208 Factsheet regarding DO, Chlorophyll-a and Turbidity TMDLs in Fort Gibson Lake

Watershed: This TMDL Study Area was located in the Lower Neosho (USGS HUC 11070209) watersheds. The Study Area covers portions of Cherokee, Mayes and Wagoner Counties.

Beneficial Uses in This Watershed: According to Oklahoma's 2010 Integrated Report, the designated beneficial uses for the waterbodies in the Arkansas River – North Canadian River Basin Study Area are Aesthetics (AES), Agriculture (AG), Fish & Wildlife Propagation-Warm Water Aquatic Community Subcategory (WWAC), Fish Consumption (FISH), Primary Body Contact Recreation (PBCR), and Public & Private Water Supply (PPWS).

Based on an assessment of water quality monitoring data for the 2010 IR, Oklahoma DEQ has determined that Fort Gibson Lake is not supporting its designated uses for Fish and Wildlife Propagation for a WWAC because of high levels of turbidity in Fort Gibson Lake, Upper (OK121600010200_00) and low dissolved oxygen (DO) in Fort Gibson Lake (OK121600010050_00). Fort Gibson Lake is also designated as one of 21 Nutrient Limited Watersheds (NLW) in Oklahoma because of nutrient enrichment and excessive levels of chlorophyll-a that impair aesthetic uses of the lake.

Waterbody Name	Waterbody ID	Size (acres)	TMDL Date	Priority	Turbidity	DO	Chl-a
Fort Gibson Lake, Upper	OK121600010200_00	7,450	2012	1	●		●
Fort Gibson Lake	OK121600010050_00	7,450	2012	1		●	●

Possible Sources of Impairments:

Point Source:

- **OPDES regulated municipal and industrial wastewater treatment facilities:** There are 11 facilities in the Study Area, including one inactivated facility. The watershed and lake models include the facilities with the effluent flow rate larger than 0.1 MGD.
- **OPDES regulated stormwater discharges:** DEQ regulates stormwater discharges from Municipal Separate Storm Sewer Systems (MS4s), industrial sites, and construction sites.
  - MS4s: Within the domain of the Fort Gibson Lake watershed model, Wagoner County and Tahlequah have been issued Phase II MS4 permits. However, Wagoner County and Tahlequah combined account for only a very small contribution (0.14%) to the total area of the watershed model domain. Therefore, the MS4 permits will not be included as WLAs and will be accounted for by LA.

- Multi-Sector General Permit (MSGP): There are 37 MSGP facilities in the Study Area. Those facilities are not considered nutrient sources and will not have a WLA because stormwater discharge from such industries will occur only during or immediately following periods of rainfall and elevated flow conditions when the turbidity criteria do not apply.

- Construction Sites: There were 13 OKR10 permits for construction projects in the Fort Gibson Lake Study Area during the time period when water samples were taken.

- **No-Discharge Facilities**: There are four facilities in the Study Area. For the purposes of these TMDLs, it is assumed that no-discharge facilities (such as towns with total retention lagoons) do not contribute to nutrients or TSS getting into the waterbodies. However, It is possible that the wastewater collection system associated with no-discharge facilities could be a source of pollutant loading to streams, or that discharges from the WWTP may occur during large rainfall events that exceed the storage capacity of the wastewater system.

- **Sanitary Sewer Overflows (SSO)**: between 1999 and 2015, 117 SSO occurrences were reported with amounts ranging from a minimal amount to greater than 3 million gallons

- **NPDES regulated Animal Feeding Operations (AFOs):** In the Study Area, there are 30 PFOs. Chicken litter data was not explicitly included in the watershed model. The impact of chicken litter on water quality, however, has been implicitly accounted for by agricultural land use in calibration of the watershed model.

Nonpoint Sources:

- **Upstream River and Watershed Loading** – External loading of nutrients and sediments to Fort Gibson Lake is contributed by the outflow from Lake Hudson to the Neosho River and runoff over the watershed drainage area to Fort Gibson Lake from Lake Hudson to the dam in Fort Gibson Lake. Loading from Lake Hudson is driven by outflow from Spavinaw Lake and Eucha Lake to the Spavinaw River, and outflow from Grand Lake to the Neosho River. Outflows from these reservoirs are controlled by upstream watershed loading and physical transport and biochemical processes in the reservoirs.

- **Atmospheric Deposition** – Atmospheric deposition of nitrogen and phosphorus to a waterbody is contributed by both dry and wet deposition. Dry deposition is defined as a mass flux rate (as g/m2-day) for a constituent that settles as dust or is deposited on a dry surface during a period of no precipitation. The mass flux of a constituent from wet deposition is defined by the concentration of the constituent in rainfall and the rate of precipitation.

- **Internal Loading** – Particulate organic matter settles out of the water column, accumulates within the sediment bed, and undergoes decomposition processes. During the summer months of stratification from April through October, decay processes within the sediment bed deplete dissolved oxygen below the thermocline and release inorganic nutrients from the sediment bed back into the water column.

TMDL Calculation:

The WLA and LA for TN, TP, TOC and TSS, determined from the lake model response to external load reductions, are based on 45% reduction of the existing 2006 inflow from Lake Hudson, NPDES wastewater dischargers, and watershed runoff loads.

TP TMDL

Fort Gibson Lake Total-Phosphorus			% R= 45% TMDL=	2,087.6	kg/day	
Source	Existing E(X) Mean	Existing % Share	LA kg/day	WLA kg/day	LA+WLA kg/day	Margin of Safety
Lake Hudson Inflow	565.8	49.8%	1,039.95	0.0	1,039.9	Implicit
Watershed HSPF	187.4	16.5%	344.56	0.0	344.6	Implicit
Small WWTP	4.0	0.4%	0.00	7.4	7.4	Implicit
Large WWTP	378.5	33.3%	0.00	695.7	695.7	Implicit
Total	**1,135.7**	**100.0%**	**1,384.50**	**703.1**	**2,087.6**	Implicit
NPDES Wastewater						
OK0043907 (S)	3.5	0.31%	0	6.5	6.5	Implicit
OKG380001 (S)	0.3	0.03%	0	0.5	0.5	Implicit
OK0033791 (S)	0.2	0.02%	0	0.4	0.4	Implicit
OK34568-006 (L)	364.7	32.11%	0	670.3	670.3	Implicit
OK0000272 (L)	1.8	0.16%	0	3.3	3.3	Implicit
OK0035149 (L)	12.0	1.06%	0	22.1	22.1	Implicit
Lake Hudson Inflow	Delta lognormal distribution					
Watershed HSPF	Lognormal distribution					
Small WWTP	Lognormal distribution					
Large WWTP	Lognormal distribution					

TN TMDL

Fort Gibson Lake Total-Nitrogen			% R= 45% TMDL=	16,711.0	kg/day	
Source	Existing E(X) Mean	Existing % Share	LA kg/day	WLA kg/day	LA+WLA kg/day	Margin of Safety
Lake Hudson Inflow	5,012.2	68.0%	11,361.0	0.0	11,361.0	Implicit
Watershed HSPF	1,663.9	22.6%	3,771.5	0.0	3,771.5	Implicit
Small WWTP	29.0	0.4%	0.0	65.6	65.6	Implicit
Large WWTP	667.4	9.1%	0.0	1,512.9	1,512.9	Implicit
Total	**7,372.5**	**100.0%**	**15,132.5**	**1,578.5**	**16,711.0**	Implicit
NPDES Wastewater						
OK0043907 (S)	10.53	0.14%	0	23.9	23.9	Implicit
OKG380001 (S)	10.55	0.14%	0	23.9	23.9	Implicit

Fort Gibson Lake Total-Nitrogen			% R= 45% TMDL= 16,711.0 kg/day			
Source	Existing E(X) Mean	Existing % Share	LA kg/day	WLA kg/day	LA+WLA kg/day	Margin of Safety
OK0033791 (S)	7.87	0.11%	0	17.8	17.8	Implicit
OK34568-006 (L)	570.46	7.74%	0	1,293.0	1,293.0	Implicit
OK0000272 (L)	17.12	0.23%	0	38.8	38.8	Implicit
OK0035149 (L)	80.22	1.09%	0	181.8	181.8	Implicit
Lake Hudson Inflow	Delta lognormal distribution					
Watershed HSPF	Lognormal distribution					
Small WWTP	Lognormal distribution					
Large WWTP	Lognormal distribution					

TOC TMDL

Fort Gibson Lake Total Organic Carbon (TOC)			% R= 45% TMDL= 63,109.4 kg/day			
Source	Existing E(X) Mean	Existing % Share	LA kg/day	WLA kg/day	LA+WLA kg/day	Margin of Safety
Lake Hudson Inflow	9,211.8	26.6%	16,800.3	0.0	16,800.3	Implicit
Watershed HSPF	23,794.4	68.8%	43,395.9	0.0	43,395.9	Implicit
Small WWTP	37.6	0.1%	0.0	68.6	68.6	Implicit
Large WWTP	1,559.8	4.5%	0.0	2,844.7	2,844.7	Implicit
Total	**34,603.6**	**100.0%**	**60,196.2**	**2,913.3**	**63,109.4**	Implicit
NPDES Wastewater						
OK0043907 (S)	30.2	0.09%	0.0	55.1	55.1	Implicit
OKG380001 (S)	4.3	0.01%	0.0	7.8	7.8	Implicit
OK0033791 (S)	3.2	0.01%	0.0	5.8	5.8	Implicit
OK34568-006 (L)	899.3	2.60%	0.0	1,640.1	1,640.1	Implicit
OK0000272 (L)	387.5	1.12%	0.0	706.8	706.8	Implicit
OK0035149 (L)	281.0	0.81%	0.0	512.5	512.5	Implicit
Lake Hudson Inflow	Delta lognormal distribution					
Watershed HSPF	Lognormal distribution					
Small WWTP	Lognormal distribution					
Large WWTP	Lognormal distribution					

TSS TMDL

Fort Gibson Lake Total Suspended Solids (TSS)			% R= 45% TMDL= 117,188.5 kg/day			
Source	Existing E(X) Mean	Existing % Share	LA kg/day	WLA kg/day	LA+WLA kg/day	Margin of Safety
Lake Hudson Inflow	27,556.7	15.7%	18,402.3	0.0	18,402.3	Implicit
Watershed HSPF	147,275.7	83.9%	98,350.3	0.0	98,350.3	Implicit
Small WWTP	10.5	0.0%	0.0	7.0	7.0	Implicit
Large WWTP	642.2	0.4%	0.0	428.9	428.9	Implicit
Total	**175,485.2**	**100.0%**	**116,752.6**	**435.9**	**117,188.5**	Implicit
NPDES Wastewater						
OK0043907 (S)	5.3	0.00%	0	3.6	3.6	Implicit
OKG380001 (S)	2.6	0.00%	0	1.7	1.7	Implicit
OK0033791 (S)	2.7	0.00%	0	1.8	1.8	Implicit
OK34568-006 (L)	438.9	0.25%	0	293.1	293.1	Implicit
OK0000272 (L)	103.0	0.06%	0	68.8	68.8	Implicit
OK0035149 (L)	103.4	0.06%	0	69.1	69.1	Implicit
Lake Hudson Inflow	Delta lognormal distribution					
Watershed HSPF	Delta lognormal distribution					
Small WWTP	Lognormal distribution					
Large WWTP	Lognormal distribution					

Fort Gibson Lake TMDL Report can be found on the following DEQ webpage: https://www.deq.ok.gov/water-quality-division/watershed-planning/tmdl/.

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