# Appendix A – Water Supply Network Description

## Introduction

The purpose of this appendix is to describe Nevada Irrigation District's (NID) water supply network. Statistics based on historical gage data are presented to quantify regulated flow within watersheds that contribute runoff to NID's water supply.

## Network Overview

NID's water supply network is characterized by high elevation storage and low elevation power generation via a network of natural and man-made conveyances. Water is stored and released from the high-elevation reservoirs based on NID's consumptive needs and reservoir carryover storage targets. Discretionary releases for water supply are made from Jackson Meadows Reservoir and Jackson, French, Faucherie, and Sawmill reservoirs during the spring runoff season through late fall. Releases from Jackson Meadows Reservoir are conveyed to Bowman Lake via the Milton-Bowman Tunnel. Releases from Jackson, French, Faucherie, and Sawmill lakes are stored and released by Bowman Dam through Bowman Powerhouse into the Bowman-Spaulding Conduit Diversion Impoundment.

While the majority of the Bowman-Spaulding Conduit flow is provided by releases at Bowman Lake, five small diversion structures (known as "feeders") on creeks that run perpendicular to the alignment of the Bowman-Spaulding Conduit also provide water to the conduit. These feeders augment flows in the conduit up to its capacity, and spill the remainder into their respective natural drainages downstream of the conduit. Flows upstream of the Bowman-Spaulding Conduit in Texas, Fall, and Rucker creeks are regulated by upstream reservoirs owned and operated by PG&E.

Flows from the Bowman-Spaulding Conduit are then passed through PG&E's Lake Spaulding into PG&E's Drum and South Yuba canals. Water transported into the South Yuba Canal is diverted into South Fork Deer Creek to supply NID customers in the Nevada City-Grass Valley area. This water is largely diverted at the Cascade Canal Diversion Dam located immediately downstream, but is also used to manage Scotts Flat Reservoir storage. Releases from Scotts Flat Reservoir provide water to four other downstream diversions downstream along Deer Creek.

Water transported into the Drum Canal is passed through PG&E's Drum Forebay into the Bear River at PG&E's Drum Afterbay. Water is diverted and returned several times along the Bear River reach upstream of Rollins Reservoir by NID and PG&E for power generation. Daily volumes are scheduled by NID and PG&E for downstream consumptive demand.

Rollins Reservoir is NID's major low-elevation storage reservoir on the Bear River. Rollins Reservoir is a multipurpose facility that meets municipal, irrigation, domestic water supply, recreation, and power generation needs. From Rollins, water supplies NID customers in southern Nevada County and Placer County.

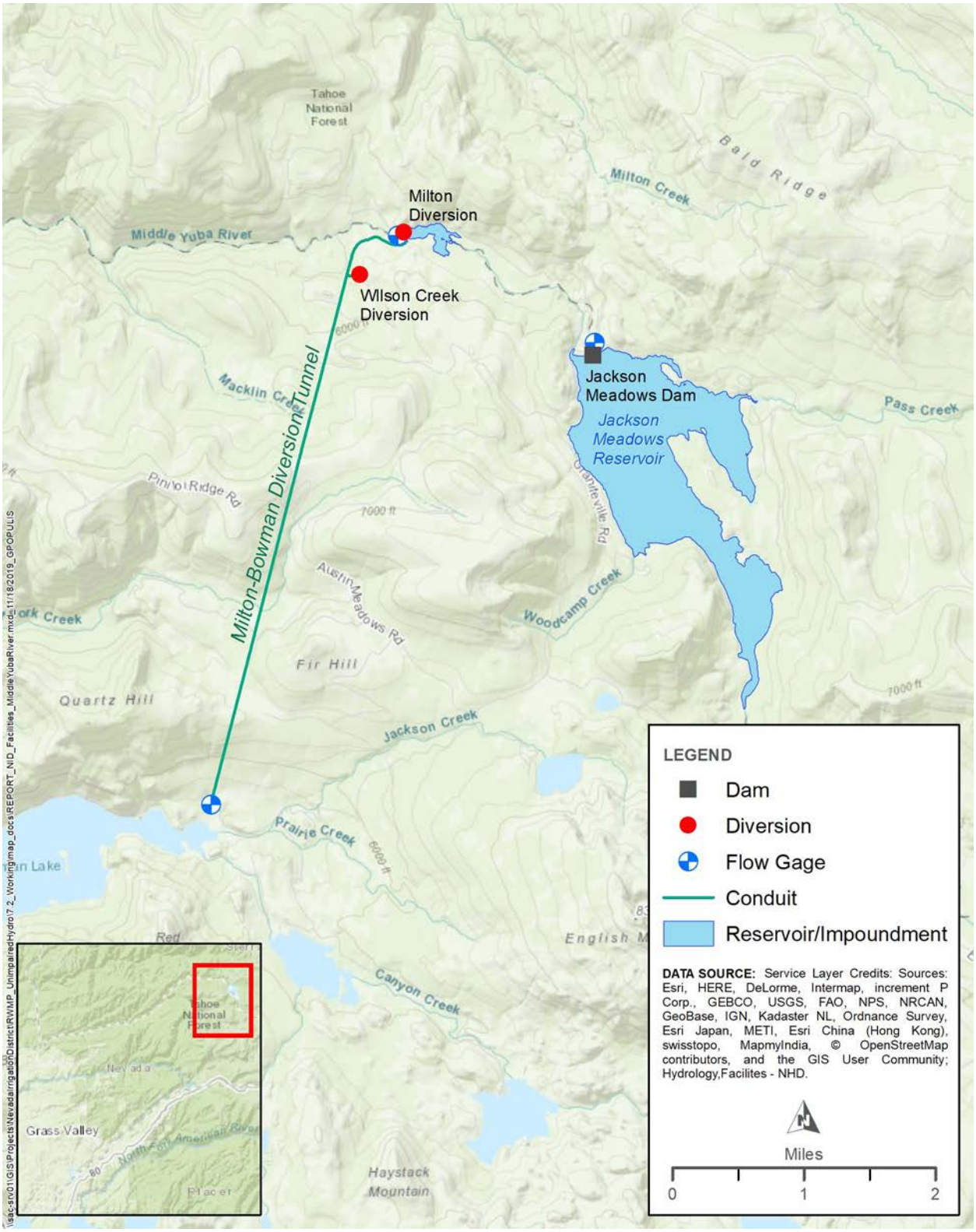
The following sections summarize historical flows within NID's water supply network by watershed, from the Middle and South Yuba rivers, the primary source of watershed runoff, and from Bear River and Deer Creek, where NID's customer demand is concentrated. There is also an overview of historical reservoir carryover storage.

## Middle Yuba River

Middle Yuba River is a predominantly snowmelt-fed stream, with peak runoff occurring from March through June. Runoff is stored in Jackson Meadows Reservoir, which has a usable storage capacity[1] of 64,641 ac-ft (NID 2012). Discretionary releases are made from Jackson Meadows Reservoir during the spring runoff season through late fall. These releases are conveyed to Bowman Lake via the Milton-Bowman Tunnel. The FERC license of NID's Yuba-Bear Hydroelectric Project (FERC Project Number 2266) includes minimum instream flow requirements below Jackson Meadows Reservoir and Milton Diversion Dam. Releases to the Middle Yuba River below Milton Diversion Dam are unrecoverable to NID. Figure A-1 shows a map of these facilities.

[1] Not all reservoir storage is usable. Unusable storage is made up of either dead storage or minimum-pool storage. Dead storage is storage volume within a reservoir that is located below the lowest reservoir outlet. Minimum-pool storage is a regulatory requirement to maintain reservoir storage above a certain level.

## Figure A-1. Map of NID facilities located within the Middle Yuba River watershed.



Average historical monthly flows in the Middle Yuba River Watershed are shown in Table A-1. There is approximately 2.5 square miles of contributing watershed area between Jackson Meadows Dam and Milton Dam.

**Table A-1. Historical Average Monthly Flows in the Middle Yuba River Watershed.**

| Location | Average Monthly Inflow[1] (cfs) | | | | | | | | | | | | Total (TAF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | |
| **Middle Yuba River Below Jackson Meadows Dam[2]** | 156.4 | 98.0 | 50.2 | 35.4 | 67.2 | 97.9 | 118.2 | 154.6 | 153.5 | 104.1 | 82.5 | 140.8 | 76.0 |
| **Milton-Bowman Tunnel Outlet[3]** | 153.1 | 84.8 | 40.8 | 32.2 | 45.5 | 75.9 | 68.9 | 94.8 | 88.2 | 90.0 | 90.1 | 126.0 | 59.9 |
| **Middle Yuba River Below Milton Dam[4]** | 5.7 | 6.0 | 19.9 | 30.3 | 27.0 | 18.6 | 47.7 | 113.4 | 87.4 | 16.8 | 3.8 | 4.4 | 23.0 |

[1] Common period of record for all gages 10/01/1975 – 9/30/1987, 7/17/1994 – 9/30/2004, 10/01/2008 – 9/30/2009
[2] Middle Yuba River below Jackson Meadows Dam flow from USGS Gage 11407900
[3] Milton-Bowman Tunnel outlet flow from USGS Gage 11408000
[4] Middle Yuba River below Milton Dam flow from USGS Gage 11408550
Key: cfs = cubic feet per second TAF = thousand acre-feet

## South Yuba River Tributaries

Canyon Creek is a tributary to the South Yuba River. It is a predominantly snowmelt-fed stream, with peak runoff occurring from March through June. The combined usable storage capacity[2] in the Canyon Creek watershed is 90,048 ac-ft. The largest storage reservoir is Bowman Lake, with a usable storage capacity of 68,363 ac-ft, followed by French Lake with a usable storage of capacity of 13,940 ac-ft, Faucherie Lake with a usable storage of capacity of 3,740 ac-ft, Sawmill Lake with a usable storage of capacity of 3,030 ac-ft, and Jackson Lake with a usable storage of capacity of 975 ac-ft (NID 2012) Discretionary releases are made from Jackson, French, Faucherie, Sawmill, and Bowman lakes during the spring runoff season through late fall. Bowman Lake also receives inflow from the Middle Yuba River through the Milton-Bowman Tunnel. Water is released from Bowman Lake and is either diverted to the Bowman-Spaulding Canal or released to Canyon Creek below the Bowman-Spaulding Canal Diversion Dam. NID's FERC license includes minimum instream flow requirements below Bowman-Spaulding Diversion Dam, which are unrecoverable to NID. Feeder creeks that run perpendicular to the alignment of the canal augment flows up to its capacity.

[2] Not all reservoir storage is usable. Unusable storage is made up of either dead storage or minimum-pool storage. Dead storage is storage volume within a reservoir that is located below the lowest reservoir outlet. Minimum-pool storage is a regulatory requirement to maintain reservoir storage above a certain level.

Figure A-2 shows a map of NID's facilities in the South Yuba River watershed. Average monthly flows from gages in the South Yuba River watershed are shown in Table A-2.

## Figure A-2. Map of NID facilities located within the South Yuba River watershed.

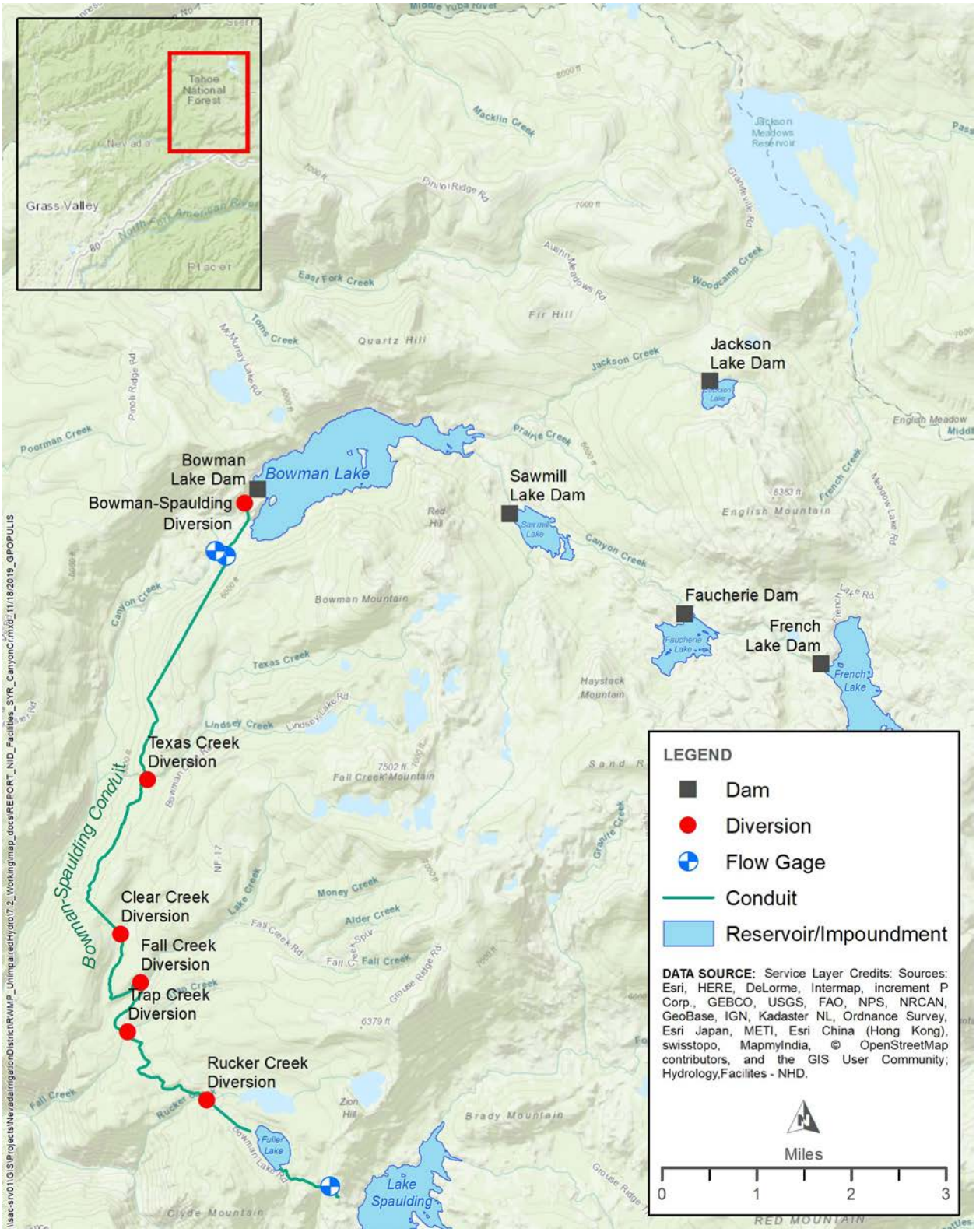


**Table A-2. Historical Average Monthly Flows in the South Yuba Watershed.**

| Location | Average Monthly Inflow[1] (cfs) | | | | | | | | | | | | Total (TAF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | |
| **Canyon Creek Below Bowman Lake[2]** | 4.9 | 9.4 | 26.0 | 24.3 | 32.3 | 47.0 | 55.3 | 107.2 | 85.5 | 14.9 | 4.7 | 5.1 | 25.1 |
| **Bowman-Spaulding Canal Intake[3]** | 194.2 | 154.8 | 139.2 | 90.2 | 127.5 | 129.6 | 116.4 | 134.6 | 168.4 | 199.1 | 247.2 | 243.9 | 117.5 |
| **Bowman-Spaulding Canal above Lake Spaulding[4]** | 202.1 | 169.9 | 164.4 | 110.5 | 170.4 | 196.9 | 206.7 | 232.1 | 211.2 | 209.5 | 248.0 | 249.4 | 143.1 |

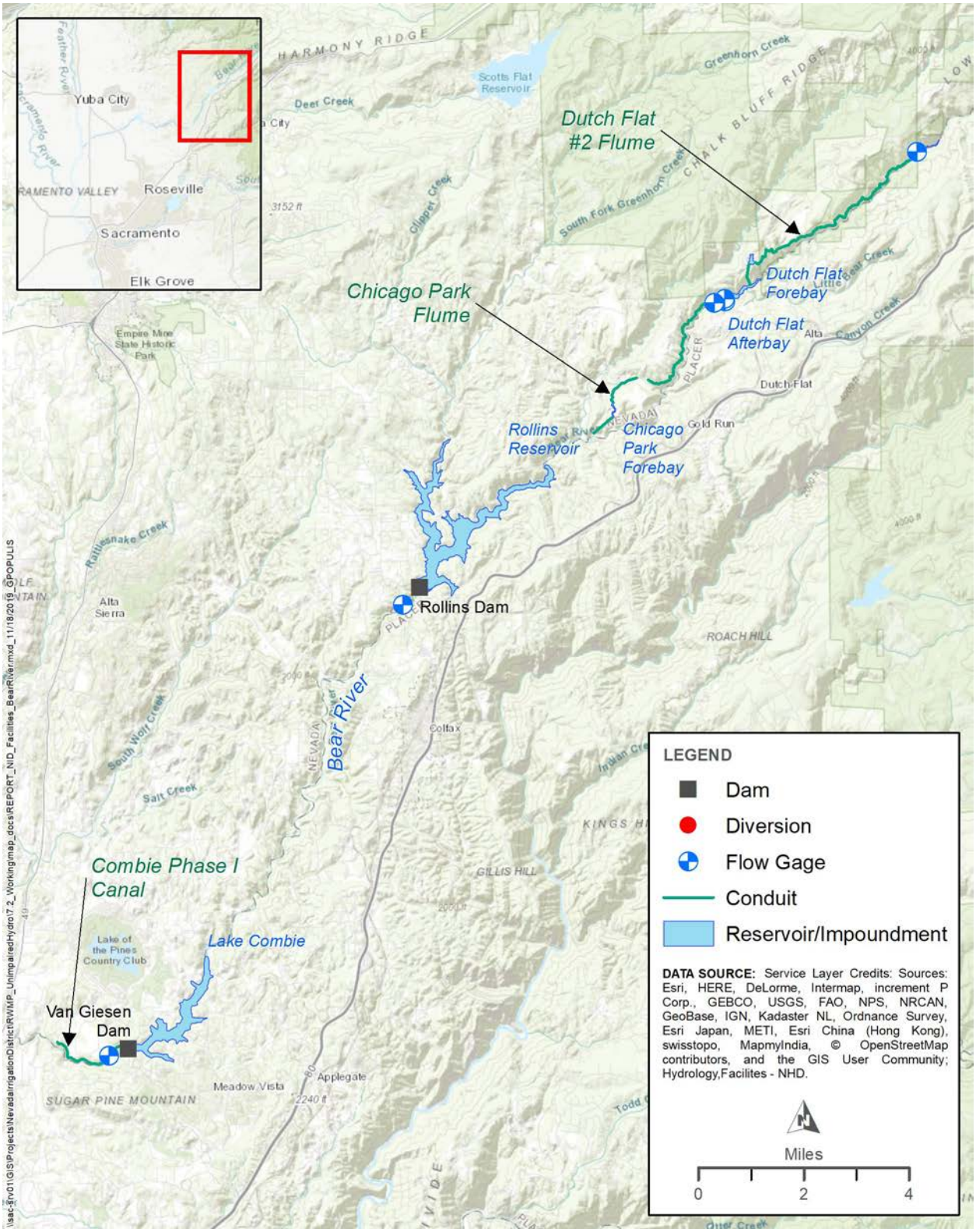
[1] Common period of record of all gages is 10/01/1975- 9/30/2003, 10/01/2005 – 9/30/2017
[2] Canyon Creek below Bowman Lake flow from USGS Gage 11416500
[3] Bowman-Spaulding Canal Intake flow from USGS Gage 11416000
[4] Bowman-Spaulding Canal above Lake Spaulding from USGS Gage 11416100
Key: cfs = cubic feet per second TAF = thousand acre-feet

## Bear River

The Bear River is a predominantly rainfall-fed stream, with peak runoff occurring from December through May. Both NID and PG&E use the Bear River as a conveyance reach for water originating in the Yuba River and American River watersheds, and both have water rights to natural runoff in the Bear River. Water is diverted by NID and PG&E from Lake Spaulding to the Bear River through the Drum Canal. Both imported and natural water in the Bear River pass through a series of powerhouses before entering Rollins Reservoir, the primary storage reservoir on the Bear River, with a usable storage capacity[3] of 54,453 ac-ft (NID 2012). A portion of the releases from Rollins Reservoir are diverted immediately downstream to the Bear River Canal by NID and PG&E. NID also diverts water from the Bear River to the Combie Phase I Canal, located approximately 13 miles downstream of Rollins Reservoir at Lake Combie. Figure A-3 shows a map of facilities located in the Bear River watershed. Average monthly flows for gages in the Bear River watershed are shown in Table A-3. Flows in Table A-3 represent a blend of imported and natural water. Not all of the flows reported in Table A-3 are available to NID for use as water supply.

[3] Not all reservoir storage is usable. Unusable storage is made up of either dead storage or minimum-pool storage. Dead storage is storage volume within a reservoir that is located below the lowest reservoir outlet. Minimum-pool storage is a regulatory requirement to maintain reservoir storage above a certain level.

## Figure A-3. Map of NID facilities located within the Bear River watershed.



### Table A-3. Historical Average Monthly Flows in the Bear River Watershed.

| Location | Average Monthly Inflow[1] (cfs) | | | | | | | | | | | | Total (TAF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | |
| **Bear River near Emigrant Gap[2]** | 8.3 | 11.8 | 24.8 | 25.0 | 36.1 | 73.3 | 81.5 | 100.0 | 61.0 | 24.6 | 15.6 | 12.1 | 28.6 |
| **Drum Canal[3]** | 314.4 | 381.0 | 431.0 | 428.2 | 449.4 | 509.1 | 600.2 | 668.0 | 649.6 | 623.2 | 579.6 | 328.4 | 360.0 |
| **Bear River below Drum Afterbay[4]** | 6.8 | 8.9 | 15.4 | 16.7 | 28.0 | 32.6 | 39.8 | 32.8 | 15.8 | 12.2 | 13.5 | 11.6 | 14.1 |
| **Dutch Flat No 2 Flume[5]** | 147.8 | 191.6 | 234.9 | 243.5 | 300.6 | 359.8 | 351.1 | 378.2 | 346.2 | 332.5 | 302.5 | 162.3 | 202.2 |
| **Bear River below Dutch Flat Afterbay[6]** | 18.0 | 14.1 | 30.0 | 21.1 | 40.9 | 31.1 | 54.7 | 32.5 | 33.5 | 28.7 | 25.9 | 26.1 | 21.4 |
| **Chicago Park Flume[7]** | 302.9 | 417.6 | 518.4 | 555.5 | 599.6 | 668.9 | 697.7 | 749.4 | 683.3 | 621.9 | 567.2 | 323.4 | 404.6 |
| **Bear River below Rollins[8]** | 115.4 | 177.1 | 439.1 | 568.4 | 743.5 | 758.7 | 680.1 | 542.2 | 364.4 | 248.3 | 186.2 | 150.6 | 298.7 |
| **Bear River below Lake Combie[9]** | 36.7 | 160.3 | 447.8 | 558.3 | 745.0 | 845.4 | 704.9 | 478.7 | 276.3 | 139.7 | 68.8 | 54.8 | 270.9 |

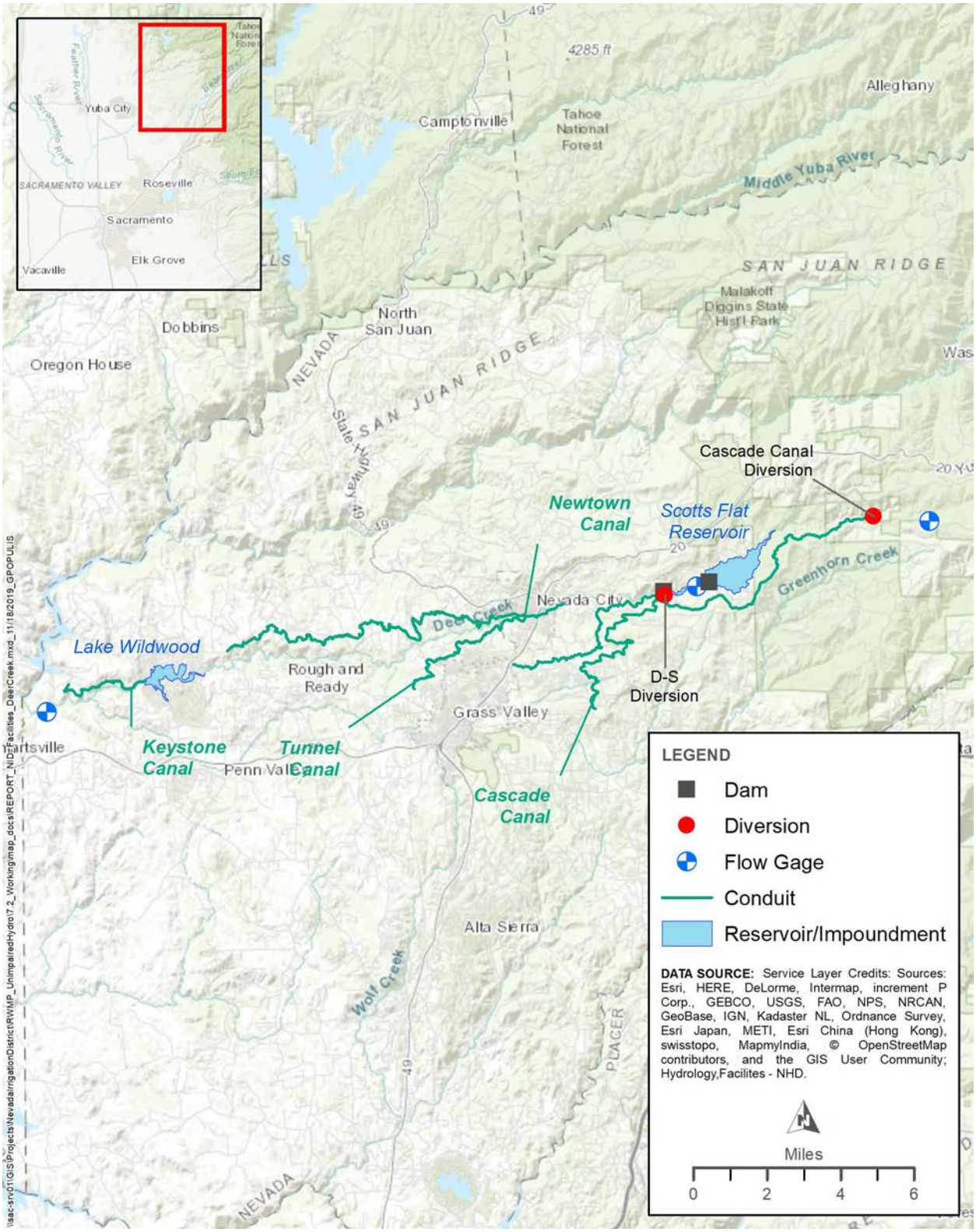
[1] Common period of record of all gages is 12/18/1978 – 9/30/2017
[2] Bear River near Emigrant Gap flow from USGS Gage 11421710
[3] Drum Canal flow from USGS Gage 11414170
[4] Bear River below Drum Afterbay flow from USGS Gage 11421770
[5] Dutch Flat No 2 Flume flow from USGS Gage 11421760
[6] Bear River below Dutch Flat Afterbay flow from USGS Gage 11421790
[7] Chicago Park Flume flow from USGS Gage 11421780
[8] Bear River below Rollins Dam flow from USGS Gage 11422500
[9] Bear River below Lake Combie flow from NID Gage BR300
Key: cfs = cubic feet per second TAF = thousand acre-feet

## Deer Creek

Deer Creek is a predominantly rainfall-fed stream, with peak runoff occurring from December through May. Water is also imported into Deer Creek by NID from the Bowman-Spaulding Conduit through the South Yuba Canal. Local watershed runoff and imported water are stored in Scotts Flat Reservoir, which has a usable storage capacity[4] of 43,547 ac-ft (Kleinschmidt Associates 2011). Figure A-4 shows a map of NID facilities located in Deer Creek. Water is released from Scotts Flat Reservoir from mid-April through mid-October to meet seasonal NID customer demand. Average monthly flows for gages in the Deer Creek watershed are shown in Table A-4.

[4] Not all reservoir storage is usable. Unusable storage is made up of either dead storage or minimum-pool storage. Dead storage is storage volume within a reservoir that is located below the lowest reservoir outlet. Minimum-pool storage is a regulatory requirement to maintain reservoir storage above a certain level.

## Figure A-4. Map of NID facilities located within the Deer Creek watershed.



### Table A-4. Historical Average Monthly Flows in the Deer Creek Watershed.

| Location | Average Monthly Inflow[1] (cfs) | | | | | | | | | | | | Total (TAF) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | |
| **Chalk Bluff Canal[2]** | 53.7 | 41.1 | 38.3 | 39.3 | 39.7 | 41.6 | 23.6 | 51.3 | 63.2 | 61.9 | 61.7 | 60.2 | 34.8 |
| **Deer Creek below Scotts Flat Reservoir[3]** | 42.8 | 12.1 | 11.1 | 17.9 | 24.5 | 40.5 | 56.2 | 62.8 | 69.8 | 83.9 | 89.2 | 83.6 | 36.0 |
| **Deer Creek near Smartsville[4]** | 38.2 | 42.2 | 144.7 | 250.1 | 315.9 | 304.7 | 163.0 | 65.6 | 16.0 | 5.1 | 3.9 | 5.3 | 106.1 |

[1] Common period of record of all gages is 10/1/1975-9/30/2018
[2] Chalk Bluff Canal flow from Gage YB-34
[3] Deer Creek below Scotts Flat Reservoir flow from NID Gage DC-125
[4] Deer Creek near Smartsville flow from USGS Gage 11418500
Key: cfs = cubic feet per second TAF = thousand acre-feet

## Reservoir Storage

Reservoir (carryover) storage is the second largest source of water supply available to NID to meet customer demand. Historical reservoir storage is summarized in Table A-5 for Water Years 1976 through 2017. April 15 is the approximate starting date of the irrigation season, June 15 is the approximate end date of rainfall and snowmelt runoff, and October 14 is the approximate end data of the irrigation season. Any storage left in reservoirs at the end of the irrigation season is considered carryover storage. Carryover storage is stored water held in reserve for droughts or for emergency supply to avoid water shortages, and to meet environmental flow requirements.

## Table A-5. Historical average reservoir storage on April 15, June 15, and October 14, for Water Years 1976 through 2017.

| Location | Average Reservoir Storage (ac-ft) | | |
|---|---|---|---|
| | **April 15** | **June 15** | **October 14** |
| Jackson Meadows[1] | 41,056 | 57,973 | 36,974 |
| Jackson Lake | 941 | 1,230 | 845 |
| French Lake | 10,334 | 12,384 | 7,131 |
| Faucherie Lake | 3,840 | 3,955 | 2,865 |
| Sawmill Lake | 3,019 | 3,006 | 2,153 |
| Bowman Lake[2] | 43,463 | 60,896 | 42,517 |
| **Total Mountain Division Storage** | **102,653** | **139,445** | **92,485** |
| Rollins Reservoir[3] | 55,256 | 54,405 | 34,625 |
| Lake Combie | 5,528 | 5,115 | 3,057 |
| Scotts Flat Reservoir | 46,343 | 44,588 | 29,647 |
| **Foothill Division Storage** | **107,127** | **104,108** | **67,329** |
| ***Total Storage[4]*** | ***209,780*** | ***243,553*** | ***159,814*** |
| ***Total Usable Storage[5]*** | ***200,562*** | ***234,335*** | ***150,596*** |

[1, 2] Based on 2009 bathymetric survey storage capacity curve (Devine Tarbell & Associates 2009).
[3] Based on 2007/2008 bathymetric survey storage capacity curve (Devine Tarbell & Associates 2009).
[4] Sum of the total Mountain Division storage and the Foothill Division storage.
[5] Total storage minus 9,218 ac-ft of dead storage and/or minimum pool storage.
Key: ac-ft = acre-feet

Not all reservoir storage is usable. System-wide, a total of 9, 218 ac-ft of reservoir storage is considered either dead storage or minimum-pool storage, as summarized in Table A-6, and is not available for use. Dead storage is storage volume within a reservoir that is located below the lowest reservoir outlet. Minimum-pool storage is a regulatory requirement to maintain reservoir storage above a certain level. The estimate of system-wide amount of usable storage has increased from previous studies (Kleinschmidt et al 2005, Kleinschmidt Associates 2011) primarily because of changes to regulatory requirements for Jackson Meadows Reservoir. Previous values included a 21,000 ac-ft regulatory minimum-pool, which is no longer required. Dead storage values have also been updated based on new bathymetric surveys for Jackson Meadows and Rollins reservoirs. The usable storage reported in Table A-5 is the total storage minus 9,218 ac-ft.

## Table A-6. Unusable reservoir volume in NID's storage reservoirs.

| Reservoir | Unusable Storage (ac-ft) |
|---|---|
| Jackson Meadows | 2,486[1] |
| Jackson Lake | 0 |
| French Lake | 0 |
| Fauchierie Lake | 249[2] |
| Sawmill Lake | 0 |
| Bowman Lake | 0[2] |
| Rollins Reservoir | 270[3] |
| Lake Combie | 1,213[4] |
| Scotts Flat Reservoir | 5,000[5] |
| ***Total*** | ***9,218*** |

[1] Reservoir storage at elevation 5,933 ft, the low-level outlet invert. Based on 2009 bathymetric survey storage capacity curve (Devine Tarbell & Associates 2009).

[2] California State Water Resources Control Board regulatory minimum-pool requirement.

[2] Reservoir storage at elevation 5,401 ft, the low-level outlet invert. Based on 2009 bathymetric survey storage capacity curve (Devine Tarbell & Associates 2009).

[3] Reservoir storage at elevation 1,970 ft, the low-level outlet invert. Based on 2007/2008 bathymetric survey storage capacity curve (Devine Tarbell & Associates 2009).

[4] Reservoir storage at elevation 1,580 ft, practical level to avoid souring accumulated sediment causing extreme water quality issues.

[5] California Department of Fish and Wildlife regulatory minimum-pool requirement.

Key: ac-ft = acre-feet

# References

Devine Tarbell & Associates. 2009. Preliminary Bathymetric Study Report. August 2009.

Kleinschmidt, West Yost & Associates, and Robertson-Bryan, Inc. (NID). 2005. Nevada Irrigation District Raw Water Master Plan Update, Phase I. September 2005.

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US Geological Survey National Water Information System. https://waterdata.usgs.gov/nwis. June 2019.