRES 39) was constructed from information contained in documents titled “O’Shaughnessy Reservoir Capacity, Area Flooded, Length and Average Width at Various Elevations” and “O’Shaughnessy Reservoir Spillway Rating Curve” also supplied by the City of Columbus (Lynn Kelly, City of Columbus, written commun., 2011).

The depth-area-volume relationship for Hoover Reservoir (RCHRES 38) was constructed from information contained in a document titled “Storage Capacity of Hoover Reservoir” and information from a spreadsheet titled” HooverReleaseEstimator.xls” supplied by the City of Columbus (Lynn Kelly, City of Columbus, written commun., 2011). The FTABLE for Hoover Reservoir contains three outflow columns, each representing a different outflow regime depending on the elevation of drum gates on the Hoover Reservoir dam (discussed further in the Hoover Reservoir section).

The depth-area-volume relationship for Delaware Lake (RCHRES 42) was constructed from information contained in a document titled “Delaware Reservoir Olentangy River Area and Capacity Tables” supplied by the USACE (Ben O’Dell, USACE, written commun., 2011). Outflows from Delaware Lake are varied as a function of downstream conditions and reservoir water levels, so outflows from Delaware Lake are computed in HSPF by means of Special Actions (discussed further in the Delaware Lake section).

The depth-area-volume relationship for Alum Creek Lake (RCHRES 9) was constructed from information contained in a document titled “Alum Creek Lake Area and Capacity Tables” supplied by the USACE (Bob Wattenschaidt, USACE, written commun., 2011). Like Delaware Lake, outflows from Alum Creek Lake are varied as a function of downstream conditions and reservoir water levels, so outflows from Alum Creek Lake also are computed in HSPF by means of Special Actions (discussed further in the Alum Creek Lake section).

## Water Withdrawals, Returns, and Diversions

Water withdrawals and returns were accounted for in the model by supplying time series of withdrawal and return data. As stated earlier, groundwater withdrawals and returns, other than those associated with major water suppliers, were not explicitly represented in the model. In no case does the model account for the direct effects of groundwater withdrawals on groundwater discharge to streams.

A diversion from Alum Creek Lake to Hoover Reservoir was included in the model. Any other transfers of water across basin boundaries that may exist were not directly represented in the model. Each individual withdrawal and return flow was represented in the model as a time series associated with the RCHRES where the facility is located.

# Reservoirs

There are five inline reservoirs (formed by damming valleys) in the Upper Scioto River Basin: Griggs Reservoir, O'Shaughnessy Reservoir, and Hoover Reservoir are water-supply reservoirs operated by the City of Columbus; and Delaware Lake and Alum Creek Lake are flood-control reservoirs operated by USACE. As of this writing (August 2014), there is one upground reservoir (formed by pumping water from the stream into an excavated area adjacent to the stream) in operation with two more planned. The upground reservoirs will be operated by the City of Columbus. The following sections describe the approach to handling each reservoir in the model. All reported elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29).

## Griggs Reservoir

Griggs Reservoir (RCHRES 11), on the Scioto River, is a water-supply reservoir for the City of Columbus, Ohio. The Griggs Reservoir dam has 2.2-foot (ft)-high flashboards that sit atop a 500-ft-long spillway. The elevation of the crest of the flashboards is 755.35 ft. Water can flow over the flashboards (unregulated) when water levels are sufficiently high, and the dam has gates to release water downstream to meet or help meet water-supply demands when water levels are below the top of the flashboards. When the water elevation in the reservoir is less than 755.35 ft, gates are opened to pass 60–100 $ft^3/s$ downstream to meet demand. When the water elevation is greater than 755.35 ft but less than 755.65 ft, gate releases are added to discharge over flashboards to meet demand. When the water elevation is greater than 755.65 ft, water demands can be met by discharge over the flashboards. The gates are never shut fully but are left 10 percent open to prevent them from becoming stuck in the closed position (Scott Lockhart, City of Columbus, oral commun., 2012).

In the model, outflow from the dam was computed by using an FTABLE for RCHRES 11. Column 4 in the FTABLE is used to compute flow over the flashboards, and column 5 is used to compute flow through the gates. The 60- to 100-$ft^3/s$ range of release through the gates was treated as a uniform 80-$ft^3/s$ release in the model, and the flow through the gates when 10 percent open was assumed to be 8 $ft^3/s$. At a depth equal to or less than 23.35 ft (corresponding to a reservoir water elevation of 755.35 ft), outflow over the flashboards (column 4) was 0 $ft^3/s$, whereas outflow through the gates (column 5) was 80 $ft^3/s$. For depths greater than 23.35 ft, outflow over the flashboards followed the rating curve, and outflow through the gages either supplemented flows over the flashboards to reach a total outflow of 80 $ft^3/s$ or was left at 8 $ft^3/s$.

## O'Shaughnessy Reservoir

O'Shaughnessy Reservoir (RCHRES 39), on the Scioto River, is a water-supply reservoir for the City of Columbus, Ohio. The O'Shaughnessy Reservoir dam has an 883-ft-long spillway crest, separated by fourteen 4-ft-wide piers and a gate house into twelve 70.8-ft-long gateless chambers with 3.5-ft-high flashboards sitting atop the spillway. The elevation of the crest of the flashboards is 848.5 ft. When water levels are sufficiently high, water can flow over the flashboards (unregulated). In addition, there are gates that can release water downstream to help meet water-supply demands. When the water elevation in the reservoir is less than 848.5 ft, gates are opened to pass 60 $ft^3/s$ downstream to meet demand. When the water elevation is greater than 848.5 ft, water demand can be met by discharge over the flashboards. The gates are never shut fully but are left 10 percent open to prevent the gates from becoming stuck in the closed position (Scott Lockhart, City of Columbus, oral commun., 2012).

Hydroelectric power generators are also present at the dam. Two hydraulic turbines were installed in 1987; however, only one turbine currently works as of this writing (the date the other turbine went out of service could not be determined). The operational turbine can pass up to 300 $ft^3/s$, and the minimum flow for operation is 200 $ft^3/s$. The turbine has had a sporadic use schedule and has not been used on most weekends and when personnel are not readily available to respond to operational or maintenance needs. When the turbine is in use, it is rarely run at maximum discharge. The turbine is also shut off when water elevation in the reservoir drops below 848 ft (Scott Lockhart, City of Columbus, oral commun., 2012). Initially, flow through the turbine was modeled by using Special Actions in HSPF. However, it was not possible to achieve good model calibration (likely because of the irregular pattern of turbine use) and so the Special Actions were removed.

In the model, outflow from the O'Shaughnessy Reservoir dam was handled in the FTABLE for RCHRES 39. Column 4 in the FTABLE is used to compute flow over the flashboards and flow through the gates. Initially, the model was set up to simulate 60 $ft^3/s$ being released when the depth was at or below 53.5 ft (corresponding to a reservoir water elevation of 848.5 ft); however, after examining the measured flow records below the dam (station 03221000), as well as drawdown periods of the reservoir and the water balance between Griggs and O'Shaughnessy reservoirs, it was decided that a more complex low flow release was needed. From this examination of the measured record, 80 $ft^3/s$ is released when the water level ranges from 53.6 ft to 50 ft, tapering to 70 $ft^3/s$ at 41 ft, and down to 3 $ft^3/s$ at 31 ft. Between 31 ft and 0 ft, the flow decreases by 1 $ft^3/s$ for each 10-ft decrease in depth. When the depth was above 53.6 ft, the flow follows the rating curve plus the 6 $ft^3/s$ released from the gates, except flows at depths between 53.6 ft and 53.8 ft, which were adjusted to aid in calibration.

## Hoover Reservoir

Hoover Reservoir (RCHRES 38), on Big Walnut Creek, is a water-supply reservoir for the City of Columbus, Ohio. The dam is 680 ft long with seven 8-ft wide piers separating eight 78-ft-wide mechanical drum gates. The drum gates can be raised and lowered to change the water-surface elevation of the reservoir. The normal pool for the reservoir is 894 ft. Dam operators try to keep the maximum depth above the drum gates at 1.6 ft. Drum gates are set at an elevation of 894 ft until the water level in the reservoir rises above 895.6 ft, at which point the drum gates are raised to maintain 1.6 ft depth above the drum gates. When the water level rises above 897 ft, drum gates are kept at 895.4 ft (Mike Colley, City of Columbus, oral commun., 2012).

Hoover Reservoir also has bunger valves (fixed-cone valves used to reduce energy in the water discharging from low-level outlet works of a dam) to release water downstream from the reservoir. When the water level of the reservoir is above the drum gates, the bunger valves are opened fully and release 198 $ft^3/s$. When the water level of the reservoir is below the drum gates, the bunger valves release 10 Mgal/d (18.58 $ft^3/s$) more than the demand at the Hap Cremean Water Plant (located in RCHRES 33) (Mike Colley, City of Columbus, oral commun., 2012).

A simple depth-outflow relationship could not be established for Hoover Reservoir because flow is dependent on the depth above the drum gates (which vary in elevation) and not the total depth of the reservoir. To solve this problem, the drum-gate operations were handled in the model by using both the Special Actions block of HSPF and an FTABLE. The column indicator (COLIND) function in HSPF allows the model to indicate from which column of the FTABLE to obtain outflow data. In the Special Actions block, a COLIND time series is created by using conditional statements. If the water-surface elevation of Hoover Reservoir is less than or equal to 895.6 ft, then the value of COLIND is 4, which indicates to the model to get outflow data from column 4 of the FTABLE. Column 4 of the FTABLE is the rating curve for flow over the spillway when the drum gates are set at 894 ft. If the water-surface elevation is greater than 895.6 ft but less than 897 ft, then the value of COLIND is 6. Column 6 of the FTABLE is set to a flow of 4,211 $ft^3/s$, which is the flow from the rating curve that corresponds to a depth of 1.6 ft above the drum gates. If the water-surface elevation is greater than 897 ft, then the value of the COLIND function is 5. Column 5 of the FTABLE is the rating curve for flow over the spillway when the drum gates are set at 895.4 ft.

The bunger valves were also handled using the Special Actions block of HSPF. After examining the measured flow record for the gage downstream from the dam (station 03228500), it was determined that 55 $ft^3/s$ is released through the bunger valves in the winter when water is flowing over the drum gates and that 198 $ft^3/s$ is released in the summer. The conditional statements work so that from April 1 through November 15, 198 $ft^3/s$ is released when water is flowing over the drum gates, and from November 16 through March 31, 55 $ft^3/s$ is released. When water is not flowing over the drum gates, the bunger valves release 15 $ft^3/s$ (approximately 10 Mgal/d) more than the demand at the Hap Cremean Water Plant.

## Delaware Lake

Delaware Lake (RCHRES 43), on the Olentangy River, is a flood-control reservoir. The dam has a 232-ft-long spillway with six 32-ft-long and 25-ft-high tainter gates (radial-arm floodgates) that sit atop the spillway, separated by five 8-ft-wide piers. Five 6.5-ft-square sluice gates (metal gates that slide vertically in grooves set in the sides of the waterway) can pass water downstream when the water-surface elevation is below the spillway. The elevation of the crest of the spillway is 922 ft. The summer target pool elevation of the reservoir is 915 ft, and the winter target pool elevation is 910 ft. The fill period to achieve the summer pool starts on April 1 and lasts for a month, and the drawdown for the winter pool starts on November 1 and also lasts for a month. The maximum release from the reservoir without directive from the USACE Huntington District is 1,862 $ft^3/s$. The maximum release from the reservoir with directive from Huntington is 4,282 $ft^3/s$ (Ben O'Dell, USACE, oral commun., 2012).

When the water-surface elevation is below the elevation of the spillway, a minimum-flow release is made. The minimum-flow release for Delaware Lake follows a seasonal schedule. When the water-surface elevation rises above the target pool elevation, dam operators observe three USGS streamgages downstream to ensure that no downstream flooding is occurring while they make releases. The downstream gages are the Olentangy River at Worthington (03226800), the Scioto River at Columbus (03227500), and the Scioto River at Circleville (03230700). If downstream flooding is occurring, a minimum-flow release is made. If no downstream flooding is occurring, water is released from the reservoir to bring the water-surface elevation back down to the target elevation. Releases from the dam do not follow a strict protocol but are based on a multitude of factors that may be present at the time, most importantly the experience of the dam operator (Ben O'Dell, USACE, oral commun., 2012).

In the model, releases from the reservoir were handled in Special Actions. The summer pool elevation was set at 915 ft for April 30–November 1, and the winter pool elevation was set at 910 ft for November 30–April 1. To simulate the spring increase in pool elevation, the target elevation is incrementally increased during the month of April. To simulate the fall drawdown in pool elevation, the target elevation is incrementally decreased during the month of November. Target flows also are set for the downstream streamgages that are monitored during releases from the reservoir. The minimum flow schedule specified by the USACE also was input into

the model; however, after examining the measured flow data, the minimum flow schedule was adjusted to aid in calibration.

Conditional statements are used in the Special Actions block to determine whether releases should be made and, if so, how much should be released. Eleven conditional statements are used to compare the water-surface elevation of the reservoir to the target pool elevation and to check the status of downstream streamgages. If the elevation of the water surface is above a given threshold and no downstream flooding is occurring, the reservoir will release a flow equivalent to the flow coming into the reservoir plus predefined amounts of water, but not to exceed the maximum flow without directive from the USACE Huntington District. If flooding is occurring, the model reverts to the minimum-flow release schedule. If the elevation of the water surface is above 945 ft, then the maximum flow with directive by the USACE Huntington District is released.

Owing to the variability of releases and the lack of specific information on the dam operations, elevation thresholds were set at 0.10, 0.25, 1.0, 2.0, 5.0, 10.0, and 15.0 ft above the seasonally varying target pool elevations, as well as elevations of 935 and 945 ft. Observed outflows (at streamgage 03225500) were then compared to the measured depth above the target pool elevation (at the thresholds listed above) in order to determine typical releases associated with those depths. The median flow values associated with the above thresholds were added to the flow coming into the reservoir as an initial estimate for releases and were adjusted to aid in calibration.

## Alum Creek Lake

Alum Creek Lake (RCHRES 9), on Alum Creek, is a flood-control reservoir. The dam has a 118-ft-long spillway with three 34-ft-long and 25-ft-high tainter gates that sit atop the spillway, separated by two 8-ft-wide piers. The elevation of the crest of the spillway is 878 ft. The summer target pool elevation of the reservoir is 888 ft, and the winter target pool elevation is 885 ft. The fill period to achieve the summer pool starts on April 1 and ends April 15, and the drawdown for the winter pool starts on November 1 and lasts for a month. The maximum release from the reservoir without directive from the USACE Huntington District varies seasonally, with a winter maximum release of 926 $ft^3/s$ from December 1 to April 15 and a summer maximum release of 495 $ft^3/s$ from April 16 to November 30. The maximum release from the reservoir with directive from USACE Huntington District is 1,651 $ft^3/s$ (Bob Wattenschaidt, USACE, oral commun., 2012).

When the water-surface elevation is below the spillway, a minimum-flow release is made. The minimum-flow release for Alum Creek Lake is 5 $ft^3/s$. When the water-surface elevation rises above the target pool elevation, dam operators observe three USGS streamgages downstream to ensure that no downstream flooding is occurring while they make releases. The downstream gages are Alum Creek at Columbus (03229000), Big Walnut Creek at Rees (03229500), and the Scioto River at Circleville (03230700). If downstream flooding is occurring, a minimum-flow release is made. If no downstream flooding is occurring, water is released from the reservoir to bring the surface elevation back down to the target elevation. Releases from the dam do not follow a strict protocol but are based on a multitude of factors that may be present at the time, most importantly the experience of the dam operator (Bob Wattenschaidt, USACE, oral commun., 2012).

In the model, releases from the reservoir were handled in Special Actions. The summer pool elevation is set at 888 ft for April 15–November 1, and the winter pool elevation is set at 885 ft for November 30–April 1. To simulate the spring increase in pool elevation, the target elevation is incrementally increased from April 1 to April 15. To simulate the fall drawdown in pool elevation, the target elevation is incrementally decreased during the month of November. Target flows are also set for the downstream streamgages that are monitored during releases from the reservoir. After comparing measured flows to measured elevation records, a seasonal minimum flow schedule was included in the model to aid in calibration.

Conditional statements are used in the Special Actions block to determine whether releases should be made and how much should be released. Nineteen conditional statements are used to compare the water-surface elevation of the reservoir to the target pool elevation and to check

the status of downstream streamgages. If the elevation of the water surface is above a given threshold and no downstream flooding is occurring, the reservoir will release a flow equivalent to the flow coming into the reservoir plus predefined amounts of water, but not to exceed the maximum flow without directive from Huntington. If flooding is occurring, the model reverts to the minimum-flow release schedule. If the elevation of the water surface exceeds 891.1 ft, then the maximum flow with directive from the USACE Huntington District is released.

Owing to the variability of releases and the lack of specific release information in the dam operations, elevation thresholds were set at 0.1-ft and in 0.2-ft increments from 0.2 ft to 3.0 ft above the seasonal target elevation, as well as an elevation of 891.1 ft. Observed outflows (at streamgage 03228805) were then compared to the measured depth above the target elevation (in the thresholds listed above) in order to determine typical releases associated with those depths historically. The median flow values associated with the above thresholds were added to the flow coming into the reservoir as the starting point for releases and were adjusted to aid in calibration.

A diversion from Alum Creek Lake to Hoover Reservoir is also handled in Special Actions. If the water-surface elevation of Hoover Reservoir drops below 889.23 ft (80 percent capacity assuming a normal pool elevation of 894 ft), 54 $ft^3/s$ is pumped from Alum Creek Lake to Hoover Reservoir (Lynn Kelly, City of Columbus, oral commun., 2012). In the model, a time series is created in the Special Actions block to simulate this diversion. A conditional statement compares the water elevation in Hoover Reservoir to 889.23 ft and populates the new time series with 54 $ft^3/s$ if the elevation is less than 889.23 ft and 0.0 $ft^3/s$ if it is greater. This time series is then passed to Hoover Reservoir (RCHRES 38) in the Schematic block of the model.

## Upground Reservoirs

The City of Columbus has developed one upground reservoir and has plans to develop two more. These reservoirs (named the John R. Doutt Reservoir [formerly called R-2], R-1, and R-3) are to be filled by pumping water from a pool formed by an inflatable dam on the Scioto River, about 0.65 mile upstream from the Scioto River at Prospect streamgage (RCHRES 45, fig. A5). The John R. Doutt Reservoir was completed in fall 2013, and R-1 and R-3 are expected to be in use sometime beyond 2040. The John R. Doutt Reservoir has a storage capacity of 9.6 billion gallons, whereas R-1 and R-3 will each have a storage capacity of over 4 billion gallons (City of Columbus, 2014).

Water will be pumped into the reservoirs by four pumps: a two-speed pump that can pump 17.8 $ft^3/s$ at low speed and 61.9 $ft^3/s$ at high speed, and three single-speed pumps with a pumping capacity of 61.9 $ft^3/s$. Of the three single-speed pumps, one will always be out of service, so the total pumping capacity at the pumping station will be 186 $ft^3/s$ (City of Columbus, 2010).

When water is pumped into the upground reservoirs, a minimum flow must be left in the Scioto River. From April through June the minimum flow is 100 $ft^3/s$, and from July through March the minimum flow is 24.1 $ft^3/s$. Water will not be diverted to the reservoirs until there is a sufficient in-stream flow to initiate the low-speed pump. Contrary to these minimum-flow limits, from April through June, pumping will not occur if the flow is equal to or less than 118 $ft^3/s$; and from July through March, pumping will not occur if the flow is equal to or less than 41.9 $ft^3/s$ (City of Columbus, 2010).

During fish spawning season (April through June), there is a limit of 14 consecutive pumping days, after which point the pumps must be inactive for 14 days (City of Columbus, 2010). This particular operation was not modeled because of the complexity of modeling the operation.

Releases from the upground reservoirs into the Scioto River will depend on the elevation of the water level in O'Shaughnessy Reservoir. When the O'Shaughnessy Reservoir pool drops below 80 percent capacity (an elevation of 844.5 ft), 21 Mgal/d (32.5 $ft^3/s$) will be released from the John R. Doutt Reservoir, and R-1 and R-3 (once they come online) each will release 11 Mgal/d (17.0 $ft^3/s$). These releases are added back into the Scioto River in RCHRES 5. By contract, an additional 8 Mgal/d is delivered to the Del-Co Water Company, with 4 Mgal/d (7.43 $ft^3/s$) coming out of the John R. Doutt Reservoir and 2 Mgal/d (3.72 $ft^3/s$) coming out of R-1 and R-3 each (City of Columbus, 2010).

In the model, pumping to and releases from the upground reservoirs are handled in the Special Actions block. Any pumping or release activity in the model associated with R-2 is set in the model to begin on January 1, 2014, and those associated with R-1 and R-3 are set to begin January 1, 2040. A variable (VOLUME) is used to keep track of the volume of water (in acre-feet) in the upground reservoirs, with pumping figures added to this number at each time step and withdrawal figures subtracted from this number at each time step. This variable is used to determine whether the reservoirs are full or whether water is available to release. Four variables (TARGET, TARGT2, TARGT3, and TARGT4) are set up as target flows for the Scioto River to indicate to the model if there is enough water in the river to pump at different pumping levels. These target variables represent flows in the Scioto River at which another pump can be turned on. Conditional statements look to these target flows, as well as at the VOLUME variable and the elevation of the O'Shaughnessy Reservoir pool, to determine how much water to pump into the upground reservoirs. If there is enough flow in the stream to pump, if the upground reservoirs are not full, and if the elevation of O'Shaughnessy is greater than 844.5 ft (the elevation below which the upground reservoirs release water into the Scioto River), then a flow-dependent withdrawal of water is initiated from the Scioto River to the upground reservoirs. If any of the above conditions are false, then no water is removed from the Scioto River. The water pumped from the river (in cubic feet per second) is converted to reservoir storage (in acre-feet) and added to the VOLUME variable at each time step. The pumping time series (in cubic feet per second) is assigned to exit 2 (OUTDGT 2) from RCHRES 45.

Releases from the upground reservoirs are handled with conditional statements in the Special Actions block. If the water elevation in O'Shaughnessy Reservoir is less than or equal to 844.5, then the combined reservoir release is set to 32.5 $ft^3/s$ beginning in 2014 (when the John R. Doutt Reservoir has filled) and to 66.5 $ft^3/s$ beginning in 2040 (when R-1 and R-3 are assumed to come online). If the water elevation in O'Shaughnessy Reservoir is greater than 844.5, then no water is released. The release time series was converted from units of streamflow (in cubic feet per second) into units of storage (in acre-feet) and is subtracted from the VOLUME variable at each time step. The Del-Co withdrawal (in acre-feet) also is subtracted from the VOLUME variable at each time step. The release time series (in cubic feet per second) was assigned to RCHRES 5 as an inflow (IVOL).

## Streamflow Calibration and Validation

The model was run to simulate the period from January 1, 1989, to December 31, 2010. Results from calendar years 1989–1990 were not used to assess calibration because those years were used to initialize the model and establish a reasonable water balance. As noted in the Streamflow section of this appendix, calibration and validation periods varied depending on the available measured data for each subbasin. Precipitation from 1991 to 2010 at the 10 precipitation stations used in the model ranged from an average of 35.1 to 39.0 inches per year. Based on average precipitation for the 10 precipitation stations, 2004 was the wettest year (44.1 inches) and 1991 was the driest (27.0 inches).

The HSPF model was calibrated in accordance with guidelines by Donigian and others (1984), Lumb and others (1994), and USEPA (2000). The first step in calibration was to adjust the potential evaporation inputs with a multiplier so that the potential evapotranspiration for the model fell within the expected range of 32–34 inches for central Ohio (Harstine, 1991). These multipliers varied between 1.00 and 1.37 and were applied to the potential evaporation data for each PERLND, IMPLND, and RCHRES. Snow parameters were then adjusted so that snowpack values appeared reasonable when compared to historical snowpack data for Columbus and Marion. The parameters SLSUR (average slope of assumed overland flow path), LSUR (length of assumed overland flow plane), MELEV (mean elevation), and ELDAT (elevation difference) were determined from geospatial data.

Parameters that were adjusted for calibration include LZSN (lower zone nominal soil moisture storage), INFILT (infiltration capacity), KVARY (variable groundwater recession), AGWRC (base groundwater recession), DEEPFR (fraction of groundwater inflow to deep recharge), BASETP (fraction of remaining ET from baseflow), AGWETP (fraction of remaining ET from active groundwater), CEPSC (interception storage capacity), UZSN (upper zone nominal soil moisture storage), INTFW (interflow inflow), IRC (interflow recession), and LZETP (lower zone ET). These parameters were independently adjusted for pervious land segments in each RCHRES to fit the calibration guidelines.

The modeled streamflow was compared to actual streamflow data at 18 USGS streamgage sites by using HSPEXP+ Version 1.0 (a stand-alone Visual Basic program written by AQUA TERRA Consultants and the Virginia Tech Center for Watershed Studies). HSPEXP+ computes and reports percentage errors between simulated and measured total volume; 10-, 25-, and 50-percent highest and lowest flows; low-flow recession; storm volumes; seasonal volume; average storm peak; summer and winter volumes; and summer and winter storm volumes. These model-fit statistics are presented in table A11 for all calibration and validation model runs for the 18 streamgage sites, along with the target criterion for calibration and validation set forth by Donigian (2000) and the HSPexp program (Lumb and others, 1994). Hydrographs, flow-duration curves, and scatterplots of simulated and measured streamflows (not shown) were also used to assess model calibration.

**Table A11.** Model-fit statistics for calibration and validation simulation results from the HSPF model of the Upper Scioto River Basin, Ohio.

[N/A, not applicable; empty cell indicates no data or not applicable; $ft^3/s$, cubic feet per second]

| STATISTIC | CALIBRATION | | | | | | VALIDATION | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean annual observed runoff (inches) | Mean annual simulated runoff (inches) | Mean annual runoff error (inches) | Mean annual runoff error ($ft^3/s$) | Mean annual runoff error (percent) | Narrative performance category (Donigian, 2000) | Mean annual observed runoff (inches) | Mean annual simulated runoff (inches) | Mean annual runoff error (inches) | Mean annual runoff error ($ft^3/s$) | Mean annual runoff error (percent) | Narrative performance category (Donigian, 2000) |
| RCHRES 2 (Olentangy R at Claridon) | | | | | 1991-1998 | | RCHRES 2 | | | | | N/A |
| Total volume | 16.0 | 16.3 | 0.3 | 3.6 | 2% | Very good | OBSERVED RECORD TOO SHORT FOR VALIDATION | | | | | |
| 10% high | 9.8 | 9.2 | –0.7 | –7.7 | –7% | Very good | | | | | | |
| 25% high | 13.0 | 13.1 | 0.0 | 0.5 | 0% | | | | | | | |
| 50% high | 15.1 | 15.3 | 0.2 | 2.7 | 2% | | | | | | | |
| 50% low | 0.882 | 0.957 | 0.075 | 0.87 | 9% | Good | | | | | | |
| 25% low | 0.167 | 0.166 | –0.001 | –0.01 | –1% | | | | | | | |
| 10% low | 0.025 | 0.025 | 0.000 | 0.00 | 0% | | | | | | | |
| Low-flow recession | 0.93 | 0.91 | –0.02 | | | | | | | | | |
| Storm volume | 7.0 | 7.5 | 0.4 | 5.1 | 6% | Very good | | | | | | |
| Average storm peak ($ft^3/s$) | 1,114 | 1,019 | | –94 | –8% | | | | | | | |
| Summer volume | 3.6 | 3.0 | –0.6 | –7.3 | –18% | Good | | | | | | |
| Winter volume | 5.6 | 5.6 | 0.0 | 0.4 | 1% | Very good | | | | | | |
| Summer storms | 1.9 | 1.6 | –0.3 | –3.6 | –17% | Very good | | | | | | |
| Winter storms | 2.3 | 2.7 | 0.4 | 4.2 | 16% | | | | | | | |
| RCHRES 6 (Big Walnut Cr at Sunbury) | | | | | 1991-2002 | | RCHRES 6 | | | | | 2003-2010 |
| Total volume | 13.4 | 13.0 | –0.4 | –3.0 | –3% | Very good | 15.2 | 16.4 | 1.2 | 8.7 | 8% | Good |
| 10% high | 8.7 | 8.3 | –0.5 | –3.6 | –6% | Very good | 9.9 | 10.2 | 0.3 | 2.2 | 3% | Very good |
| 25% high | 11.5 | 11.1 | –0.4 | –2.7 | –3% | | 12.8 | 13.7 | 1.0 | 7.2 | 8% | |
| 50% high | 13.1 | 12.7 | –0.4 | –2.8 | –3% | | 14.6 | 15.8 | 1.2 | 8.7 | 8% | |
| 50% low | 0.359 | 0.330 | –0.029 | –0.22 | –8% | Good | 0.649 | 0.647 | –0.002 | –0.01 | 0% | Very good |
| 25% low | 0.018 | 0.018 | 0.000 | 0.00 | 0% | | 0.061 | 0.081 | 0.020 | 0.15 | 33% | |
| 10% low | 0.000 | 0.000 | 0.000 | 0.00 | 0% | | 0.003 | 0.009 | 0.006 | 0.04 | 200% | |

**Table A11.** Model-fit statistics for calibration and validation simulation results from the HSPF model of the Upper Scioto River Basin, Ohio.—Continued

[N/A, not applicable; empty cell indicates no data or not applicable; $ft^3/s$, cubic feet per second]

| STATISTIC | CALIBRATION | | | | | | VALIDATION | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean annual observed runoff (inches) | Mean annual simulated runoff (inches) | Mean annual runoff error (inches) | Mean annual runoff error ($ft^3/s$) | Mean annual runoff error (percent) | Narrative performance category (Donigian, 2000) | Mean annual observed runoff (inches) | Mean annual simulated runoff (inches) | Mean annual runoff error (inches) | Mean annual runoff error ($ft^3/s$) | Mean annual runoff error (percent) | Narrative performance category (Donigian, 2000) |
| RCHRES 6 (Big Walnut Cr at Sunbury)—continued | | | | 1991-2002 | | | RCHRES 6 | | | | 2003-2010 | |
| Low-flow recession | 0.88 | 0.84 | –0.04 | | | | 0.88 | 0.85 | –0.03 | | | |
| Storm volume | 5.4 | 4.9 | –0.5 | –4.0 | –10% | Very good | 5.4 | 5.5 | 0.1 | 0.4 | 1% | Very good |
| Average storm peak ($ft^3/s$) | 680 | 542 | | –138 | –20% | | 459 | 385 | | –75 | –16% | |
| Summer volume | 2.4 | 2.2 | –0.2 | –1.3 | –7% | Very good | 2.2 | 2.2 | 0.0 | –0.1 | 0% | Very good |
| Winter volume | 4.7 | 4.6 | –0.1 | –0.6 | –2% | Very good | 5.1 | 6.7 | 1.7 | 12.3 | 33% | Fair |
| Summer storms | 1.0 | 1.0 | 0.0 | 0.2 | 3% | Very good | 1.1 | 1.2 | 0.1 | 0.7 | 9% | Very good |
| Winter storms | 2.1 | 1.8 | –0.3 | –2.6 | –16% | | 1.5 | 1.8 | 0.3 | 2.4 | 21% | |
| RCHRES 7 (Mill Cr at Bellepoint) | | | | 1991-2002 | | | RCHRES 7 | | | | 2003-2010 | |
| total volume | 12.4 | 13.0 | 0.6 | 8.1 | 5% | Very good | 15.9 | 17.5 | 1.5 | 19.9 | 10% | Good |
| 10% high | 8.6 | 8.3 | –0.3 | –3.7 | –3% | Very good | 10.8 | 10.7 | –0.1 | –1.1 | –1% | Very good |
| 25% high | 10.7 | 11.2 | 0.5 | 6.5 | 5% | | 13.7 | 14.7 | 1.0 | 13.2 | 7% | |
| 50% high | 11.8 | 12.4 | 0.6 | 7.7 | 5% | | 15.2 | 16.7 | 1.5 | 19.6 | 10% | |
| 50% low | 0.522 | 0.548 | 0.026 | 0.34 | 5% | Very good | 0.778 | 0.801 | 0.023 | 0.30 | 3% | Very good |
| 25% low | 0.140 | 0.136 | –0.004 | –0.05 | –3% | | 0.185 | 0.186 | 0.001 | 0.01 | 1% | |
| 10% low | 0.038 | 0.034 | –0.004 | –0.05 | –11% | | 0.040 | 0.043 | 0.003 | 0.04 | 7% | |
| Low-flow recession | 0.93 | 0.89 | –0.04 | | | | 0.91 | 0.88 | –0.04 | | | |
| Storm volume | 6.8 | 7.1 | 0.3 | 4.2 | 5% | Very good | 5.8 | 6.2 | 0.5 | 6.0 | 8% | Very good |
| Average storm peak ($ft^3/s$) | 1,288 | 1,333 | | 45 | 4% | | 695 | 814 | 119 | 119 | 17% | |
| Summer volume | 2.3 | 2.4 | 0.0 | 0.3 | 1% | Very good | 2.5 | 2.4 | –0.1 | –1.1 | –3% | Very good |
| Winter volume | 3.8 | 4.2 | 0.4 | 5.4 | 11% | Very good | 5.3 | 6.5 | 1.2 | 15.5 | 22% | Good |
| Summer storms | 1.1 | 1.0 | 0.0 | –0.1 | –1% | Very good | 1.1 | 0.9 | –0.2 | –2.5 | –18% | Very good |
| Winter storms | 2.3 | 2.3 | 0.0 | 0.4 | 1% | | 2.0 | 2.6 | 0.6 | 7.4 | 28% | |

**Table A11.** Model-fit statistics for calibration and validation simulation results from the HSPF model of the Upper Scioto River Basin, Ohio.—Continued

[N/A, not applicable; empty cell indicates no data or not applicable; $ft^3/s$, cubic feet per second]

| STATISTIC | CALIBRATION | | | | | | VALIDATION | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean annual observed runoff (inches) | Mean annual simulated runoff (inches) | Mean annual runoff error (inches) | Mean annual runoff error ($ft^3/s$) | Mean annual runoff error (percent) | Narrative performance category (Donigian, 2000) | Mean annual observed runoff (inches) | Mean annual simulated runoff (inches) | Mean annual runoff error (inches) | Mean annual runoff error ($ft^3/s$) | Mean annual runoff error (percent) | Narrative performance category (Donigian, 2000) |
| | RCHRES 8 (Scioto R below O'Shaughnessy) | | | | 1991-2002 | | RCHRES 8 | | | | 2003-2010 | |
| Total volume | 12.3 | 12.4 | 0.0 | 1.3 | 0% | Very good | 16.1 | 14.7 | –1.4 | –100.1 | –9% | Good |
| 10% high | 6.9 | 6.7 | –0.2 | –15.2 | –3% | Very good | 8.7 | 8.0 | –0.8 | –57.0 | –9% | Very good |
| 25% high | 9.9 | 9.7 | –0.2 | –13.6 | –2% | | 12.8 | 11.4 | –1.3 | –95.7 | –10% | |
| 50% high | 11.7 | 11.5 | –0.1 | –9.3 | –1% | | 15.0 | 13.7 | –1.3 | –95.1 | –9% | |
| 50% low | 0.664 | 0.811 | 0.147 | 10.62 | 22% | Fair | 1.083 | 1.012 | –0.071 | –5.13 | –7% | Good |
| 25% low | 0.143 | 0.275 | 0.132 | 9.53 | 92% | | 0.244 | 0.280 | 0.036 | 2.60 | 15% | |
| 10% low | 0.033 | 0.108 | 0.075 | 5.42 | 227% | | 0.053 | 0.110 | 0.057 | 4.12 | 108% | |
| Low-flow recession | 0.97 | 0.96 | –0.01 | | | | 0.94 | 0.92 | –0.02 | | | |
| Storm volume | 6.3 | 5.8 | –0.4 | –30.4 | –7% | Very good | 6.3 | 5.1 | –1.2 | –90.1 | –20% | Good |
| Average storm peak ($ft^3/s$) | 4,174 | 4,521 | | 348 | 8% | | 2,518 | 2,727 | | 209 | 8% | |
| Summer volume | 2.3 | 2.2 | –0.1 | –9.2 | –5% | Very good | 2.4 | 2.2 | –0.2 | –15.4 | –9% | Very good |
| Winter volume | 4.0 | 4.1 | 0.0 | 1.7 | 1% | Very good | 5.9 | 5.4 | –0.6 | –39.9 | –9% | Very good |
| Summer storms | 1.1 | 0.9 | –0.2 | –11.8 | –15% | Very good | 1.0 | 0.8 | –0.2 | –15.7 | –21% | Very good |
| Winter storms | 1.9 | 1.8 | –0.1 | –10.3 | –7% | | 2.6 | 2.3 | –0.2 | –17.5 | –9% | |
| | RCHRES 10 (Alum Cr at Africa) | | | | 1991-1998 | | RCHRES 10 | | | | N/A | |
| Total volume | 13.4 | 12.5 | –1.0 | –8.7 | –7% | Good | OBSERVED RECORD TOO SHORT FOR VALIDATION | | | | | |
| 10% high | 8.5 | 7.8 | –0.8 | –7.0 | –9% | Very good | | | | | | |
| 25% high | 11.6 | 10.7 | –0.8 | –7.3 | –7% | | | | | | | |
| 50% high | 12.7 | 11.8 | –0.9 | –8.3 | –7% | | | | | | | |
| 50% low | 0.714 | 0.672 | –0.042 | –0.38 | –6% | Good | | | | | | |
| 25% low | 0.261 | 0.251 | –0.010 | –0.09 | –4% | | | | | | | |
| 10% low | 0.084 | 0.076 | –0.008 | –0.07 | –10% | | | | | | | |

**Table A11.** Model-fit statistics for calibration and validation simulation results from the HSPF model of the Upper Scioto River Basin, Ohio.—Continued

[N/A, not applicable; empty cell indicates no data or not applicable; $ft^3/s$, cubic feet per second]

| STATISTIC | CALIBRATION | | | | | | VALIDATION | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean annual observed runoff (inches) | Mean annual simulated runoff (inches) | Mean annual runoff error (inches) | Mean annual runoff error ($ft^3/s$) | Mean annual runoff error (percent) | Narrative performance category (Donigian, 2000) | Mean annual observed runoff (inches) | Mean annual simulated runoff (inches) | Mean annual runoff error (inches) | Mean annual runoff error ($ft^3/s$) | Mean annual runoff error (percent) | Narrative performance category (Donigian, 2000) |
| RCHRES 10 (Alum Cr at Africa)—continued | | | | | 1991-1998 | | RCHRES 10 | | | | N/A | |
| Low-flow recession | 1.00 | 1.00 | 0.00 | | | | OBSERVED RECORD TOO SHORT FOR VALIDATION | | | | | |
| Storm volume | 3.3 | 3.0 | –0.3 | –2.2 | –8% | Very good | | | | | | |
| Average storm peak ($ft^3/s$) | 268 | 237 | | –31 | –12% | | | | | | | |
| Summer volume | 2.8 | 2.7 | –0.1 | –1.0 | –4% | Very good | | | | | | |
| Winter volume | 4.7 | 4.4 | –0.3 | –2.9 | –7% | Very good | | | | | | |
| Summer storms | 1.6 | 1.3 | –0.2 | –2.1 | –15% | Very good | | | | | | |
| Winter storms | 0.1 | 0.1 | 0.0 | –0.4 | –48% | | | | | | | |
| RCHRES 12 (Little Darby Cr at West Jefferson) | | | | | 1992-2005 | | RCHRES 12 | | | | N/A | |
| Total volume | 14.9 | 15.1 | 0.3 | 3.1 | 2% | Very good | OBSERVED RECORD TOO SHORT FOR VALIDATION | | | | | |
| 10% high | 7.9 | 8.0 | 0.1 | 1.3 | 1% | Very good | | | | | | |
| 25% high | 11.3 | 11.6 | 0.3 | 3.8 | 3% | | | | | | | |
| 50% high | 13.7 | 14.1 | 0.4 | 4.3 | 3% | | | | | | | |
| 50% low | 1.125 | 1.021 | –0.104 | –1.25 | –9% | Good | | | | | | |
| 25% low | 0.221 | 0.223 | 0.002 | 0.02 | 1% | | | | | | | |
| 10% low | 0.044 | 0.047 | 0.003 | 0.04 | 7% | | | | | | | |
| Low-flow recession | 0.94 | 0.91 | –0.03 | | | | | | | | | |
| Storm volume | 6.7 | 6.8 | 0.1 | 1.6 | 2% | Very good | | | | | | |
| Average storm peak ($ft^3/s$) | 1,510 | 1,503 | | –6.9 | 0% | | | | | | | |
| Summer volume | 2.9 | 3.0 | 0.1 | 0.9 | 3% | Very good | | | | | | |
| Winter volume | 4.7 | 5.1 | 0.4 | 4.4 | 8% | Very good | | | | | | |
| Summer storms | 0.7 | 0.8 | 0.1 | 1.1 | 14% | Very good | | | | | | |
| Winter storms | 2.8 | 2.8 | 0.0 | 0.1 | 0% | | | | | | | |

**Table A11.** Model-fit statistics for calibration and validation simulation results from the HSPF model of the Upper Scioto River Basin, Ohio.—Continued

[N/A, not applicable; empty cell indicates no data or not applicable; $ft^3/s$, cubic feet per second]

| STATISTIC | CALIBRATION | | | | | | VALIDATION | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean annual observed runoff (inches) | Mean annual simulated runoff (inches) | Mean annual runoff error (inches) | Mean annual runoff error ($ft^3/s$) | Mean annual runoff error (percent) | Narrative performance category (Donigian, 2000) | Mean annual observed runoff (inches) | Mean annual simulated runoff (inches) | Mean annual runoff error (inches) | Mean annual runoff error ($ft^3/s$) | Mean annual runoff error (percent) | Narrative performance category (Donigian, 2000) |
| | RCHRES 13 (Big Walnut Cr at Central College) | | | | 1991-2002 | | RCHRES 13 | | | | 2003-2010 | |
| Total volume | 15.4 | 14.9 | –0.5 | –7.0 | –3% | Very good | 17.1 | 17.0 | –0.1 | –1.0 | 0% | Very good |
| 10% high | 6.5 | 5.8 | –0.7 | –9.4 | –10% | Very good | 7.5 | 7.6 | 0.1 | 1.6 | 1% | Very good |
| 25% high | 8.5 | 7.8 | –0.7 | –9.1 | –8% | | 9.8 | 10.1 | 0.2 | 3.3 | 2% | |
| 50% high | 11.2 | 10.5 | –0.7 | –9.8 | –6% | | 12.6 | 12.7 | 0.1 | 1.0 | 1% | |
| 50% low | 4.211 | 4.407 | 0.196 | 2.74 | 5% | Very good | 4.486 | 4.346 | –0.140 | –1.96 | –3% | Very good |
| 25% low | 1.907 | 2.044 | 0.137 | 1.92 | 7% | | 2.080 | 2.001 | –0.079 | –1.11 | –4% | |
| 10% low | 0.681 | 0.741 | 0.060 | 0.84 | 9% | | 0.778 | 0.722 | –0.056 | –0.78 | –7% | |
| Low-flow recession | 0.99 | 1.00 | 0.01 | | | | 1.00 | 1.00 | 0.00 | | | |
| Storm volume | 3.5 | 3.1 | –0.4 | –5.5 | –11% | Good | 5.2 | 4.8 | –0.5 | –6.4 | –9% | Very good |
| Average storm peak ($ft^3/s$) | 1,255 | 1,020 | | –234 | –19% | | 1,143 | 939 | –204 | –204 | –18% | |
| Summer volume | 3.9 | 3.8 | 0.0 | –0.5 | –1% | Very good | 3.5 | 3.5 | –0.1 | –0.8 | –2% | Very good |
| Winter volume | 3.3 | 3.3 | 0.1 | 1.1 | 2% | Very good | 4.9 | 5.4 | 0.5 | 6.4 | 9% | Very good |
| Summer storms | 0.7 | 0.5 | –0.1 | –1.6 | –17% | Very good | 0.6 | 0.6 | –0.1 | –1.0 | –12% | Very good |
| Winter storms | 0.5 | 0.4 | –0.1 | –1.1 | –16% | | 2.2 | 2.0 | –0.2 | –2.3 | –8% | |
| | RCHRES 16 (Scioto River at Columbus) | | | | 1997-2005 | | RCHRES 16 | | | | 2006-2010 | |
| Total volume | 13.9 | 13.7 | –0.2 | –26.4 | –2% | Very good | 14.7 | 14.9 | 0.2 | 22.7 | 1% | Very good |
| 10% high | 6.9 | 6.7 | –0.2 | –23.3 | –3% | Very good | 7.4 | 7.5 | 0.1 | 14.3 | 2% | Very good |
| 25% high | 10.5 | 9.9 | –0.6 | –67.0 | –5% | | 11.3 | 11.2 | –0.1 | –9.4 | –1% | |
| 50% high | 12.7 | 12.3 | –0.3 | –41.7 | –3% | | 13.4 | 13.6 | 0.2 | 26.0 | 2% | |
| 50% low | 1.255 | 1.382 | 0.127 | 15.16 | 10% | Good | 1.311 | 1.283 | –0.028 | –3.34 | –2% | Very good |
| 25% low | 0.352 | 0.397 | 0.045 | 5.37 | 13% | | 0.376 | 0.334 | –0.042 | –5.01 | –11% | |
| 10% low | 0.108 | 0.116 | 0.008 | 0.96 | 7% | | 0.109 | 0.100 | –0.009 | –1.07 | –8% | |

**Table A11.** Model-fit statistics for calibration and validation simulation results from the HSPF model of the Upper Scioto River Basin, Ohio.—Continued

[N/A, not applicable; empty cell indicates no data or not applicable; $ft^3/s$, cubic feet per second]

| STATISTIC | CALIBRATION | | | | | | VALIDATION | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean annual observed runoff (inches) | Mean annual simulated runoff (inches) | Mean annual runoff error (inches) | Mean annual runoff error ($ft^3/s$) | Mean annual runoff error (percent) | Narrative performance category (Donigian, 2000) | Mean annual observed runoff (inches) | Mean annual simulated runoff (inches) | Mean annual runoff error (inches) | Mean annual runoff error ($ft^3/s$) | Mean annual runoff error (percent) | Narrative performance category (Donigian, 2000) |
| | RCHRES 16 (Scioto River at Columbus)—continued | | | | 1997-2005 | | RCHRES 16 | | | | 2006-2010 | |
| Low-flow recession | 0.95 | 0.90 | –0.05 | | | | 0.95 | 0.90 | –0.05 | | | |
| Storm volume | 7.2 | 6.6 | –0.6 | –77.5 | –9% | Very good | 8.2 | 6.9 | –1.4 | –164.0 | –17% | Good |
| Average storm peak ($ft^3/s$) | 6,158 | 6,392 | | 235 | 4% | | 3,692 | 3,687 | | –5 | 0% | |
| Summer volume | 2.3 | 2.3 | 0.0 | –1.6 | –1% | Very good | 2.4 | 2.4 | 0.0 | 4.2 | 1% | Very good |
| Winter volume | 4.8 | 4.8 | –0.1 | –7.9 | –1% | Very good | 5.2 | 5.2 | 0.0 | 0.2 | 0% | Very good |
| Summer storms | 0.8 | 0.7 | –0.1 | –12.2 | –13% | Very good | 1.0 | 0.7 | –0.2 | –28.2 | –24% | Very good |
| Winter storms | 3.0 | 2.9 | –0.1 | –12.7 | –4% | | 3.3 | 2.6 | –0.7 | –78.8 | –20% | |
| | RCHRES 26 (Walnut Cr at Ashville) | | | | 2005-2010 | | RCHRES 26 | | | | N/A | |
| Total volume | 15.4 | 15.4 | 0.1 | 1.6 | 1% | Very good | OBSERVED RECORD TOO SHORT FOR VALIDATION | | | | | |
| 10% high | 8.3 | 8.4 | 0.1 | 2.1 | 1% | Very good | | | | | | |
| 25% high | 11.3 | 11.5 | 0.2 | 3.7 | 2% | | | | | | | |
| 50% high | 13.8 | 13.8 | 0.0 | 1.0 | 0% | | | | | | | |
| 50% low | 1.591 | 1.621 | 0.030 | 0.60 | 2% | Very good | | | | | | |
| 25% low | 0.452 | 0.472 | 0.020 | 0.40 | 4% | | | | | | | |
| 10% low | 0.133 | 0.136 | 0.003 | 0.06 | 2% | | | | | | | |
| Low-flow recession | 0.94 | 0.93 | –0.02 | | | | | | | | | |
| Storm volume | 6.3 | 6.1 | –0.3 | –5.2 | -4% | Very good | | | | | | |
| Average storm peak ($ft^3/s$) | 2,345 | 2,417 | | 72 | 3% | | | | | | | |
| Summer volume | 2.1 | 2.5 | 0.3 | 6.6 | 15% | Very good | | | | | | |
| Winter volume | 5.1 | 5.1 | 0.0 | 0.4 | 0% | Very good | | | | | | |
| Summer storms | 0.6 | 0.7 | 0.0 | 0.2 | 2% | Very good | | | | | | |
| Winter storms | 2.7 | 2.5 | –0.2 | –4.6 | –8% | | | | | | | |

**Table A11.** Model-fit statistics for calibration and validation simulation results from the HSPF model of the Upper Scioto River Basin, Ohio.—Continued

[N/A, not applicable; empty cell indicates no data or not applicable; $ft^3/s$, cubic feet per second]

| STATISTIC | CALIBRATION | | | | | | VALIDATION | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean annual observed runoff (inches) | Mean annual simulated runoff (inches) | Mean annual runoff error (inches) | Mean annual runoff error ($ft^3/s$) | Mean annual runoff error (percent) | Narrative performance category (Donigian, 2000) | Mean annual observed runoff (inches) | Mean annual simulated runoff (inches) | Mean annual runoff error (inches) | Mean annual runoff error ($ft^3/s$) | Mean annual runoff error (percent) | Narrative performance category (Donigian, 2000) |
| | RCHRES 29 (Scioto R near Commercial Point) | | | | 2005-2010 | | RCHRES 29 | | | | | N/A |
| Total volume | 15.1 | 16.6 | 1.5 | 252.8 | 10% | Good | OBSERVED RECORD TOO SHORT FOR VALIDATION | | | | | |
| 10% high | 6.8 | 7.5 | 0.6 | 106.2 | 9% | Very good | | | | | | |
| 25% high | 10.6 | 11.5 | 1.0 | 160.8 | 9% | | | | | | | |
| 50% high | 13.1 | 14.5 | 1.4 | 229.2 | 10% | | | | | | | |
| 50% low | 1.960 | 2.101 | 0.141 | 23.59 | 7% | Good | | | | | | |
| 25% low | 0.673 | 0.686 | 0.013 | 2.17 | 2% | | | | | | | |
| 10% low | 0.220 | 0.219 | –0.001 | –0.17 | 0% | | | | | | | |
| Low-flow recession | 0.95 | 0.92 | –0.03 | | | | | | | | | |
| Storm volume | 6.8 | 6.5 | –0.3 | -42.2 | -4% | Very good | | | | | | |
| Average storm peak ($ft^3/s$) | 11,437 | 12,568 | | 1,131 | 10% | | | | | | | |
| Summer volume | 2.5 | 2.8 | 0.4 | 61.9 | 15% | Very good | | | | | | |
| Winter volume | 5.0 | 5.7 | 0.7 | 115.4 | 14% | Very good | | | | | | |
| Summer storms | 0.7 | 0.6 | –0.1 | –9.4 | -8% | Very good | | | | | | |
| Winter storms | 2.8 | 2.8 | –0.1 | –10.9 | -2% | | | | | | | |
| | RCHRES 30 (Big Walnut Cr at Rees) | | | | 1991-2002 | | RCHRES 30 | | | | | 2003-2010 |
| Total volume | 10.9 | 11.1 | 0.2 | 9.1 | 2% | Very good | 14.3 | 14.6 | 0.3 | 12.9 | 2% | Very good |
| 10% high | 5.6 | 5.4 | –0.2 | –8.1 | -4% | Very good | 6.7 | 7.0 | 0.4 | 14.2 | 5% | Very good |
| 25% high | 8.1 | 8.1 | 0.0 | 0.5 | 0% | | 10.1 | 10.5 | 0.4 | 16.8 | 4% | |
| 50% high | 9.7 | 9.9 | 0.2 | 7.7 | 2% | | 12.5 | 13.0 | 0.4 | 17.9 | 4% | |
| 50% low | 1.140 | 1.178 | 0.038 | 1.52 | 3% | Very good | 1.737 | 1.614 | –0.123 | –4.93 | –7% | Good |
| 25% low | 0.376 | 0.411 | 0.035 | 1.40 | 9% | | 0.614 | 0.539 | –0.075 | –3.01 | –12% | |
| 10% low | 0.109 | 0.128 | 0.019 | 0.76 | 17% | | 0.195 | 0.169 | –0.026 | –1.04 | –13% | |

**Table A11.** Model-fit statistics for calibration and validation simulation results from the HSPF model of the Upper Scioto River Basin, Ohio.—Continued

[N/A, not applicable; empty cell indicates no data or not applicable; $ft^3/s$, cubic feet per second]

| STATISTIC | CALIBRATION | | | | | | VALIDATION | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean annual observed runoff (inches) | Mean annual simulated runoff (inches) | Mean annual runoff error (inches) | Mean annual runoff error ($ft^3/s$) | Mean annual runoff error (percent) | Narrative performance category (Donigian, 2000) | Mean annual observed runoff (inches) | Mean annual simulated runoff (inches) | Mean annual runoff error (inches) | Mean annual runoff error ($ft^3/s$) | Mean annual runoff error (percent) | Narrative performance category (Donigian, 2000) |
| RCHRES 30 (Big Walnut Cr at Rees)—continued | | | | 1991-2002 | | | RCHRES 30 | | | | 2003-2010 | |
| Low-flow recession | 0.93 | 0.94 | 0.00 | | | | 0.93 | 0.93 | 0.00 | | | |
| Storm volume | 5.8 | 5.5 | –0.3 | –13.1 | –6% | Very good | 5.3 | 5.2 | –0.1 | –2.7 | –1% | Very good |
| Average storm peak ($ft^3/s$) | 2,444 | 2,351 | | –92 | –4% | | 1,789 | 1,709 | | –80 | –4% | |
| Summer volume | 2.4 | 2.6 | 0.2 | 7.8 | 8% | Very good | 2.7 | 2.9 | 0.3 | 10.5 | 10% | Very good |
| Winter volume | 3.0 | 3.0 | 0.0 | 1.4 | 1% | Very good | 4.5 | 5.0 | 0.5 | 19.6 | 11% | Very good |
| Summer storms | 1.2 | 1.2 | 0.0 | 0.2 | 0% | Very good | 1.0 | 1.1 | 0.1 | 4.2 | 10% | Very good |
| Winter storms | 1.6 | 1.4 | –0.1 | –5.5 | –9% | | 1.7 | 1.8 | 0.1 | 3.3 | 5% | |
| RCHRES 31 (Big Darby Cr at Darbyville) | | | | 1991-2002 | | | RCHRES 31 | | | | 2003-2010 | |
| Total volume | 12.8 | 12.7 | –0.1 | –3.1 | –1% | Very good | 15.8 | 16.0 | 0.2 | 7.9 | 1% | Very good |
| 10% high | 6.8 | 6.5 | –0.3 | –12.5 | –5% | Very good | 8.5 | 8.0 | –0.5 | –19.4 | –6% | Very good |
| 25% high | 9.8 | 9.5 | –0.2 | –8.8 | –2% | | 11.9 | 11.7 | –0.3 | –10.2 | –2% | |
| 50% high | 11.8 | 11.7 | 0.0 | –1.3 | 0% | | 14.4 | 14.6 | 0.2 | 8.1 | 1% | |
| 50% low | 0.996 | 0.952 | –0.044 | –1.73 | –4% | Very good | 1.429 | 1.423 | –0.006 | –0.24 | 0% | Very good |
| 25% low | 0.252 | 0.243 | –0.009 | –0.35 | –4% | | 0.327 | 0.360 | 0.033 | 1.30 | 10% | |
| 10% low | 0.062 | 0.055 | –0.007 | –0.28 | –11% | | 0.068 | 0.092 | 0.024 | 0.94 | 35% | |
| Low-flow recession | 0.945 | 0.931 | –0.01 | | | | 0.93 | 0.92 | –0.01 | | | |
| Storm volume | 6.6 | 6.4 | –0.2 | –6.7 | –3% | Very good | 11.3 | 10.5 | –0.8 | –29.9 | –7% | Very good |
| Average storm peak ($ft^3/s$) | 1,915 | 1,805 | | –109 | –6% | | | 1,766 | | –312 | –15% | |
| Summer volume | 2.7 | 2.5 | –0.2 | –8.1 | –8% | Very good | 2.2 | 2.5 | 0.3 | 10.5 | 12% | Very good |
| Winter volume | 3.8 | 4.1 | 0.3 | 12.0 | 8% | Very good | 5.7 | 5.8 | 0.0 | 1.9 | 1% | Very good |
| Summer storms | 1.1 | 1.0 | 0.0 | –1.2 | –3% | Very good | 1.3 | 1.4 | 0.1 | 2.4 | 5% | Very good |
| Winter storms | 2.5 | 2.5 | 0.0 | 0.5 | 1% | | 4.4 | 3.9 | –0.5 | –20.2 | –12% | |

**Table A11.** Model-fit statistics for calibration and validation simulation results from the HSPF model of the Upper Scioto River Basin, Ohio.—Continued

[N/A, not applicable; empty cell indicates no data or not applicable; $ft^3/s$, cubic feet per second]

| STATISTIC | CALIBRATION | | | | | | VALIDATION | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean annual observed runoff (inches) | Mean annual simulated runoff (inches) | Mean annual runoff error (inches) | Mean annual runoff error ($ft^3/s$) | Mean annual runoff error (percent) | Narrative performance category (Donigian, 2000) | Mean annual observed runoff (inches) | Mean annual simulated runoff (inches) | Mean annual runoff error (inches) | Mean annual runoff error ($ft^3/s$) | Mean annual runoff error (percent) | Narrative performance category (Donigian, 2000) |
| RCHRES 34 (Alum Cr at Columbus) | | | | 1991-1998 | | | RCHRES 34 | | | | N/A | |
| Total volume | 14.8 | 15.1 | 0.3 | 4.3 | 2% | Very good | OBSERVED RECORD TOO SHORT FOR VALIDATION | | | | | |
| 10% high | 7.8 | 7.3 | –0.5 | –7.2 | –7% | Very good | | | | | | |
| 25% high | 11.6 | 11.5 | –0.1 | –0.8 | 0% | | | | | | | |
| 50% high | 13.6 | 14.0 | 0.3 | 4.7 | 2% | | | | | | | |
| 50% low | 1.167 | 1.141 | –0.026 | –0.36 | –2% | Very good | | | | | | |
| 25% low | 0.328 | 0.344 | 0.016 | 0.22 | 5% | | | | | | | |
| 10% low | 0.087 | 0.093 | 0.006 | 0.08 | 7% | | | | | | | |
| Low-flow recession | 0.93 | 0.92 | –0.01 | | | | | | | | | |
| Storm volume | 8.0 | 7.1 | –0.9 | –12.5 | –11% | Good | | | | | | |
| Average storm peak ($ft^3/s$) | 1,242 | 1,184 | | –58 | –5% | | | | | | | |
| Summer volume | 3.7 | 3.8 | 0.2 | 2.3 | 5% | Very good | | | | | | |
| Winter volume | 4.5 | 4.7 | 0.1 | 1.8 | 3% | Very good | | | | | | |
| Summer storms | 2.4 | 2.3 | –0.1 | –1.2 | –4% | Very good | | | | | | |
| Winter storms | 2.5 | 2.1 | –0.4 | –6.0 | –17% | | | | | | | |
| RCHRES 36 (Olentangy R near Worthington) | | | | 1996-2005 | | | RCHRES 36 | | | | 2006-2010 | |
| Total volume | 14.5 | 14.0 | –0.5 | –19.3 | –4% | Very good | 15.7 | 16.5 | 0.9 | 32.4 | 6% | Good |
| 10% high | 7.8 | 7.5 | –0.3 | –10.4 | –4% | Very good | 8.6 | 8.7 | 0.1 | 2.1 | 1% | Very good |
| 25% high | 11.7 | 10.9 | –0.7 | –26.5 | –6% | | 12.7 | 13.0 | 0.3 | 12.6 | 3% | |
| 50% high | 13.6 | 13.1 | –0.6 | –21.9 | –4% | | 14.7 | 15.5 | 0.8 | 28.5 | 5% | |
| 50% low | 0.892 | 0.963 | 0.071 | 2.60 | 8% | Good | 0.950 | 1.058 | 0.108 | 3.96 | 11% | Fair |
| 25% low | 0.208 | 0.231 | 0.023 | 0.84 | 11% | | 0.257 | 0.232 | –0.025 | –0.92 | –10% | |
| 10% low | 0.053 | 0.057 | 0.004 | 0.15 | 8% | | 0.068 | 0.058 | –0.010 | –0.37 | –15% | |

**Table A11.** Model-fit statistics for calibration and validation simulation results from the HSPF model of the Upper Scioto River Basin, Ohio.—Continued

[N/A, not applicable; empty cell indicates no data or not applicable; $ft^3/s$, cubic feet per second]

| STATISTIC | CALIBRATION | | | | | | VALIDATION | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean annual observed runoff (inches) | Mean annual simulated runoff (inches) | Mean annual runoff error (inches) | Mean annual runoff error ($ft^3/s$) | Mean annual runoff error (percent) | Narrative performance category (Donigian, 2000) | Mean annual observed runoff (inches) | Mean annual simulated runoff (inches) | Mean annual runoff error (inches) | Mean annual runoff error ($ft^3/s$) | Mean annual runoff error (percent) | Narrative performance category (Donigian, 2000) |
| | RCHRES 36 (Olentangy R near Worthington)—continued | | | 1996-2005 | | | RCHRES 36 | | | | 2006-2010 | |
| Low-flow recession | 0.96 | 0.90 | –0.06 | | | | 0.96 | 0.91 | –0.05 | | | |
| Storm volume | 8.7 | 8.3 | –0.4 | –13.7 | –4% | Very good | 8.1 | 8.1 | 0.0 | 1.0 | 0% | Very good |
| Average storm peak ($ft^3/s$) | 2,130 | 2,342 | | 212 | 10% | | 894 | 895 | | 1 | 0% | |
| Summer volume | 2.2 | 2.3 | 0.0 | 0.7 | 1% | Very good | 2.6 | 2.8 | 0.2 | 9.1 | 10% | Very good |
| Winter volume | 5.5 | 5.4 | –0.1 | –2.3 | –1% | Very good | 5.8 | 6.0 | 0.1 | 5.0 | 2% | Very good |
| Summer storms | 1.0 | 0.8 | –0.2 | –6.1 | –17% | Very good | 1.1 | 1.3 | 0.2 | 6.2 | 15% | Very good |
| Winter storms | 4.2 | 4.1 | –0.1 | –3.4 | –2% | | 3.1 | 3.0 | –0.1 | –4.7 | –4% | |
| | RCHRES 40 (Alum Cr near Kilbourne) | | | 2000-2010 | | | RCHRES 40 | | | | N/A | |
| Total volume | 15.0 | 15.2 | 0.1 | 0.7 | 1% | Very good | OBSERVED RECORD TOO SHORT FOR VALIDATION | | | | | |
| 10% high | 9.8 | 10.1 | 0.3 | 1.3 | 3% | Very good | | | | | | |
| 25% high | 12.6 | 12.7 | 0.2 | 0.7 | 1% | | | | | | | |
| 50% high | 14.3 | 14.5 | 0.2 | 0.9 | 1% | | | | | | | |
| 50% low | 0.761 | 0.719 | –0.042 | –0.20 | –6% | Good | | | | | | |
| 25% low | 0.124 | 0.122 | –0.002 | –0.01 | –2% | | | | | | | |
| 10% low | 0.018 | 0.019 | 0.001 | 0.00 | 6% | | | | | | | |
| Low-flow recession | 0.91 | 0.89 | –0.02 | | | | | | | | | |
| Storm volume | 9.9 | 9.6 | –0.3 | –1.4 | –3% | Very good | | | | | | |
| Average storm peak ($ft^3/s$) | 867 | 885 | | 18 | 2% | | | | | | | |
| Summer volume | 1.7 | 1.8 | 0.1 | 0.6 | 8% | Very good | | | | | | |
| Winter volume | 5.6 | 6.3 | 0.7 | 3.2 | 12% | Very good | | | | | | |
| Summer storms | 1.1 | 1.0 | 0.0 | –0.1 | –2% | Very good | | | | | | |
| Winter storms | 3.9 | 4.2 | 0.3 | 1.6 | 8% | | | | | | | |

**Table A11.** Model-fit statistics for calibration and validation simulation results from the HSPF model of the Upper Scioto River Basin, Ohio.—Continued

[N/A, not applicable; empty cell indicates no data or not applicable; $ft^3/s$, cubic feet per second]

| STATISTIC | CALIBRATION | | | | | | VALIDATION | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean annual observed runoff (inches) | Mean annual simulated runoff (inches) | Mean annual runoff error (inches) | Mean annual runoff error ($ft^3/s$) | Mean annual runoff error (percent) | Narrative performance category (Donigian, 2000) | Mean annual observed runoff (inches) | Mean annual simulated runoff (inches) | Mean annual runoff error (inches) | Mean annual runoff error ($ft^3/s$) | Mean annual runoff error (percent) | Narrative performance category (Donigian, 2000) |
| | RCHRES 42 (Olentangy R near Delaware) | | | | 1996-2005 | | RCHRES 42 | | | | 2006-2010 | |
| Total volume | 13.9 | 12.5 | –1.4 | –41.1 | –10% | Good | 14.5 | 15.6 | 1.0 | 30.4 | 7% | Good |
| 10% high | 7.9 | 7.1 | –0.8 | –21.8 | –10% | Very good | 8.3 | 8.8 | 0.5 | 14.9 | 6% | Very good |
| 25% high | 11.4 | 10.1 | –1.3 | –37.0 | –11% | | 12.0 | 12.7 | 0.7 | 19.9 | 6% | |
| 50% high | 13.2 | 11.8 | –1.4 | –39.9 | –10% | | 13.8 | 14.8 | 1.0 | 28.1 | 7% | |
| 50% low | 0.687 | 0.646 | –0.041 | –1.19 | –6% | Good | 0.691 | 0.768 | 0.077 | 2.23 | 11% | Fair |
| 25% low | 0.165 | 0.155 | –0.010 | –0.29 | –6% | | 0.171 | 0.163 | –0.008 | –0.23 | –5% | |
| 10% low | 0.048 | 0.043 | –0.005 | –0.14 | –10% | | 0.039 | 0.042 | 0.003 | 0.09 | 8% | |
| Low-flow recession | 1.00 | 0.95 | –0.06 | | | | 1.00 | 0.94 | –0.06 | | | |
| Storm volume | 4.6 | 4.5 | –0.1 | –2.2 | –2% | Very good | 5.2 | 5.2 | 0.0 | 0.1 | 0% | Very good |
| Average storm peak ($ft^3/s$) | 1,872 | 1,928 | | 56 | 3% | | 1,183 | 1,224 | | 41 | 3% | |
| Summer volume | 2.1 | 1.8 | –0.2 | –6.8 | –11% | Very good | 2.3 | 2.6 | 0.3 | 8.1 | 12% | Very good |
| Winter volume | 5.2 | 4.9 | –0.4 | –10.4 | –7% | Very good | 5.5 | 5.6 | 0.2 | 4.8 | 3% | Very good |
| Summer storms | 0.7 | 0.6 | –0.1 | –1.9 | –10% | Very good | 1.0 | 1.0 | 0.0 | –0.1 | 0% | Very good |
| Winter storms | 1.8 | 1.9 | 0.1 | 3.0 | 6% | | 2.5 | 2.5 | 0.0 | 0.6 | 1% | |
| | RCHRES 44 (Whetstone Cr at Mt Gilead) | | | | 1996-2010 | | RCHRES 44 | | | | N/A | |
| Total volume | 15.2 | 15.2 | 0.0 | –0.1 | 0% | Very good | OBSERVED RECORD TOO SHORT FOR VALIDATION | | | | | |
| 10% high | 9.3 | 10.0 | 0.7 | 2.0 | 8% | Very good | | | | | | |
| 25% high | 12.4 | 12.8 | 0.3 | 0.9 | 3% | | | | | | | |
| 50% high | 14.4 | 14.4 | –0.1 | –0.2 | 0% | | | | | | | |
| 50% low | 0.826 | 0.845 | 0.019 | 0.05 | 2% | Very good | | | | | | |
| 25% low | 0.167 | 0.172 | 0.005 | 0.01 | 3% | | | | | | | |
| 10% low | 0.032 | 0.032 | 0.000 | 0.00 | 0% | | | | | | | |

**Table A11.** Model-fit statistics for calibration and validation simulation results from the HSPF model of the Upper Scioto River Basin, Ohio.—Continued

[N/A, not applicable; empty cell indicates no data or not applicable; ft³/s, cubic feet per second]

| STATISTIC | CALIBRATION | | | | | | VALIDATION | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean annual observed runoff (inches) | Mean annual simulated runoff (inches) | Mean annual runoff error (inches) | Mean annual runoff error (ft³/s) | Mean annual runoff error (percent) | Narrative performance category (Donigian, 2000) | Mean annual observed runoff (inches) | Mean annual simulated runoff (inches) | Mean annual runoff error (inches) | Mean annual runoff error (ft³/s) | Mean annual runoff error (percent) | Narrative performance category (Donigian, 2000) |
| RCHRES 44 (Whetstone Cr at Mt Gilead)—continued | | | | | 1996-2010 | | RCHRES 44 | | | | | N/A |
| Low-flow recession | 0.92 | 0.92 | 0.00 | | | | OBSERVED RECORD TOO SHORT FOR VALIDATION | | | | | |
| Storm volume | 9.3 | 9.3 | –0.1 | –0.2 | –1% | Very good | | | | | | |
| Average storm peak (ft³/s) | 451 | 469 | | 19 | 4% | | | | | | | |
| Summer volume | 2.3 | 2.6 | 0.2 | 0.6 | 9% | Very good | | | | | | |
| Winter volume | 5.5 | 5.6 | 0.2 | 0.4 | 3% | Very good | | | | | | |
| Summer storms | 1.4 | 1.5 | 0.1 | 0.2 | 4% | Very good | | | | | | |
| Winter storms | 3.7 | 3.8 | 0.1 | 0.3 | 3% | | | | | | | |
| RCHRES 45 (Scioto R at Prospect) | | | | | 1990-2002 | | RCHRES 45 | | | | 2003-2010 | |
| Total volume | 11.3 | 12.3 | 0.9 | 38.5 | 8% | Good | 16.2 | 14.1 | –2.1 | –86.7 | –13% | Fair |
| 10% high | 6.3 | 6.7 | 0.4 | 16.1 | 6% | Very good | 8.5 | 7.5 | –1.0 | –42.5 | –12% | Good |
| 25% high | 9.2 | 9.7 | 0.5 | 22.7 | 6% | | 12.7 | 10.9 | –1.9 | –77.6 | –15% | |
| 50% high | 10.8 | 11.6 | 0.9 | 35.7 | 8% | | 15.2 | 13.2 | –2.0 | –83.2 | –13% | |
| 50% low | 0.593 | 0.660 | 0.067 | 2.80 | 11% | Fair | 1.042 | 0.959 | –0.083 | –3.47 | -8% | Good |
| 25% low | 0.126 | 0.138 | 0.012 | 0.50 | 10% | | 0.207 | 0.187 | –0.020 | –0.84 | –10% | |
| 10% low | 0.034 | 0.032 | –0.002 | –0.08 | –6% | | 0.040 | 0.041 | 0.001 | 0.04 | 3% | |
| Low-flow recession | 0.94 | 0.90 | –0.04 | | | | 0.9 | 0.9 | 0.0 | | | |
| Storm volume | 4.9 | 4.8 | –0.1 | –5.7 | –3% | Very good | 8.1 | 6.1 | –2.0 | –85.1 | –25% | Fair |
| Average storm peak (ft³/s) | 1,637 | 1,867 | | 230 | 14% | | 1,555 | 1,570 | | 16 | 1% | |
| Summer volume | 2.0 | 2.0 | 0.0 | 1.7 | 2% | Very good | 2.4 | 2.1 | –0.3 | –12.7 | –13% | Very good |
| Winter volume | 3.8 | 4.2 | 0.4 | 16.8 | 11% | Very good | 6.0 | 5.3 | –0.7 | –30.9 | –12% | Very good |
| Summer storms | 0.6 | 0.5 | –0.1 | –3.6 | –16% | Very good | 1.1 | 0.9 | –0.3 | –12.0 | –25% | Very good |
| Winter storms | 2.2 | 2.1 | 0.0 | –1.8 | –2% | | 3.6 | 2.8 | –0.8 | –33.4 | –22% | |

In most cases, there was good agreement between the simulated and measured flows for both calibration and, where available, validation time periods listed in table A11. Agreement between the model output and measured data for low flows below O'Shaughnessy Dam on the Scioto River (RCHRES 13) was less than desirable. This is due to the complexities of the dam and hydroelectric power operations at O'Shaughnessy Reservoir. However, the model shows good agreement for low flows below the other reservoirs in the basin.

Relatively large errors were measured for the RCHRES 6 validation period, with the lowest 10 percent of flows being overestimated by 200 percent. This was due to the measured lowest 10 percent of flows being very close to zero (0.003 inch) and a difference in measured and simulated flows being just 0.04 $ft^3/s$.

Table A12 shows the measured and simulated annual mean streamflows for each of the 18 streamgage sites used in the model. For each calibration reach, there were years when streamflows were overestimated and years when streamflows were underestimated, perhaps in part reflecting spatial and (or) temporal differences between actual climatic conditions in the basins and climatic conditions as represented by the climate datasets used in the model. The maximum overestimation for a single year was 81 percent (RCHRES 7 in 2009). The maximum underestimation for a single year was 68 percent (RCHRES 10 in 1992). The mean and median of the percent errors in annual streamflows when considering all gages and both calibration and validation periods were 3 percent and 2 percent, respectively.

**Table A12.** Measured and simulated annual mean streamflows.

[ft³/s, cubic feet per second]

| Year | Observed annual mean streamflow | | Simulated annual mean streamflow | | Error | | |
|---|---|---|---|---|---|---|---|
| | (inches) | (ft³/s) | (inches) | (ft³/s) | (ft³/s) | (percent) | |
| RCHRES 2 (Olentangy River at Claridon) | | | | | | | |
| 1991 | 10.26 | 119 | 8.26 | 96 | –23 | –19% | CALIBRATION |
| 1992 | 13.85 | 160 | 12.06 | 140 | –21 | –13% | |
| 1993 | 12.80 | 148 | 15.40 | 178 | 30 | 20% | |
| 1994 | 10.51 | 122 | 11.17 | 129 | 8 | 6% | |
| 1995 | 17.65 | 204 | 18.15 | 210 | 6 | 3% | |
| 1996 | 22.25 | 257 | 22.39 | 259 | 2 | 1% | |
| 1997 | 11.80 | 137 | 13.82 | 160 | 23 | 17% | |
| RCHRES 6 (Big Walnut Creek at Sunbury) | | | | | | | |
| 1991 | 8.66 | 64 | 11.11 | 83 | 18 | 28% | CALIBRATION |
| 1992 | 12.78 | 95 | 9.77 | 73 | –22 | –24% | |
| 1993 | 18.42 | 137 | 15.83 | 118 | –19 | –14% | |
| 1994 | 10.40 | 77 | 11.48 | 85 | 8 | 10% | |
| 1995 | 17.81 | 133 | 15.12 | 113 | –20 | –15% | |
| 1996 | 22.78 | 170 | 20.93 | 156 | –14 | –8% | |
| 1997 | 14.04 | 105 | 14.84 | 110 | 6 | 6% | |
| 1998 | 12.72 | 95 | 10.95 | 82 | –13 | –14% | |
| 1999 | 9.08 | 68 | 8.12 | 60 | –7 | –11% | |
| 2000 | 13.37 | 100 | 16.12 | 120 | 20 | 21% | |
| 2001 | 10.57 | 79 | 9.97 | 74 | –4 | –6% | |
| 2002 | 10.59 | 79 | 12.10 | 90 | 11 | 14% | |
| 2003 | 17.65 | 131 | 17.07 | 127 | -4 | –3% | VALIDATION |
| 2004 | 20.36 | 152 | 20.79 | 155 | 3 | 2% | |
| 2005 | 15.10 | 112 | 18.62 | 139 | 26 | 23% | |
| 2006 | 13.11 | 98 | 12.73 | 95 | –3 | –3% | |
| 2007 | 15.92 | 119 | 17.83 | 133 | 14 | 12% | |
| 2008 | 17.77 | 132 | 19.56 | 146 | 13 | 10% | |
| 2009 | 12.27 | 91 | 12.46 | 93 | 1 | 2% | |
| 2010 | 9.79 | 73 | 12.23 | 91 | 18 | 25% | |
| RCHRES 7 (Mill Creek at Bellepoint) | | | | | | | |
| 1991 | 8.14 | 107 | 7.09 | 93 | –14 | –13% | CALIBRATION |
| 1992 | 11.87 | 156 | 12.38 | 162 | 7 | 4% | |
| 1993 | 19.09 | 250 | 19.16 | 251 | 1 | 0% | |
| 1994 | 7.31 | 96 | 10.91 | 143 | 47 | 49% | |
| 1995 | 13.90 | 182 | 13.47 | 177 | –6 | –3% | |
| 1996 | 22.32 | 293 | 19.60 | 257 | –36 | –12% | |
| 1997 | 11.94 | 157 | 8.66 | 114 | –43 | –27% | |
| 1998 | 8.67 | 114 | 11.00 | 144 | 31 | 27% | |
| 1999 | 7.27 | 95 | 9.90 | 130 | 35 | 36% | |
| 2000 | 11.27 | 148 | 12.87 | 169 | 21 | 14% | |
| 2001 | 12.59 | 165 | 14.18 | 186 | 21 | 13% | |
| 2002 | 13.89 | 182 | 16.45 | 216 | 34 | 18% | |

**Table A12.** Measured and simulated annual mean streamflows.—Continued

[$ft^3/s$, cubic feet per second]

| Year | Observed annual mean streamflow | | Simulated annual mean streamflow | | Error | | |
|---|---|---|---|---|---|---|---|
| | (inches) | ($ft^3/s$) | (inches) | ($ft^3/s$) | ($ft^3/s$) | (percent) | |
| RCHRES 7 (Mill Creek at Bellepoint)—continued | | | | | | | |
| 2003 | 23.55 | 309 | 22.72 | 298 | –11 | -4% | VALIDATION |
| 2004 | 15.75 | 207 | 15.65 | 205 | –1 | –1% | |
| 2005 | 19.54 | 256 | 20.47 | 269 | 12 | 5% | |
| 2006 | 14.29 | 187 | 13.08 | 172 | –16 | –8% | |
| 2007 | 18.23 | 239 | 21.31 | 280 | 40 | 17% | |
| 2008 | 17.90 | 235 | 21.36 | 280 | 45 | 19% | |
| 2009 | 6.64 | 87 | 12.00 | 157 | 70 | 81% | |
| 2010 | 11.59 | 152 | 13.04 | 171 | 19 | 13% | |
| RCHRES 8 (Scioto River below O'Shaughnessy) | | | | | | | |
| 1991 | 8.59 | 620 | 7.02 | 507 | –113 | –18% | CALIBRATION |
| 1992 | 11.91 | 860 | 13.02 | 940 | 80 | 9% | |
| 1993 | 18.09 | 1307 | 16.77 | 1211 | –95 | –7% | |
| 1994 | 9.87 | 713 | 9.98 | 721 | 8 | 1% | |
| 1995 | 14.78 | 1068 | 14.04 | 1014 | –53 | –5% | |
| 1996 | 21.74 | 1570 | 18.43 | 1331 | –239 | –15% | |
| 1997 | 11.78 | 851 | 11.70 | 845 | –6 | –1% | |
| 1998 | 11.73 | 847 | 12.42 | 897 | 50 | 6% | |
| 1999 | 8.18 | 591 | 10.02 | 724 | 133 | 22% | |
| 2000 | 9.34 | 675 | 11.36 | 820 | 146 | 22% | |
| 2001 | 10.68 | 771 | 11.37 | 821 | 50 | 6% | |
| 2002 | 11.38 | 822 | 12.17 | 879 | 57 | 7% | |
| 2003 | 22.24 | 1606 | 12.63 | 912 | –694 | –43% | VALIDATION |
| 2004 | 16.40 | 1185 | 15.25 | 1101 | –83 | –7% | |
| 2005 | 21.00 | 1517 | 15.13 | 1093 | –424 | –28% | |
| 2006 | 15.51 | 1120 | 11.47 | 828 | –292 | –26% | |
| 2007 | 17.63 | 1273 | 18.14 | 1310 | 37 | 3% | |
| 2008 | 18.35 | 1325 | 20.10 | 1452 | 126 | 10% | |
| 2009 | 7.73 | 558 | 11.29 | 815 | 257 | 46% | |
| 2010 | 9.54 | 689 | 13.29 | 960 | 271 | 39% | |
| RCHRES 10 (Alum Creek at Africa) | | | | | | | |
| 1991 | 8.57 | 77 | 7.85 | 71 | –6 | –8% | CALIBRATION |
| 1992 | 4.03 | 36 | 1.30 | 12 | –25 | –68% | |
| 1993 | 18.16 | 163 | 14.61 | 131 | –32 | –20% | |
| 1994 | 8.69 | 78 | 7.15 | 64 | –14 | –18% | |
| 1995 | 16.48 | 148 | 12.18 | 110 | –39 | –26% | |
| 1996 | 21.07 | 189 | 22.90 | 206 | 16 | 9% | |
| 1997 | 10.27 | 92 | 12.49 | 112 | 20 | 22% | |

**Table A12.** Measured and simulated annual mean streamflows.—Continued

[ft³/s, cubic feet per second]

| Year | Observed annual mean streamflow | | Simulated annual mean streamflow | | Error | | |
|---|---|---|---|---|---|---|---|
| | (inches) | (ft³/s) | (inches) | (ft³/s) | (ft³/s) | (percent) | |
| RCHRES 12 (Little Darby Creek at West Jefferson) | | | | | | | |
| 1993 | 18.36 | 221 | 18.00 | 216 | –4 | –2% | CALIBRATION |
| 1994 | 13.32 | 160 | 13.89 | 167 | 7 | 4% | |
| 1995 | 14.02 | 168 | 13.22 | 159 | –10 | –6% | |
| 1996 | 21.41 | 257 | 17.72 | 213 | –44 | –17% | |
| 1997 | 15.08 | 181 | 12.13 | 146 | –35 | –20% | |
| 1998 | 11.99 | 144 | 11.06 | 133 | –11 | –8% | |
| 1999 | 7.61 | 91 | 9.59 | 115 | 24 | 26% | |
| 2000 | 8.27 | 99 | 11.88 | 143 | 43 | 44% | |
| 2001 | 10.39 | 125 | 10.34 | 124 | –1 | 0% | |
| 2002 | 14.14 | 170 | 19.40 | 233 | 63 | 37% | |
| 2003 | 19.42 | 233 | 21.55 | 259 | 26 | 11% | |
| 2004 | 19.46 | 234 | 19.23 | 231 | –3 | –1% | |
| RCHRES 13 (Big Walnut Creek at Central College) | | | | | | | |
| 1991 | 15.95 | 223 | 17.60 | 246 | 23 | 10% | CALIBRATION |
| 1992 | 10.12 | 142 | 10.15 | 142 | 0 | 0% | |
| 1993 | 19.01 | 266 | 16.86 | 236 | –30 | –11% | |
| 1994 | 13.76 | 193 | 15.43 | 216 | 23 | 12% | |
| 1995 | 16.83 | 236 | 13.63 | 191 | –45 | –19% | |
| 1996 | 22.36 | 313 | 20.57 | 288 | –25 | –8% | |
| 1997 | 15.84 | 222 | 16.21 | 227 | 5 | 2% | |
| 1998 | 14.53 | 203 | 13.94 | 195 | –8 | –4% | |
| 1999 | 13.56 | 190 | 12.09 | 169 | -21 | –11% | |
| 2000 | 15.09 | 211 | 15.30 | 214 | 3 | 1% | |
| 2001 | 12.76 | 179 | 11.70 | 164 | –15 | –8% | |
| 2002 | 14.64 | 205 | 14.97 | 210 | 5 | 2% | |
| 2003 | 18.38 | 257 | 16.34 | 229 | –29 | –11% | VALIDATION |
| 2004 | 22.00 | 308 | 21.52 | 301 | –7 | –2% | |
| 2005 | 21.61 | 303 | 20.30 | 284 | –18 | –6% | |
| 2006 | 12.19 | 171 | 12.03 | 168 | –2 | –1% | |
| 2007 | 17.70 | 248 | 19.00 | 266 | 18 | 7% | |
| 2008 | 20.92 | 293 | 20.43 | 286 | –7 | –2% | |
| 2009 | 10.38 | 145 | 13.09 | 183 | 38 | 26% | |
| 2010 | 13.72 | 192 | 13.61 | 191 | –2 | –1% | |
| RCHRES 16 (Scioto River at Columbus) | | | | | | | |
| 1997 | 12.16 | 1452 | 12.92 | 1543 | 91 | 6% | CALIBRATION |
| 1998 | 11.33 | 1353 | 12.90 | 1540 | 187 | 14% | |
| 1999 | 8.37 | 999 | 10.75 | 1283 | 284 | 28% | |
| 2000 | 10.87 | 1298 | 13.50 | 1612 | 314 | 24% | |
| 2001 | 11.04 | 1318 | 12.18 | 1454 | 136 | 10% | |
| 2002 | 11.34 | 1354 | 12.17 | 1453 | 99 | 7% | |
| 2003 | 21.32 | 2545 | 16.44 | 1963 | –583 | –23% | |
| 2004 | 16.67 | 1990 | 16.71 | 1995 | 5 | 0% | |
| 2005 | 22.09 | 2637 | 15.71 | 1876 | –762 | –29% | |

**Table A12.** Measured and simulated annual mean streamflows.—Continued

[$ft^3/s$, cubic feet per second]

| Year | Observed annual mean streamflow | | Simulated annual mean streamflow | | Error | | |
|---|---|---|---|---|---|---|---|
| | (inches) | ($ft^3/s$) | (inches) | ($ft^3/s$) | ($ft^3/s$) | (percent) | |
| RCHRES 16 (Scioto River at Columbus)—continued | | | | | | | |
| 2006 | 16.73 | 1997 | 10.37 | 1238 | –759 | –38% | VALIDATION |
| 2007 | 18.00 | 2149 | 19.36 | 2311 | 162 | 8% | |
| 2008 | 19.08 | 2278 | 20.02 | 2390 | 112 | 5% | |
| 2009 | 9.17 | 1095 | 11.22 | 1340 | 245 | 22% | |
| 2010 | 10.71 | 1279 | 13.70 | 1636 | 357 | 28% | |
| RCHRES 26 (Walnut Creek at Ashville) | | | | | | | |
| 2006 | 11.4 | 229 | 9.95 | 200 | –29 | –13% | CALIBRATION |
| 2007 | 19.9 | 400 | 18.98 | 382 | –19 | –5% | |
| 2008 | 22.11 | 445 | 22.04 | 443 | –1 | 0% | |
| 2009 | 9.15 | 184 | 9.51 | 191 | 7 | 4% | |
| 2010 | 12.04 | 242 | 12.38 | 249 | 7 | 3% | |
| RCHRES 29 (Scioto River near Commercial Point) | | | | | | | |
| 2006 | 13.65 | 2284 | 11.34 | 1897 | –386 | –17% | CALIBRATION |
| 2007 | 19.25 | 3221 | 20.87 | 3492 | 271 | 8% | |
| 2008 | 21.04 | 3520 | 22.01 | 3682 | 162 | 5% | |
| 2009 | 9.01 | 1507 | 11.83 | 1979 | 472 | 31% | |
| 2010 | 11.40 | 1907 | 13.74 | 2299 | 391 | 21% | |
| RCHRES 30 (Big Walnut Creek at Rees) | | | | | | | |
| 1991 | 9.32 | 374 | 11.29 | 453 | 79 | 21% | CALIBRATION |
| 1992 | 6.87 | 275 | 7.67 | 308 | 32 | 12% | |
| 1993 | 14.26 | 572 | 13.61 | 546 | –26 | –5% | |
| 1994 | 8.71 | 349 | 9.58 | 384 | 35 | 10% | |
| 1995 | 14.28 | 573 | 12.86 | 516 | –57 | –10% | |
| 1996 | 18.85 | 756 | 18.44 | 739 | –16 | –2% | |
| 1997 | 12.18 | 488 | 12.52 | 502 | 14 | 3% | |
| 1998 | 10.03 | 402 | 10.04 | 403 | 0 | 0% | |
| 1999 | 6.54 | 262 | 6.05 | 243 | –20 | –7% | |
| 2000 | 9.84 | 395 | 11.48 | 460 | 66 | 17% | |
| 2001 | 9.08 | 364 | 8.57 | 344 | –20 | –6% | |
| 2002 | 10.50 | 421 | 11.09 | 445 | 24 | 6% | |
| 2003 | 16.38 | 657 | 16.50 | 662 | 5 | 1% | VALIDATION |
| 2004 | 18.10 | 726 | 19.40 | 778 | 52 | 7% | |
| 2005 | 17.82 | 714 | 16.50 | 662 | –53 | –7% | |
| 2006 | 12.57 | 504 | 11.20 | 449 | –55 | –11% | |
| 2007 | 13.99 | 561 | 16.04 | 643 | 82 | 15% | |
| 2008 | 17.43 | 699 | 16.87 | 676 | –22 | –3% | |
| 2009 | 8.98 | 360 | 10.28 | 412 | 52 | 14% | |
| 2010 | 8.98 | 360 | 10.04 | 403 | 42 | 12% | |

**Table A12.** Measured and simulated annual mean streamflows.—Continued

[ft³/s, cubic feet per second]

| Year | Observed annual mean streamflow | | Simulated annual mean streamflow | | Error | | |
|---|---|---|---|---|---|---|---|
| | (inches) | (ft³/s) | (inches) | (ft³/s) | (ft³/s) | (percent) | |
| RCHRES 31 (Big Darby Creek at Darbyville) | | | | | | | |
| 1991 | 9.80 | 386 | 8.42 | 331 | –54 | –14% | CALIBRATION |
| 1992 | 9.84 | 387 | 11.53 | 454 | 67 | 17% | |
| 1993 | 19.24 | 757 | 17.84 | 702 | –55 | –7% | |
| 1994 | 9.27 | 365 | 11.13 | 438 | 73 | 20% | |
| 1995 | 14.50 | 571 | 14.05 | 553 | –18 | –3% | |
| 1996 | 22.88 | 900 | 19.15 | 754 | –147 | –16% | |
| 1997 | 12.69 | 499 | 9.97 | 392 | –107 | –21% | |
| 1998 | 12.89 | 507 | 11.25 | 443 | –65 | –13% | |
| 1999 | 7.98 | 314 | 8.71 | 343 | 29 | 9% | |
| 2000 | 9.85 | 388 | 12.83 | 505 | 117 | 30% | |
| 2001 | 12.00 | 472 | 12.63 | 497 | 25 | 5% | |
| 2002 | 12.25 | 482 | 14.77 | 581 | 99 | 21% | |
| 2003 | 17.68 | 696 | 20.52 | 808 | 112 | 16% | VALIDATION |
| 2004 | 16.77 | 660 | 15.32 | 603 | –57 | –9% | |
| 2005 | 21.24 | 836 | 18.14 | 714 | –122 | –15% | |
| 2006 | 16.52 | 650 | 12.09 | 476 | –174 | –27% | |
| 2007 | 17.70 | 697 | 19.78 | 778 | 82 | 12% | |
| 2008 | 17.97 | 707 | 19.85 | 781 | 74 | 10% | |
| 2009 | 7.83 | 308 | 9.85 | 388 | 79 | 26% | |
| 2010 | 11.05 | 435 | 12.80 | 504 | 69 | 16% | |
| RCHRES 34 (Alum Creek at Columbus) | | | | | | | |
| 1991 | 9.76 | 137 | 10.80 | 151 | 15 | 11% | CALIBRATION |
| 1992 | 6.83 | 96 | 7.21 | 101 | 5 | 6% | |
| 1993 | 16.97 | 238 | 15.99 | 224 | –14 | –6% | |
| 1994 | 10.13 | 142 | 9.63 | 135 | –7 | –5% | |
| 1995 | 17.41 | 244 | 15.56 | 218 | –26 | –11% | |
| 1996 | 20.90 | 293 | 22.62 | 317 | 24 | 8% | |
| 1997 | 12.74 | 178 | 14.00 | 196 | 18 | 10% | |
| RCHRES 36 (Olentangy River near Worthington) | | | | | | | |
| 1997 | 15.54 | 569 | 18.21 | 667 | 98 | 17% | CALIBRATION |
| 1998 | 11.25 | 412 | 12.83 | 470 | 58 | 14% | |
| 1999 | 8.83 | 323 | 10.08 | 369 | 46 | 14% | |
| 2000 | 11.58 | 424 | 16.26 | 596 | 171 | 40% | |
| 2001 | 8.17 | 299 | 10.57 | 387 | 88 | 29% | |
| 2002 | 12.40 | 454 | 12.81 | 469 | 15 | 3% | |
| 2003 | 18.16 | 665 | 11.32 | 415 | –251 | –38% | |
| 2004 | 22.61 | 828 | 17.71 | 649 | –179 | –22% | |
| 2005 | 18.85 | 690 | 14.13 | 518 | –173 | –25% | |
| 2006 | 17.54 | 642 | 16.19 | 593 | –49 | –8% | VALIDATION |
| 2007 | 18.86 | 691 | 22.41 | 821 | 130 | 19% | |
| 2008 | 19.89 | 729 | 19.53 | 715 | –13 | –2% | |
| 2009 | 10.59 | 388 | 10.34 | 379 | –9 | –2% | |
| 2010 | 11.42 | 418 | 14.25 | 522 | 104 | 25% | |

**Table A12.** Measured and simulated annual mean streamflows.—Continued

[$ft^3/s$, cubic feet per second]

| Year | Observed annual mean streamflow | | Simulated annual mean streamflow | | Error | | |
|---|---|---|---|---|---|---|---|
| | (inches) | ($ft^3/s$) | (inches) | ($ft^3/s$) | ($ft^3/s$) | (percent) | |
| RCHRES 40 (Alum Creek near Kilbourne) | | | | | | | |
| 2001 | 10.53 | 50 | 10.17 | 49 | –2 | –3% | CALIBRATION |
| 2002 | 12.85 | 61 | 16.45 | 79 | 17 | 28% | |
| 2003 | 18.15 | 87 | 17.55 | 84 | –3 | –3% | |
| 2004 | 21.38 | 102 | 19.62 | 94 | –8 | –8% | |
| 2005 | 17.43 | 83 | 16.72 | 80 | –3 | –4% | |
| 2006 | 12.40 | 59 | 9.40 | 45 | –14 | –24% | |
| 2007 | 16.54 | 79 | 20.36 | 97 | 18 | 23% | |
| 2008 | 19.10 | 91 | 16.51 | 79 | –12 | –14% | |
| 2009 | 10.52 | 50 | 11.40 | 55 | 4 | 8% | |
| 2010 | 11.41 | 55 | 13.55 | 65 | 10 | 19% | |
| RCHRES 42 (Olentangy River near Delaware) | | | | | | | |
| 1997 | 15.20 | 440 | 16.84 | 488 | 48 | 11% | CALIBRATION |
| 1998 | 11.79 | 341 | 11.78 | 341 | 0 | 0% | |
| 1999 | 9.08 | 263 | 8.83 | 256 | –7 | –3% | |
| 2000 | 10.97 | 318 | 14.39 | 417 | 99 | 31% | |
| 2001 | 7.93 | 230 | 9.58 | 277 | 48 | 21% | |
| 2002 | 12.89 | 373 | 11.23 | 325 | –48 | –13% | |
| 2003 | 16.11 | 467 | 9.03 | 262 | –205 | –44% | |
| 2004 | 20.79 | 602 | 15.83 | 459 | –144 | –24% | |
| 2005 | 16.71 | 484 | 12.50 | 362 | –122 | –25% | |
| 2006 | 16.82 | 487 | 15.35 | 445 | –43 | –9% | VALIDATION |
| 2007 | 17.71 | 513 | 20.75 | 601 | 88 | 17% | |
| 2008 | 18.40 | 533 | 19.13 | 554 | 21 | 4% | |
| 2009 | 9.77 | 283 | 9.28 | 269 | –14 | –5% | |
| 2010 | 9.89 | 286 | 13.33 | 386 | 100 | 35% | |
| RCHRES 44 (Whetstone Creek at Mt Gilead) | | | | | | | |
| 1997 | 16.33 | 45 | 17.93 | 50 | 4 | 10% | CALIBRATION |
| 1998 | 16.59 | 46 | 13.58 | 38 | –8 | –18% | |
| 1999 | 10.33 | 29 | 11.13 | 31 | 2 | 8% | |
| 2000 | 13.21 | 37 | 17.12 | 48 | 11 | 30% | |
| 2001 | 10.22 | 28 | 11.21 | 31 | 3 | 10% | |
| 2002 | 14.52 | 40 | 11.07 | 31 | –10 | –24% | |
| 2003 | 14.56 | 41 | 5.95 | 17 | –24 | –59% | |
| 2004 | 20.43 | 57 | 14.55 | 41 | –16 | –29% | |
| 2005 | 19.39 | 54 | 12.8 | 36 | –18 | –34% | |
| 2006 | 16.94 | 47 | 16.7 | 47 | –1 | –1% | |
| 2007 | 18.55 | 52 | 27.33 | 76 | 24 | 47% | |
| 2008 | 19.85 | 55 | 25.88 | 72 | 17 | 30% | |
| 2009 | 9.77 | 27 | 10.13 | 28 | 1 | 4% | |
| 2010 | 11.54 | 32 | 13.52 | 38 | 6 | 17% | |

**Table A12.** Measured and simulated annual mean streamflows.—Continued

[ft³/s, cubic feet per second]

| Year | Observed annual mean streamflow | | Simulated annual mean streamflow | | Error | | |
|---|---|---|---|---|---|---|---|
| | (inches) | (ft³/s) | (inches) | (ft³/s) | (ft³/s) | (percent) | |
| RCHRES 45 (Scioto River at Prospect) | | | | | | | |
| 1991 | 7.73 | 324 | 6.94 | 291 | –33 | –10% | CALIBRATION |
| 1992 | 12.18 | 510 | 14.07 | 589 | 79 | 16% | |
| 1993 | 16.02 | 671 | 15.55 | 651 | –20 | –3% | |
| 1994 | 7.60 | 318 | 9.73 | 407 | 89 | 28% | |
| 1995 | 13.21 | 553 | 14.90 | 624 | 71 | 13% | |
| 1996 | 18.66 | 781 | 18.07 | 756 | –25 | –3% | |
| 1997 | 10.79 | 452 | 14.02 | 587 | 135 | 30% | |
| 1998 | 11.36 | 476 | 13.82 | 579 | 103 | 22% | |
| 1999 | 8.07 | 338 | 10.43 | 437 | 99 | 29% | |
| 2000 | 9.14 | 383 | 10.31 | 432 | 49 | 13% | |
| 2001 | 10.56 | 442 | 9.86 | 413 | –29 | –7% | |
| 2002 | 10.87 | 455 | 9.51 | 398 | –57 | –13% | |
| 2003 | 21.91 | 917 | 12.92 | 541 | –376 | –41% | VALIDATION |
| 2004 | 16.80 | 703 | 15.16 | 635 | –69 | –10% | |
| 2005 | 19.41 | 813 | 12.31 | 515 | –297 | –37% | |
| 2006 | 16.02 | 671 | 10.85 | 454 | –216 | –32% | |
| 2007 | 18.26 | 764 | 16.48 | 690 | –75 | –10% | |
| 2008 | 19.84 | 831 | 20.25 | 848 | 17 | 2% | |
| 2009 | 8.00 | 335 | 11.46 | 480 | 145 | 43% | |
| 2010 | 9.42 | 394 | 13.67 | 572 | 178 | 45% | |

Calibration and validation period statistics are provided in tables A13 and A14. These tables show the Pearson's correlation coefficient, coefficient of determination, root mean square error, and Nash-Sutcliffe efficiency index for annual, monthly, and daily model flow results for both the calibration and validation periods. As can be seen in the tables, the model performed better for certain subbasins than for others. The model performed best for annual flows for some subbasins and for monthly flows for other subbasins. As to be expected, model performance typically was poorer for daily streamflows, especially for subbasins below the reservoirs.

For a couple of RCHRESs (44 and 45), a negative Nash-Sutcliffe efficiency index was computed for annual flows, either for the calibration or validation period. This may be indicative of a bias in the simulated versus measured annual flows. The same RCHRESs that exhibited negative Nash-Sutcliffe efficiency indices for annual flows had positive indices for both monthly and daily flows.

**Table A13.** Calibration-period model-fit statistics for the HSPF model of the Upper Scioto River Basin, Ohio.

[Correlation coefficient refers to Pearson's r; root mean square error reported in inches for annual flows and $ft^3/s$ for monthly and daily flows]

| RCHRES 2 - Olentangy River at Claridon (1991-1998) | | | |
|---|---|---|---|
| | **Annual flow** | **Monthly flow** | **Daily flow** |
| Correlation coefficient | 0.93 | 0.88 | 0.82 |
| Coefficient of determination | 0.86 | 0.78 | 0.67 |
| Root mean square error | 1.64 | 78.66 | 213.70 |
| Nash-Sutcliffe efficiency | 0.84 | 0.77 | 0.67 |
| **RCHRES 6 - Big Walnut Creek at Sunbury (1991-2002)** | | | |
| | **Annual flow** | **Monthly flow** | **Daily flow** |
| Correlation coefficient | 0.88 | 0.91 | 0.82 |
| Coefficient of determination | 0.77 | 0.83 | 0.68 |
| Root mean square error | 2.01 | 42.91 | 159.73 |
| Nash-Sutcliffe efficiency | 0.76 | 0.82 | 0.65 |
| **RCHRES 7 - Mill Creek at Bellepoint (1991-2002)** | | | |
| | **Annual flow** | **Monthly flow** | **Daily flow** |
| Correlation coefficient | 0.88 | 0.84 | 0.69 |
| Coefficient of determination | 0.78 | 0.70 | 0.48 |
| Root mean square error | 2.17 | 97.12 | 348.82 |
| Nash-Sutcliffe efficiency | 0.76 | 0.70 | 0.41 |
| **RCHRES 8 - Scioto River below O'Shaughnessy Dam near Dublin (1991-2002)** | | | |
| | **Annual flow** | **Monthly flow** | **Daily flow** |
| Correlation coefficient | 0.94 | 0.90 | 0.78 |
| Coefficient of determination | 0.89 | 0.81 | 0.60 |
| Root mean square error | 1.47 | 406.93 | 1100.20 |
| Nash-Sutcliffe efficiency | 0.85 | 0.80 | 0.55 |
| **RCHRES 10 - Alum Creek at Africa (1991-1998)** | | | |
| | **Annual flow** | **Monthly flow** | **Daily flow** |
| Correlation coefficient | 0.93 | 0.79 | 0.47 |
| Coefficient of determination | 0.86 | 0.63 | 0.22 |
| Root mean square error | 2.67 | 77.99 | 226.16 |
| Nash-Sutcliffe efficiency | 0.78 | 0.59 | 0.04 |
| **RCHRES 12 - Little Darby Creek at West Jefferson (1992-2005)** | | | |
| | **Annual flow** | **Monthly flow** | **Daily flow** |
| Correlation coefficient | 0.83 | 0.82 | 0.68 |
| Coefficient of determination | 0.69 | 0.68 | 0.47 |
| Root mean square error | 2.45 | 103.40 | 276.07 |
| Nash-Sutcliffe efficiency | 0.67 | 0.68 | 0.34 |
| **RCHRES 13 - Big Walnut Creek at Central College (1991-2002)** | | | |
| | **Annual flow** | **Monthly flow** | **Daily flow** |
| Correlation coefficient | 0.88 | 0.90 | 0.80 |
| Coefficient of determination | 0.77 | 0.80 | 0.64 |
| Root mean square error | 1.51 | 63.23 | 209.58 |
| Nash-Sutcliffe efficiency | 0.74 | 0.80 | 0.64 |

**Table A13.** Calibration-period model-fit statistics for the HSPF model of the Upper Scioto River Basin, Ohio.—Continued

[Correlation coefficient refers to Pearson's r; root mean square error reported in inches for annual flows and $ft^3/s$ for monthly and daily flows]

| RCHRES 16 - Scioto River at Columbus (1997–2005) | | | |
|---|---|---|---|
| | **Annual flow** | **Monthly flow** | **Daily flow** |
| Correlation coefficient | 0.89 | 0.92 | 0.82 |
| Coefficient of determination | 0.80 | 0.85 | 0.68 |
| Root mean square error | 3.02 | 697.86 | 1586.00 |
| Nash-Sutcliffe efficiency | 0.58 | 0.82 | 0.66 |
| **RCHRES 26 - Walnut Creek at Ashville (2005–2010)** | | | |
| | **Annual flow** | **Monthly flow** | **Daily flow** |
| Correlation coefficient | 0.99 | 0.93 | 0.74 |
| Coefficient of determination | 0.98 | 0.86 | 0.55 |
| Root mean square error | 0.80 | 117.38 | 421.36 |
| Nash-Sutcliffe efficiency | 0.98 | 0.85 | 0.49 |
| **RCHRES 29 - Scioto River near Commercial Point (2005–2010)** | | | |
| | **Annual flow** | **Monthly flow** | **Daily flow** |
| Correlation coefficient | 0.92 | 0.94 | 0.84 |
| Coefficient of determination | 0.85 | 0.88 | 0.70 |
| Root mean square error | 2.12 | 833.45 | 2078.00 |
| Nash-Sutcliffe efficiency | 0.79 | 0.87 | 0.61 |
| **RCHRES 30 - Big Walnut Creek at Rees (1991–2002)** | | | |
| | **Annual flow** | **Monthly flow** | **Daily flow** |
| Correlation coefficient | 0.96 | 0.94 | 0.84 |
| Coefficient of determination | 0.92 | 0.89 | 0.71 |
| Root mean square error | 0.98 | 128.58 | 417.63 |
| Nash-Sutcliffe efficiency | 0.92 | 0.89 | 0.69 |
| **RRCHRES 31 - Big Darby Creek at Darbyville (1991–2002)** | | | |
| | **Annual flow** | **Monthly flow** | **Daily flow** |
| Correlation coefficient | 0.88 | 0.85 | 0.72 |
| Coefficient of determination | 0.77 | 0.72 | 0.52 |
| Root mean square error | 2.05 | 269.00 | 686.09 |
| Nash-Sutcliffe efficiency | 0.76 | 0.72 | 0.48 |
| **RCHRES 34 - Alum Creek at Columbus (1991–1998)** | | | |
| | **Annual flow** | **Monthly flow** | **Daily flow** |
| Correlation coefficient | 0.97 | 0.88 | 0.67 |
| Coefficient of determination | 0.94 | 0.78 | 0.45 |
| Root mean square error | 1.22 | 79.92 | 254.06 |
| Nash-Sutcliffe efficiency | 0.93 | 0.77 | 0.36 |
| **RCHRES 36 - Olentangy River near Worthington (1996–2005)** | | | |
| | **Annual flow** | **Monthly flow** | **Daily flow** |
| Correlation coefficient | 0.57 | 0.85 | 0.65 |
| Coefficient of determination | 0.33 | 0.72 | 0.42 |
| Root mean square error | 3.83 | 279.91 | 728.13 |
| Nash-Sutcliffe efficiency | 0.32 | 0.72 | 0.31 |

**Table A13.** Calibration-period model-fit statistics for the HSPF model of the Upper Scioto River Basin, Ohio.—Continued

[Correlation coefficient refers to Pearson's r; root mean square error reported in inches for annual flows and $ft^3/s$ for monthly and daily flows]

| RRCHRES 40 - Alum Creek near Kilbourne (2000-2010) | | | |
|---|---|---|---|
| | **Annual flow** | **Monthly flow** | **Daily flow** |
| Correlation coefficient | 0.81 | 0.84 | 0.68 |
| Coefficient of determination | 0.65 | 0.70 | 0.47 |
| Root mean square error | 2.30 | 45.06 | 115.84 |
| Nash-Sutcliffe efficiency | 0.62 | 0.68 | 0.29 |
| **RCHRES 42 - Olentangy River near Delaware (1996-2005)** | | | |
| | **Annual flow** | **Monthly flow** | **Daily flow** |
| Correlation coefficient | 0.55 | 0.86 | 0.57 |
| Coefficient of determination | 0.30 | 0.73 | 0.32 |
| Root mean square error | 3.53 | 206.97 | 637.89 |
| Nash-Sutcliffe efficiency | 0.16 | 0.72 | 0.20 |
| **RCHRES 44 - Whetstone Creek at Mt. Gilead (1996-2010)** | | | |
| | **Annual flow** | **Monthly flow** | **Daily flow** |
| Correlation coefficient | 0.56 | 0.78 | 0.72 |
| Coefficient of determination | 0.31 | 0.61 | 0.52 |
| Root mean square error | 4.71 | 27.81 | 83.38 |
| Nash-Sutcliffe efficiency | –0.72 | 0.56 | 0.31 |
| **RCHRES 45 - Scioto River at Prospect (1991-2002)** | | | |
| | **Annual flow** | **Monthly flow** | **Daily flow** |
| Correlation coefficient | 0.88 | 0.87 | 0.79 |
| Coefficient of determination | 0.78 | 0.76 | 0.62 |
| Root mean square error | 1.78 | 244.66 | 602.48 |
| Nash-Sutcliffe efficiency | 0.67 | 0.68 | 0.34 |

**Table A14.** Validation-period model-fit statistics for the HSPF model of the Upper Scioto River Basin, Ohio.

[Correlation coefficient refers to Pearson's r; root mean square error reported in inches for annual flows and $ft^3/s$ for monthly and daily flows]

| RCHRES 6 - Big Walnut Creek at Sunbury (2003-2010) | | | |
|---|---|---|---|
| | **Annual flow** | **Monthly flow** | **Daily flow** |
| Correlation coefficient | 0.91 | 0.92 | 0.80 |
| Coefficient of determination | 0.83 | 0.84 | 0.65 |
| Root mean square error | 1.80 | 51.65 | 180.08 |
| Nash-Sutcliffe efficiency | 0.69 | 0.81 | 0.61 |
| **RCHRES 7 - Mill Creek at Bellepoint (2003-2010)** | | | |
| | **Annual flow** | **Monthly flow** | **Daily flow** |
| Correlation coefficient | 0.90 | 0.87 | 0.70 |
| Coefficient of determination | 0.81 | 0.75 | 0.50 |
| Root mean square error | 2.63 | 120.44 | 416.17 |
| Nash-Sutcliffe efficiency | 0.71 | 0.69 | 0.30 |
| **RCHRES 8 - Scioto River below O'Shaughnessy Dam near Dublin (2003-2010)** | | | |
| | **Annual flow** | **Monthly flow** | **Daily flow** |
| Correlation coefficient | 0.41 | 0.89 | 0.78 |
| Coefficient of determination | 0.41 | 0.89 | 0.78 |
| Root mean square error | 4.67 | 587.52 | 1358.00 |
| Nash-Sutcliffe efficiency | 0.04 | 0.78 | 0.57 |
| **RCHRES 13 - Big Walnut Creek at Central College (2003-2010)** | | | |
| | **Annual flow** | **Monthly flow** | **Daily flow** |
| Correlation coefficient | 0.95 | 0.94 | 0.83 |
| Coefficient of determination | 0.91 | 0.89 | 0.69 |
| Root mean square error | 1.39 | 73.34 | 242.63 |
| Nash-Sutcliffe efficiency | 0.89 | 0.89 | 0.68 |
| **RCHRES 16 - Scioto River at Columbus (2006-2010)** | | | |
| | **Annual flow** | **Monthly flow** | **Daily flow** |
| Correlation coefficient | 0.65 | 0.90 | 0.79 |
| Coefficient of determination | 0.43 | 0.80 | 0.62 |
| Root mean square error | 3.36 | 813.63 | 1826.20 |
| Nash-Sutcliffe efficiency | 0.30 | 0.80 | 0.54 |
| **RCHRES 30 - Big Walnut Creek at Rees (2003-2010)** | | | |
| | **Annual flow** | **Monthly flow** | **Daily flow** |
| Correlation coefficient | 0.94 | 0.94 | 0.88 |
| Coefficient of determination | 0.88 | 0.88 | 0.77 |
| Root mean square error | 1.26 | 193.89 | 480.18 |
| Nash-Sutcliffe efficiency | 0.87 | 0.87 | 0.74 |
| **RCHRES 31 - Big Darby Creek at Darbyville (2003-2010)** | | | |
| | **Annual flow** | **Monthly flow** | **Daily flow** |
| Correlation coefficient | 0.78 | 0.89 | 0.79 |
| Coefficient of determination | 0.61 | 0.80 | 0.62 |
| Root mean square error | 2.61 | 321.09 | 760.41 |
| Nash-Sutcliffe efficiency | 0.58 | 0.79 | 0.61 |

**Table A14.** Validation-period model-fit statistics for the HSPF model of the Upper Scioto River Basin, Ohio.—Continued

[Correlation coefficient refers to Pearson's r; root mean square error reported in inches for annual flows and $ft^3/s$ for monthly and daily flows]

| RCHRES 36 - Olentangy River near Worthington (2006-2010) | | | |
|---|---|---|---|
| | **Annual flow** | **Monthly flow** | **Daily flow** |
| Correlation coefficient | 0.89 | 0.92 | 0.70 |
| Coefficient of determination | 0.79 | 0.84 | 0.49 |
| Root mean square error | 2.13 | 238.13 | 758.01 |
| Nash-Sutcliffe efficiency | 0.70 | 0.84 | 0.39 |
| **RCHRES 42 - Olentangy River near Delaware (2006-2010)** | | | |
| | **Annual flow** | **Monthly flow** | **Daily flow** |
| Correlation coefficient | 0.89 | 0.92 | 0.65 |
| Coefficient of determination | 0.78 | 0.86 | 0.42 |
| Root mean square error | 2.19 | 174.49 | 659.53 |
| Nash-Sutcliffe efficiency | 0.68 | 0.84 | 0.25 |
| **RRCHRES 45 - Scioto River at Prospect (2003-2010)** | | | |
| | **Annual flow** | **Monthly flow** | **Daily flow** |
| Correlation coefficient | 0.38 | 0.87 | 0.73 |
| Coefficient of determination | 0.14 | 0.75 | 0.54 |
| Root mean square error | 4.93 | 359.68 | 826.66 |
| Nash-Sutcliffe efficiency | –0.12 | 0.74 | 0.48 |

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