KANSAS CITY DISTRICT
Lower Kansas River– Lake Operations

Brian McNulty
Operations Project Manager
Tuttle Creek Lake
Manhattan, Kansas

Brian Twombly P.E.
Water Management
Kansas City District
# Current Conditions

**Northwestern Division, Kansas City District**

**Lower Missouri River Basin Reservoir Bulletin**

*Project Data Date/Time: 04-08-2019 06:00*

*Last Updated Date/Time: 04-08-2019 13:06*

<table>
<thead>
<tr>
<th>Project Information</th>
<th>Current Data</th>
<th>Occupied Storage</th>
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<tbody>
<tr>
<td></td>
<td>Elev (ft)</td>
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<td>Milford Dam</td>
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**Smoky Hill River Basin**

|                     | Elev (ft)    | Daily Elev Change (ft) | Storage (ac-ft) | Inflow (cfs) | Release (cfs) | Precip (in) | MP (%) | FC (ac-ft) | FC (%) |
|---------------------|--------------|                    |                   |              |               |            |        |            |        |
| Cedar Bluff Dam     | 2144.00      | 0.01               | 75,897            | 40           | 0             | 0.00        | 44.0   | 0          | 0      |
| Kanopolis Dam       | 1463.00      | 0.22               | 49,578            | 370          | 3             | 0.00        | 100.0  | 1,200      | 0.3    |
| Wilson Dam          | 1516.00      | -0.01              | 235,338           | 345          | 350           | 0.00        | 99.6   | 0          | 0      |
| Webster Dam         | 1892.45      | M                   | 79,428            | 100          | 100           | 0.00        | 100.0  | 3,226      | 1.8    |
| Kirwin Dam          | 1729.25      | M                   | 105,728           | 90           | 70            | 0.00        | 100.0  | 7,538      | 3.5    |
| Glen Elder Dam (Waconda Lake) | 1455.60 | M                   | 228,229           | 500          | 1,501         | 0.15        | 100.0  | 8,809      | 1.2    |

**Lower Kansas River Basin**

|                     | Elev (ft)    | Daily Elev Change (ft) | Storage (ac-ft) | Inflow (cfs) | Release (cfs) | Precip (in) | MP (%) | FC (ac-ft) | FC (%) |
|---------------------|--------------|                    |                   |              |               |            |        |            |        |
| Tuttle Creek Dam    | 1075.00      | 0.35               | 1,186,300         | 5,000        | 160           | 0.65        | 100.0  | 929,286    | 49.3   |
| Perry Dam           | 891.50       | 0.16               | 363,887           | 1,400        | 25            | 0.32        | 100.0  | 163,833    | 31.8   |
| Clinton Dam         | 875.50       | 0.02               | 133,763           | 400          | 21            | 0.00        | 100.0  | 15,064     | 5.2    |

**Platte River Basin**

|                     | Elev (ft)    | Daily Elev Change (ft) | Storage (ac-ft) | Inflow (cfs) | Release (cfs) | Precip (in) | MP (%) | FC (ac-ft) | FC (%) |
|---------------------|--------------|                    |                   |              |               |            |        |            |        |
| Smithville Dam      | 864.20       | -0.36              | 152,606           | 260          | 1,600         | 0.00        | 100.0  | 10,834     | 10.6   |
| Little Blue River Basin |            |                     |                    |              |               |            |        |            |        |
Milford Lake Storage Allocations
As of Last Sediment Survey Completed in October 2009

Surcharge Space = 1,475,812 AF

Flood Control Space = 757,872 AF
Peak Pool = 1181.94  (25 Jul 93)

MP Space = 373,152 AF
Minimum Pool = 1136.89  (12-13 Jan 03)

43 Years of Sediment minimal AF
42,200 AF

Freeboard = 4.8 ft
Spillway Crest = 1176.2
Current Elev 1153.8 ft

Storage Allocations (AF)

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<th></th>
<th>1967 (begin)</th>
<th>2009 survey</th>
<th>2067 (design)</th>
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<td>757,746</td>
<td>757,872</td>
<td>700,000</td>
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<td>Total Multipurpose Pool</td>
<td>415,352</td>
<td>373,152</td>
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<td>Water Supply in service</td>
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<td>101,650 (33.88%)</td>
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<td>Water Supply reserved</td>
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<td>73,152</td>
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Tuttle Creek Lake Storage Allocations

Sediment Survey Last Conducted in June 2009

Surcharge Space = 1,365,732 AF
Peak Pool Elev = 1137.77 (July 22, 1993)

Flood Control Space = 1,884,312 AF
Gated Spillway Crest at Elev 1116.0 ft
Current Elev 1114.8 ft

Multipurpose Space = 257,014 AF

48 Years of Sediment 57,393 AF
38 Years of Sediment 168,298 AF

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<th>2009</th>
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Freeboard = 2.15 ft
Top of Dam 1159.0 ft

Pre-Reservoir Bottom of Streambed
### Perry Lake Storage Allocations

*Storage Began January 15, 1969  Current Capacity Table Use Began March 1, 2012*

#### Surcharge Space
- **Surcharge Space = 695,257 AF**
- **Spillway Crest = 922.0 ft**
- **Top of Surcharge Pool**
- **Freeboard = 4.8 ft**
- **Top of Flood Control Pool**

#### Flood Control Space
- **Flood Control Space = 515,519 AF**
- **Peak Pool Elev = 920.85 (July 25, 1993)**
- **Top of Multipurpose Pool**

#### Multipurpose Space
- **Multipurpose Space = 200,004 AF**

#### Storage Allocations (AF)

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<th>2009</th>
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#### Notes
- **2009 tables now used for operations.**
- The State of Kansas (KWO) contracted for the water supply allocation in 1977.
- The initial 25,000 AF increment is contracted to the Kansas River Water Assurance District. Valley Falls has a separate water withdrawal contract.
- **Current Elev 903.6 ft**
- **Pre-Reservoir Bottom of Streambed 825.0 ft**
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<th>Rank</th>
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<th>Pool Elevation (ft)</th>
<th>Rank</th>
<th>Year</th>
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<td>17</td>
<td>2019</td>
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</table>
Kansas City District

- Total of 18 USACE lakes
  - All Multi-Purpose
  - 2 have Hydropower - (Stockton/Truman, MO)
  - 1 has Irrigation - (Harlan County, NE)
- 105 Recreation Areas
- 498 Mile Navigation Channel
- Inspect and Repair Levees (PL 84-99)
  - 54 Federally Constructed Levees (408 miles)
  - 103 Non-Federal Levees (626 miles)
Project Authorized Purposes

Milford, Tuttle Creek, and Perry

► Flood Control
► Water Supply
► Water Quality
► Fish and Wildlife
► Recreation
► Navigation on the Missouri River
► Private hydropower possible.
FACTS OF TUTTLE CREEK LAKE

Authorized in the Flood Control Acts of 1938 & 1944

Designed in late 1940’s (as a dry dam)

Construction started in 1952

Permanent pool added after mid 1950’s drought in midwest

Project placed into operation in 1962

Project is in Pottawatomie, Riley, and Marshall Counties

10,900 acre multipurpose pool (el 1075)

54,000+ acre flood control pool (el 1136)

Record Pool – el 1137.77 (July 1993)
Tuttle Creek Lake Drainage Basin

25% of Kansas Basin Flood Storage
Tuttle Creek Flood Control Facilities

- Control Tower/Outlet Tubes
  - Four Service Gates, 10x20 feet
  - Max discharge at full pool - 48,800 cfs

- Controlled Emergency Spillway (perched)
  - 18 Tainter Gates, 40x21 feet
  - Design Discharge at full flood pool - 233,500 cfs
  - Design Discharge at full surcharge approaching 600,000 cfs

- Blue Rapids Levee
  - 2 Sluice Gates, 9x9 feet
  - Approximately 1 mile of levee
  - Pumping Plant w/two 16-inch, 125 hp pumps
How is Tuttle Creek Operated?

Part of the Missouri River flood control system

- Normal Operations (up to 1136.0 feet msl)
  - Basin flows administered by Missouri River Basin Water Management in Omaha, Nebraska
  - Tuttle Creek releases are determined by Water Management Section (Kansas City, Missouri)
    - Release based on flow targets on the Kansas and Missouri Rivers, current pool elevation, and amount of water entering reservoir
    - Water Control evaluates these factors, determines release rate, and issues a gate order to the project
    - Project operates gates to release water
Flood Control

- Tuttle Creek is the Flood Control Workhorse for the Kansas River
- Provides flood protection to Manhattan, Topeka, Lawrence, and Kansas City
  - Drainage basin of 9,600+ square miles
  - No upstream reservoirs
  - Great fluctuations in the pool are common
  - Drainage basin high in agricultural production, thus has a high sediment yield
  - A large percentage of the water in the Kansas River flows through the gates of Tuttle Creek Dam
Milford Reservoir
Water Control Plan
Seasonal Release Rates

Maximum Release is 22,500 cfs
- Phase III

Maximum Release is 15,000 cfs
- Phase II

Maximum Release is 12,000 cfs
- Phase I
Relationship between Control Points and Flood Control Zones

Flood Control Zones
- SURCHARGE
- Phase III Flood Control
- Phase II Flood Control
- Phase I Flood Control
- Multi-Purpose

Water Management schedules releases from Flood Control Storage based on current pool elevation and flows/levels at the Downstream Target (control point) gage location. Downstream flow increases as reservoir pool elevation increases.
Phased Operation

Seasonal Guidelines for releases

**Phase I** - Downstream flows at a level w/out causing any downstream damages
- Provides space in lake for containing inflow of rain events
- Releases conserve channel space for protection of downstream with further rain

**Phase II** – Downstream flows well below those that cause significant downstream damages
- Little to no damages to agricultural development
- Small margin for protection of downstream with further rain
- Intended to allow control of the one percent chance of inflow with phase I release
  - 1114.4 msl August – March
  - 1102.2 msl April – July

**Phase III** - Downstream flows at maximum w/out causing significant downstream damages
- Will inundate some agricultural development
- No margin for protection of downstream with further rain
- Is the very upper portion of the flood control pool
  - 1132.3 msl August – March
  - 1128.3 msl April - July

**Parallel Balance** – Two or more lakes which are located so that their releases pass thru a common downstream river reach
- Tuttle Creek, Milford, and Perry are primary parallel lakes for the Lower Kansas River Basin and below
- Kanopolis, Wilson, and Waconda (Glen Elder) are also parallel
- Normally a 10-14 day Phase I Evacuation of flood water when downstream conditions allow
How is Tuttle Creek Operated?

- **Surcharge Operation (>1136.0 feet msl)**
  - Flood control balances upstream and downstream flood risk
  - Emphasizes preservation of structure
  - Releases are determined by current pool elevation, and amount of water entering reservoir; *downstream channel condition is irrelevant*
  - **Surcharge** = to fill or load to excess... temporary abnormal lake condition intended to buffer the amount of water going through the spillway
All flows are in cfs; schematic is not to scale.
MISSOURI RIVER MAINSTEM SYSTEM
STORAGE ZONES AND ALLOCATIONS

Historic max - 2011
72.8

April 8, 2019 – 63.9
WE ARE HERE

Nov 5, 2018 – 59.3

Historic min – 2007
33.9

Permanent Pool 24%

Exclusive Flood Control 7%

Annual Flood Control & Multiple Use 16%

Carryover Multiple Use 53%
Mainstem Current Conditions

Northwestern Division, Missouri River Basin Water Management
Mainstem and Tributary Reservoir Bulletin
Project Data Date/Time: 04-08-2019 00:00
Last Updated Date/Time: 04-08-2019 16:05

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<tr>
<th>Project</th>
<th>Elevation (ft)</th>
<th>Cumulative Storage (ac-ft)</th>
<th>Current Data</th>
<th>Occupied Storage</th>
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<td>System Totals</td>
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The Missouri River Basin mountain snowpack normally peaks near April 15. On April 8, 2019 the mountain Snow Water Equivalent (SWE) in the “Total above Fort Peck” reach was 15.8”, 97% of the April 8 average. The mountain SWE in the “Total Fort Peck to Garrison” reach was 13.3”, 93% of the April 8 average.

*Generally considered the high and low year of the last 20-year period, respectively.

Provisional data. Subject to revision.
Flood Reduction Benefits – FY2018 and Cumulative
BLUE DOTS are Big Blue River flow readings coming into Tuttle Creek

Estimated Peak Discharge of 1951 flood on Big Blue River: 93,400 cfs

Approximate Level of Protection Provided by Levee on Big Blue segment: 100-year with 3 feet of freeboard

100-year (1%) flood = 71,600 cfs

1993 flood = 58,800 cfs

Big Blue River Channel Capacity = 35,000 cfs
BLUE DOTS are Big Blue River flow readings coming into Tuttle Creek

*1993 estimated peak inflow 96,000 cfs
Tuttle Creek Dam Project Benefits

- **Authorized Annual Benefits**
  - $55 million
  - Flood Control $46 Million
  - Recreation & Other $6.5 Million
  - Navigation $2.5 Million

- Since 1962: $8.35 Billion Flood Damage Prevented (2016)

- Next 50 years $3-5 Billion in Flood Damage Prevention

- No other benefits included
Questions and Discussion
Volume Equivalents
Surcharge Area vs Normal Flood Control Pool

- **1993 Flood Event**
  - 1136.0-1137.8 = 1075.0-1082.5
  - 1.8 feet = 7.5 feet

- **Flowage Easement Zone**
  - 1136.0-1140.0 = 1075.0-1089.5
  - 4.0 feet = 14.5 feet

- **Induced Surcharge Zone**
  - 1136.0-1142.0 = 1075.0-1095.0
  - 6.0 feet = 20 feet

- **Full Surcharge Zone**
  - 1136.0-1156.85 = 1075.0-1125.5
  - 20.85 feet = 50.5 feet (equiv of 1973 flood event)
Flood Control to Surcharge transition

- Prevents a sudden, large increase in lake discharges when surcharge operations are imminent due to a rapidly rising pool
  - Is based on rate of rise in the upper flood pool
  - Insures releases will not exceed what would have naturally occurred
- Spillway Preset Gate Settings
  - Set at 0.4 feet for initial opening, then 0.8 feet per preset up to a gate setting of 6.0 feet
  - Gates can be manually stopped at any level
- Once lake is projected to exceed 1142.0 (gate opening of 6 feet), gates are traveled to wide open setting and there is no induced surcharge at that point
- While in surcharge operation (i.e. pool is above 1136.0 msl), once a gate setting is reached, it will not be reduced
  - Once lake falls below 1136.0 msl, Phased operation is resumed until flood pool is evacuated
  - Spillway or Outlet Works can be used between elevation 1116.0 and 1136.0
  - Outlet works only below elevation 1116.0
  - 1993 Peak spillway gate setting was 4.0 feet
    - Spillway gate maximum opening is 26.5 feet

~Were operational plans adhered to during 1993 event? Yes
~What did the Corps learn from the 1993 flood? Many of our dams attained record pools and all functioned as designed
1993 Parallel Balance and Water Storage used

- Bureau of Reclamation Lakes, percent of flood control pool used
  - Republican Basin: *Bonny 0.0%, *Swanson, 1.2%, *Enders 0.0%, *Hugh Butler 0.0%, *Harry Strunk 20.5%, *Keith Sebelius 0.0%, *Lovewell 100.4%
    - All of these lakes are above Milford (tandem lakes)
  - Smoky Hill Basin: *Webster 28.5%, *Kirwin 12.9%, Waconda 94.1%, *Cedar Bluff 0.0%
    - Waconda is the only lake that discharges below Kanopolis Lake and not tandem to the Kansas River
  - 918,200 acre/feet of flood control storage used in all Bureau Lakes combined

- U.S. Army Corps of Engineers Lakes, percent of flood control pool used/surcharge space used
  - Kansas River Basin: *Harlan County 16.2%, Milford 126.5%/200,800 ac/ft, Wilson 79.4%, Kanopolis 91.5%, Tuttle Creek 104.7%/90,700 ac/ft, Perry 101.4%/7,000 ac/ft, Clinton 38.3%
  - 4,435,900 acre/feet of flood control storage and 298,500 acre/feet of surcharge space occupied