Nutrient TMDL for Homme Dam in Walsh County, North Dakota

Final: September 2012

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1.0 INTRODUCTION AND DESCRIPTION OF THE WATERSHED

Homme Dam is located on the South Branch of the Park River located two miles west of Park River (Figure 1). Completed in 1950, Homme Dam is a 194-acre reservoir designed for flood control and water supply benefits (NDDoH, 2010) (Table 1 and Figure 2).

The Homme Dam Recreation Area provides local residents plenty of leisure opportunities such as fishing, boating, camping, hiking, hunting, and snowmobiling. Recently, a beach and swimming area have been reconditioned near the dam. A bike/walking trail have also been constructed on the west side of the Park River that leads to Homme Dam.

Table 1. General Characteristics of Homme Dam and Homme Dam Watershed.

Legal Name	Homme Dam
Major Drainage Basin	Park River Basin
Nearest Municipality	Park River, North Dakota
Assessment Unit ID	ND-09020310-001-L_00
County Location	Cavalier and Walsh Counties
Physiographic Region	Northern Glaciated Plains and Lake Agassiz Plain
Latitude	48.40628
Longitude	-97.79094
Watershed Area	131,699 acres
Surface Area	194 acres
Average Depth	16.5 feet
Maximum Depth	34.5 feet
Volume	2,863.9 acre/feet
Tributaries	South Branch Park River
Type of Waterbody	Reservoir
Dam Type	Earthen Dam
Fishery Type	Northern Pike, Yellow Perch, Crappie

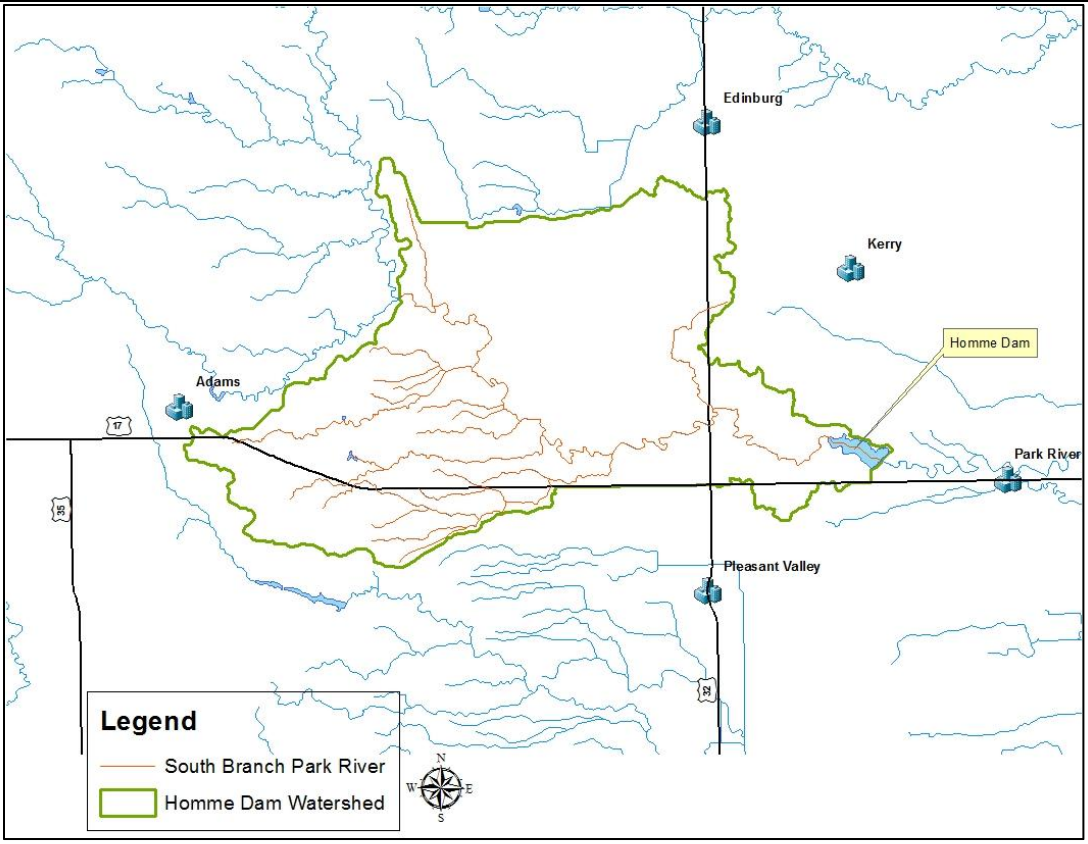

Figure 1. General Location of Homme Dam and It's Watershed.

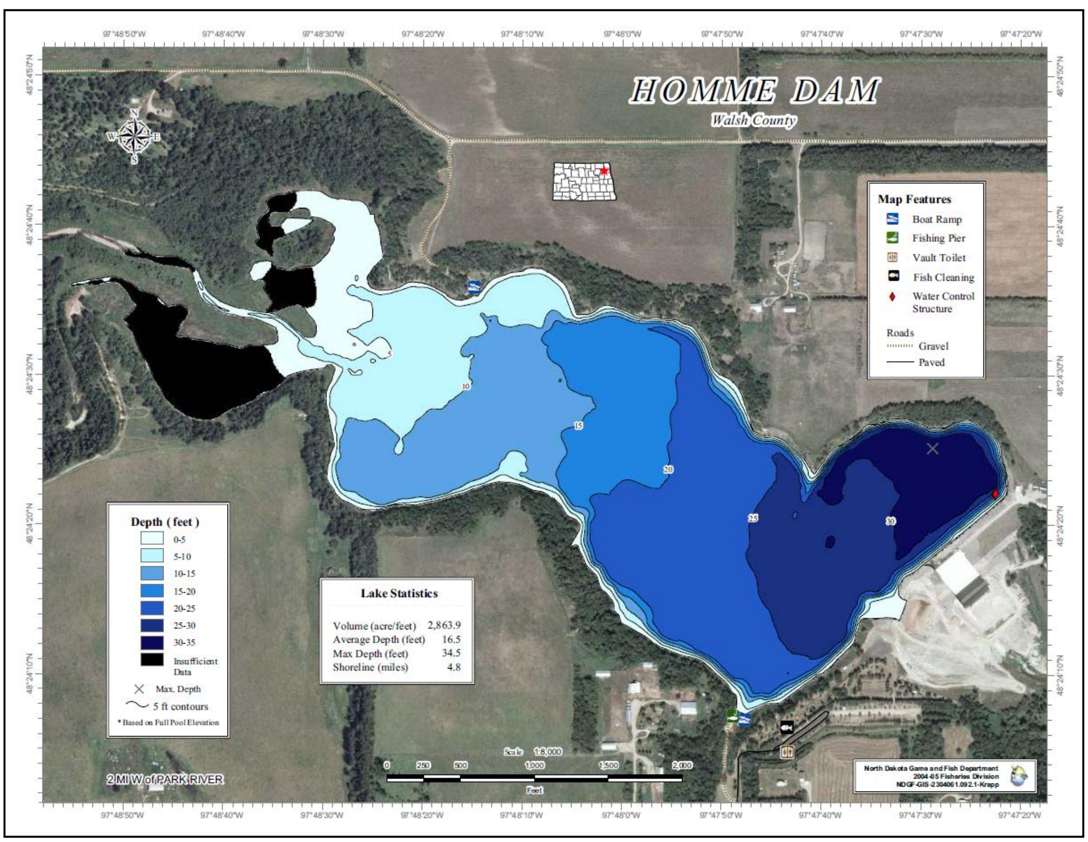

Figure 2. North Dakota Game and Fish Contour Map of Homme Dam.

The Homme Dam watershed lies within four level IV ecoregions. These are the Pembina Escarpment (46a), Northern Black Prairie (46g), Drift Plains (46i), Glacial Lake Agassiz Basin (48a), and Sand Deltas and Beach Ridges (48b) (Figure 3). The Pembina Escarpment (46a) ecoregion is characterized by a steep dissected escarpment created by glacial scouring, with glacial till over Tertiary sandstone and shale. Perennial streams within the Pembina Escarpment ecoregion have high gradients and consist of cobble substrate. The Northern Black Prairie (46g) consists of glacial till soils over a generally flat landscape dotted by the occasional washboard undulations, a high concentration of temporary and seasonal wetlands, and a simple drainage pattern. The Drift Plains ecoregion (46i) was created from the retreating Wisconsinan glaciers which left a subtle rolling topography, thick glacial till and a large number of temporary and seasonal wetlands. The Drift Plains contain productive soils and level topography which largely favors cultivation practices. The Glacial Lake Agassiz Basin (48a) is distinguished by thick lacustrine sediments underlain by glacial till, the landscape is extremely flat, and contains few lakes or wetlands compared to adjacent ecoregions. The Sand Deltas and Beach Ridges (48b), which consists of parallel lines of sand and gravel formed from the wave action of Lake Agassiz's varying shorelines. The subhumid climate fosters a grassland, transitional between the tall and shortgrass prairie. The historic tall grass prairie has been replaced by intensive agriculture (USGS, 2006) (Figure 3).

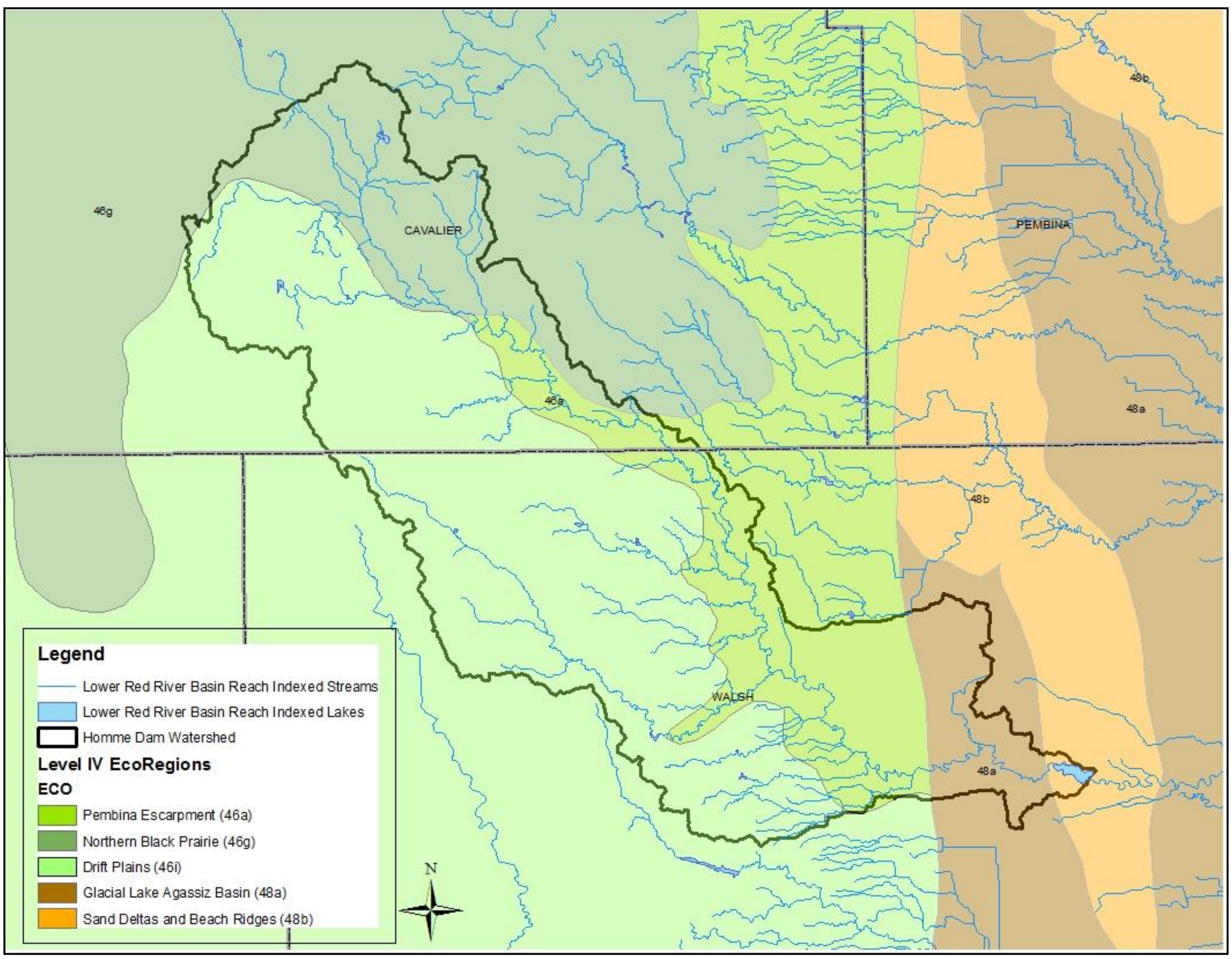

Figure 3. Level IV Ecoregions in the Homme Dam Watershed.

1.1 Clean Water Act Section 303(d) Listing Information

As part of the 2012 Section 303(d) List of Impaired Waters Need Total Maximum Daily Loads (i.e., 2012 TMDL List), the North Dakota Department of Health (NDDoH) has assessed Homme Dam as "fully supporting, but threatened" (i.e., impaired) for "fish and other aquatic biota" (i.e., aquatic life) and recreation uses. It should be noted that this assessment was first done for the 2002 Section 303(d) listing cycle using the 1996 LWQA total phosphorus data as the primary trophic status indicator (Table 2). As described in the 2012 TMDL list, the cause of the use impairments was described as "nutrient/eutrophication/biological indicators." North Dakota's 2012 TMDL list did not provide information on any potential sources of these impairments. This TMDL report addresses both the aquatic life and recreation impairments caused by "nutrient/eutrophication/biological indicators."

Homme Dam has been classified as a Class 3 warm-water fishery, "capable of supporting natural reproduction and growth of warm-water fishes (i.e. largemouth bass and bluegill) and associated aquatic biota and marginal growth. Some cool water species may also be present." (NDDoH, 2011).

As reflected in its title, this TMDL report only addresses the nutrient impairments for aquatic life and recreation use. Sediment remains as a Section 303(d) TMDL listed pollutant threatening aquatic life use. Once the suspended sediment data that we collected as part of the watershed assessment project (NDDoH, 2010) are made available, these data will be analyzed and a TMDL will be prepared to address this pollutant.

Table 2. Homme Dam Section 303(d) Listing Information (NDDoH, 2012).

Assessment Unit ID	**ND-09020310-001-L_00**
Waterbody Name	**Homme Dam**
Class	**3 – Warm-water fishery**
Impaired Uses	**Fish and Other Aquatic Biota and Recreation (fully supporting, but threatened)**
Causes	**Nutrient/Eutrophication Indicators; Sediment**
Priority	**High**
First Appeared on 303(d) List	**2002**

1.2 Land Use/Land Cover

Land use in the Homme Dam watershed is primarily agricultural. According to the 2007 National Agricultural Statistical Service (NASS) land survey data, approximately 58 percent of the land is active cropland, 22 percent pasture/grassland, 9 percent wetlands, and the remaining 11 percent in either forest, open water, barren, urban development, or fallow/idle cropland. The majority of the crops grown consist of spring wheat, canola, barley, sunflowers, and soybeans (Figure 4).

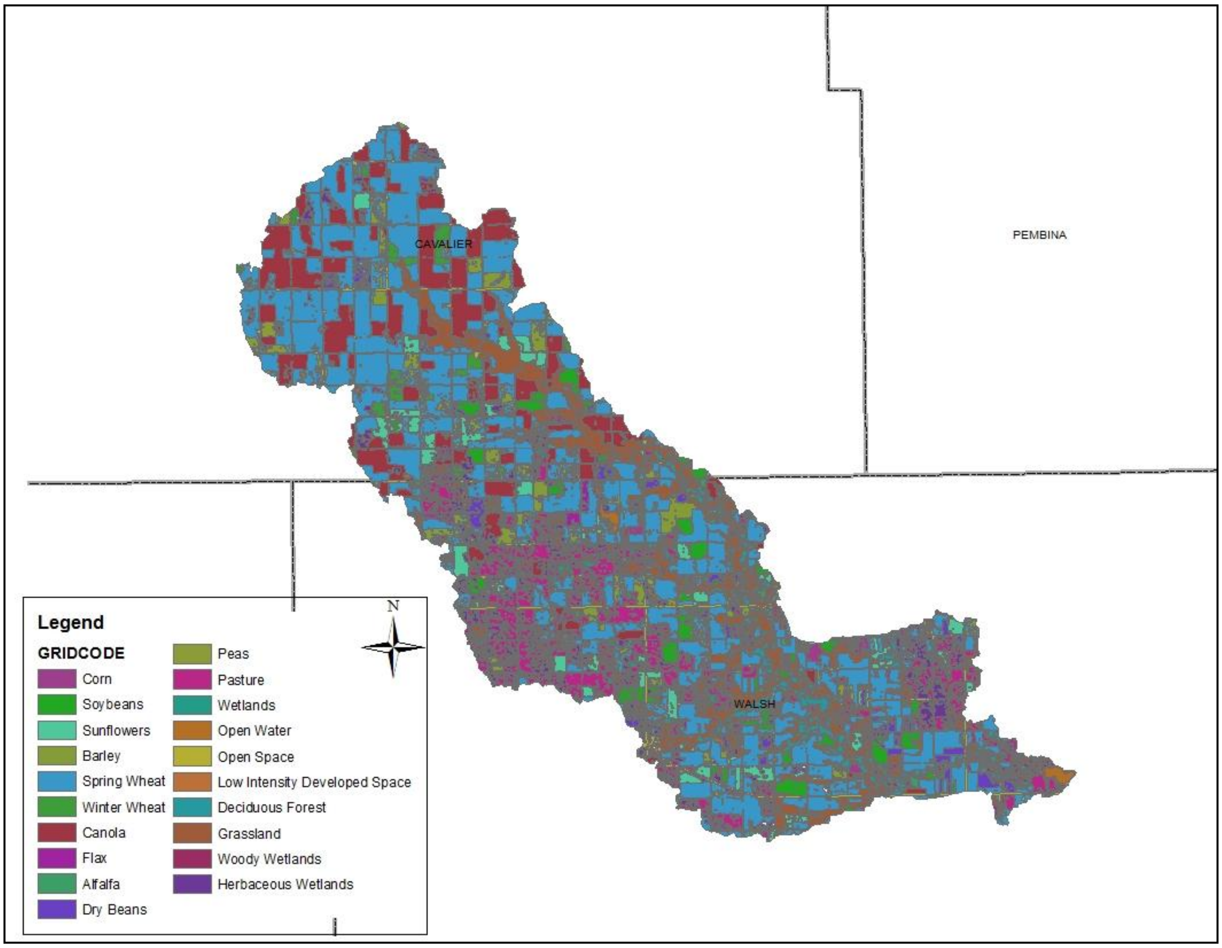

Figure 4. National Agricultural Statistical Survey (2007) Land Use Map for the Homme Dam Watershed.

1.3 Climate and Precipitation

Walsh County has a subhumid climate characterized by warm summers with frequent hot days and occasional cool days. Winters are very cold influenced by blasts of arctic air surging over the area. Average temperatures range from 20º F in the winter to 68º F in the summer. Precipitation occurs primarily during the warm period and is normally heavy in late spring and early summer. Total average annual precipitation for Walsh County is about 20 inches. About 16 inches or 85 percent of rain falls between April and October. Figure 4 and 5 shows the annual precipitation (1991-2011) and total precipitation (2010-2011) for the area as represented by the North Dakota Agricultural Weather Network (NDAWN) weather station located in Langdon, ND.

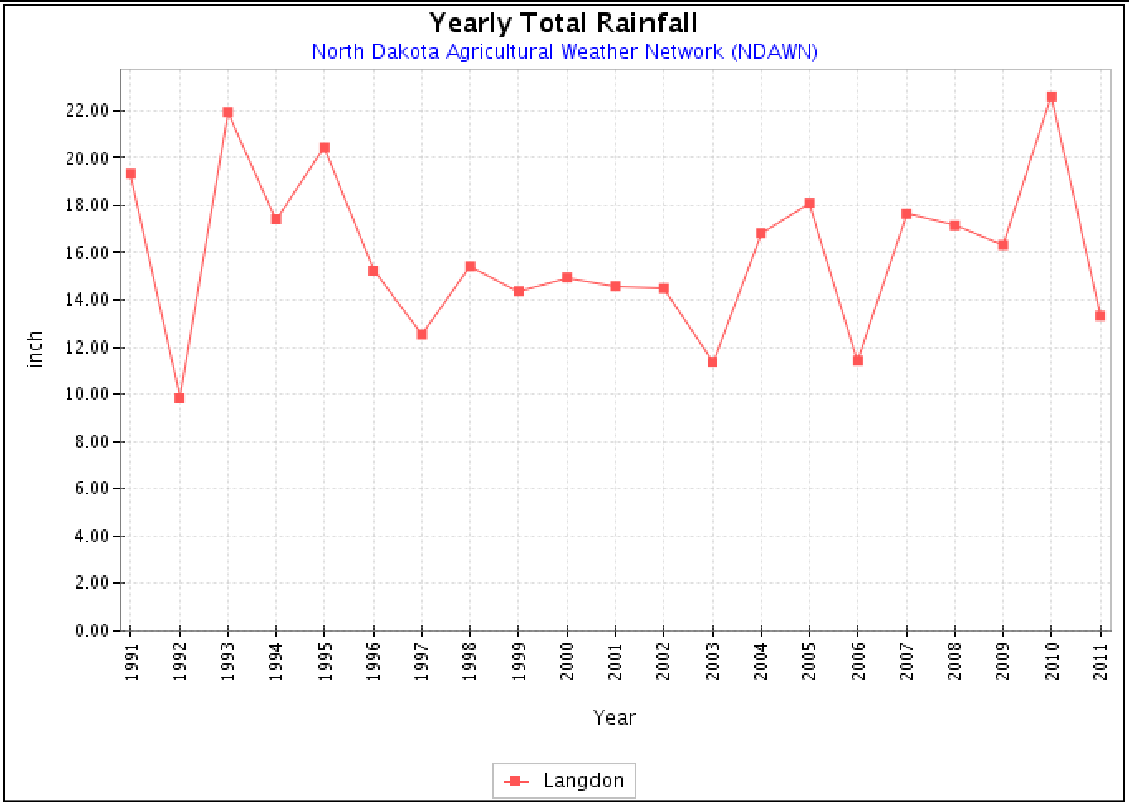

Figure 5. Annual Precipitation (1991-2011) at the NDAWN Weather Station Located in Langdon, ND.

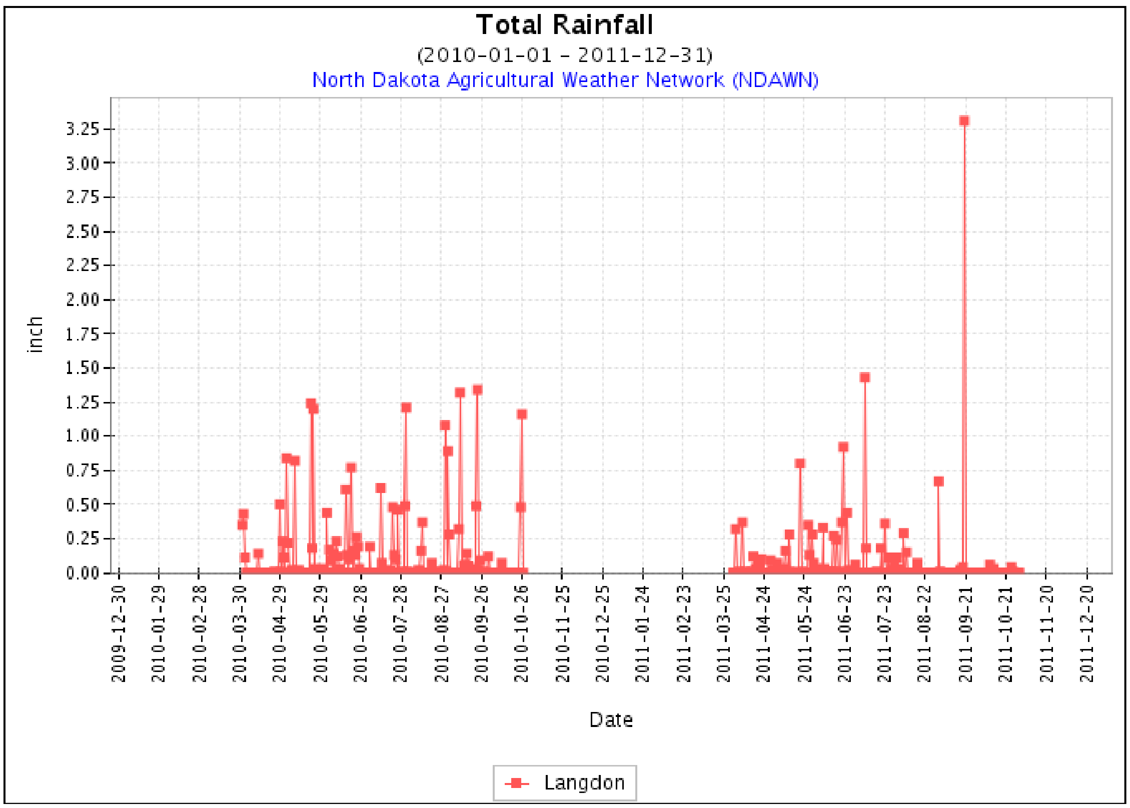

Figure 6. Total Precipitation (2010-2011) at the NDAWN Weather Station Located in Langdon, ND.

1.4 Available Water Quality Data

1.4.1 1996 Lake Water Quality Assessment Project

In the late 1990's through a grant from the EPA Clean Lakes Program the North Dakota Department of Health conducted a Lake Water Quality Assessment Project (LWQA) on lakes and reservoirs in the state.

Homme Dam was one of the reservoirs targeted for the 1996 LWQA. As such, monitoring consisted of one sample collected in July and August 2006. The samples were collected at one site located in the deepest area of the lake (381260) (Figure 6).

The 1996 LWQA Project characterized Homme Dam as having mean surface concentration of total phosphorus of 0.074 mg/L, which exceeded the State's guideline goal for lake maintenance and improvement concentration of 0.02 mg/L during all sampling occasions.

Table 3. Data Summary for Homme Dam Lake Water Quality Assessment (1996).

Deepest Site (381260)		
Parameter	**# of Samples**	**Average**
Total Phosphorus (mg/L)	2	0.074
Dissolved Phosphorus (mg/L)	2	0.048
Total Kjeldahl Nitrogen (mg/L)	2	0.70
Nitrate/Nitrite (mg/L)	2	0.035

1.4.2 2006 Homme Dam Water Quality

Homme Dam was also sampled at the deepest site 381260 in July, August, and September 2006. Homme Dam's mean surface concentration of total phosphorus was calculated at 0.146 mg/L, almost twice the concentration reported in 1996.

Table 4. Data Summary for Homme Dam Water Quality Assessment (2006).

Deepest Site (381260)		
Parameter	**# of Samples**	**Average**
Total Phosphorus (mg/L)	3	0.146
Dissolved Phosphorus (mg/L)	3	0.087
Total Nitrogen (mg/L)	3	1.18
Total Kjeldahl Nitrogen (mg/L)	3	1.16
Nitrate/Nitrite (mg/L)	3	0.02

1.4.3 2010-2011 Homme Dam Water Quality and Watershed Assessment Project

The Walsh County-Three Rivers Soil Conservation District (SCD) conducted a water quality and watershed assessment of Homme Dam and it's watershed from June 2010 to September 2011. Sampling was conducted at one tributary inlet site (380121), at the outlet from Homme Dam (385537), and at one reservoir site located in the deepest area of the reservoir (381260). Monitoring sites are identified in Table 4 and Figure 7.

Table 5. General Information for Water Quality Sampling Sites for Homme Dam.

Sample Site	Site ID	Dates Sampled		Latitude	Longitude
		Start	End		
Stream Sites					
Inlet	380121	June 2010	September 2011	48.41447	-97.86189
Outlet	385537	June 2010	September 2011	48.4	-97.76
Lake Sites					
Deepest	381260	June 2010	September 2011	48.40628	-97.79094

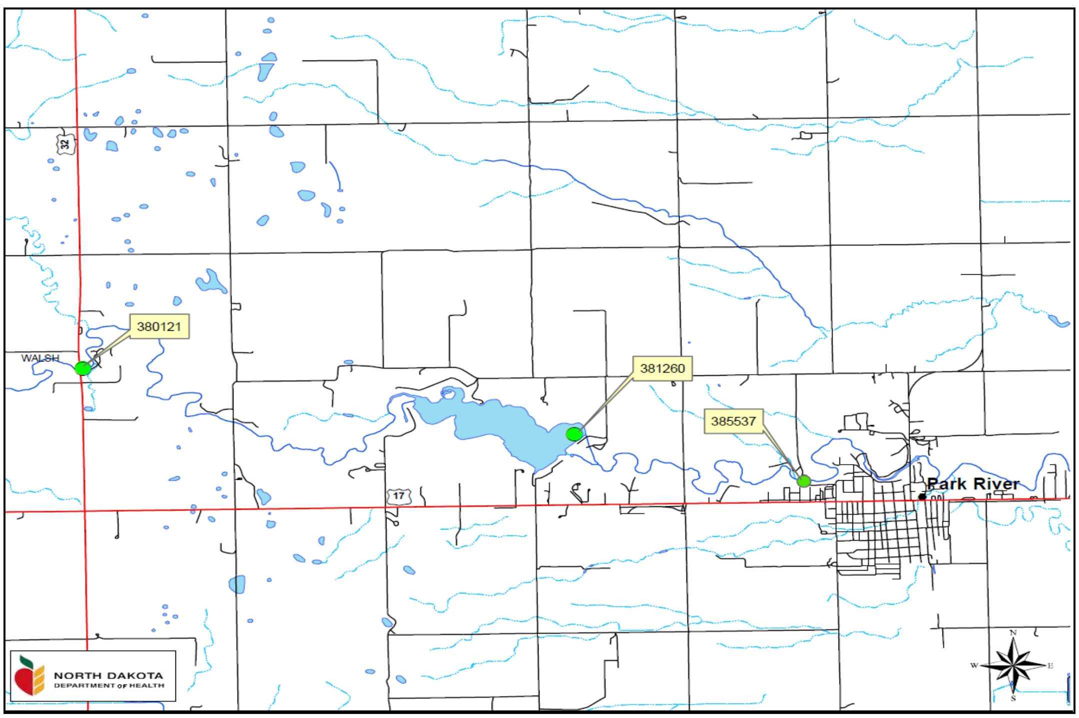

Figure 7. Stream and Lake Sampling Sites for Homme Dam.

<u>Stream Monitoring</u>

Sampling frequency for the stream sampling sites was stratified to coincide with the typical hydrograph for the region. This sampling design resulted in more frequent samples collected during spring and early summer, typically when stream discharge is greatest, and less frequent samples collected during the summer and fall. Sampling was discontinued during the winter during ice cover. Stream sampling was also terminated if the stream stopped flowing. If the stream began to flow again, water quality sampling was reinitiated.

Lake Monitoring

Water quality was monitored by the Walsh County-Three Rivers SCD in Homme Dam at the deepest site (381260) between June 2010 and September 2011. In order to accurately account for temporal variation in lake water quality, the lake was sampled twice per month during the open water season and monthly under ice cover conditions.

The Walsh County-Three Rivers SCD followed the methodology for water quality sampling found in the Quality Assurance Project Plan (QAPP) for the Homme Dam Water Quality and Watershed Assessment Project (NDDoH, 2010b).

Nutrient Data

In 2010, average growing season (April-November) total phosphorus concentrations and dissolved phosphorus concentrations were 0.338 mg/L and 0.300 mg/L, respectfully, while average total nitrogen and total Kjeldahl nitrogen concentrations were 1.600 mg/L and 1.001 mg/L, respectively (Table 6). The average chlorophyll-a concentration was 13.3 µg/L in 2010 (Table 6).

In 2011, the average total phosphorus concentration was 0.233 mg/L, while the average dissolved phosphorus concentration was 0.189 mg/L (Table 7). Total nitrogen and total Kjeldahl nitrogen concentrations were 1.615 mg/L and 0.987 mg/L, respectively. The average chlorophyll-a concentration was 20.5 µg/L.

Average nitrate/nitrate concentrations were 0.27 mg/L and 0.422 mg/L in 2010 and 2011, respectfully. Of the 56 nitrate/nitrite samples collected in 2010 and 2011, four samples (7 %) exceeded the interim guideline limit of 1.0 mg/L (Table 8).

Table 6. 2010 Homme Dam (Deepest Site 381260) Water Quality Data Summary.

Parameter	N	Average	Minimum	Maximum	Median
Total Phosphorus (mg/L)	27	0.338	0.194	0.884	0.302
Dissolved Phosphorus (mg/L)	24	0.300	0.176	0.776	0.260
Total Nitrogen (mg/L)	27	1.600	1.020	2.290	1.490
Total Kjeldahl Nitrogen (mg/L)	27	1.001	0.839	1.175	0.975
Nitrate/Nitrite (mg/L)	27	0.270	0.015	0.870	0.18
Chlorophyll-a (µg/L)	9	13.3	0.75	36.7	12.2
Secchi Disk (meters)	9	1.3	0.6	2.7	1.2

Table 7. 2011 Homme Dam (Deepest Site 381260) Water Quality Data Summary.

Parameter	N	Average	Minimum	Maximum	Median
Total Phosphorus (mg/L)	29	0.233	0.117	0.904	0.184
Dissolved Phosphorus (mg/L)	29	0.189	0.078	0.758	0.147
Total Nitrogen (mg/L)	29	1.615	0.936	2.750	1.35
Total Kjeldahl Nitrogen (mg/L)	29	0.987	0.321	1.534	0.975
Nitrate/Nitrite (mg/L)	29	0.422	0.015	1.24	0.086
Chlorophyll-a (µg/L)	10	20.5	0.75	61.4	17.9
Secchi Disk (meters)	9	1.3	0.4	2.1	1.3

Secchi Disk Transparency Data

The average growing season Secchi disk transparency in 2010 and 2011 was 1.3 meters (Tables 6 and 7). In 2010, the maximum Secchi disk transparency measurement recorded was 2.7 meters, while the maximum measurement in 2011 was 2.1 meters.

2.0 WATER QUALITY STANDARDS

The Clean Water Act requires that Total Maximum Daily Loads (TMDLs) be developed for waters on a state's Section 303(d) list. A TMDL is defined as "the sum of the individual wasteload allocations for point sources and load allocations for nonpoint sources and natural background" such that the capacity of the waterbody to assimilate pollutant loadings is not exceeded. The purpose of a TMDL is to identify the pollutant load reductions or other actions that should be taken so that impaired waters will be able to attain water quality standards. TMDLs are required to be developed with seasonal variations and must include a margin of safety that addresses the uncertainty in the analysis. Separate TMDLs are required to address each pollutant or cause of impairment (i.e., nutrients, sediment).

2.1 Narrative Water Quality Standards

The NDDoH has set narrative water quality standards, which apply to all surface waters in the state. The narrative standards pertaining to nutrient impairments are listed below (NDDoH, 2011).

- All waters of the state shall be free from substances attributable to municipal, industrial, or other discharges or agricultural practices in concentrations or combinations which are toxic or harmful to humans, animals, plants, or resident aquatic biota.

- No discharge of pollutants, which alone or in combination with other substances shall:
  1) Cause a public health hazard or injury to environmental resources;
  2) Impair existing or reasonable beneficial uses of the receiving waters; or
  3) Directly or indirectly cause concentrations of pollutants to exceed applicable standards of the receiving waters.

In addition to the narrative standards, the NDDoH has set a biological goal for all surface waters in the state. The goal states that "the biological condition of surface waters shall be similar to that of sites or waterbodies determined by the department to be regional reference sites," (NDDoH, 2011).

2.2 Numeric Water Quality Standards

Homme Dam is classified as a Class 3 warm water fishery. Class 3 fisheries are defined as waterbodies "capable of supporting natural reproduction and growth of warm water fishes (i.e. largemouth bass and bluegill) and associated aquatic biota. Some cool water species may also be present" (NDDoH, 2011). All classified lakes in North Dakota are assigned aquatic life, recreation, irrigation, livestock watering, and wildlife beneficial uses. The North Dakota State Water Quality Standards (NDDoH, 2011) state that lakes shall use the same numeric criteria as Class 1 streams, including the State standard for dissolved nitrate as N, of 1.0 mg/L, where up to 10 percent of samples may exceed the 1.0 mg/L, and State guideline nutrient goals for lakes and reservoirs (Table 7).

Table 8. Numeric Standards Applicable for North Dakota Lakes and Reservoirs (NDDoH , 2011).

State Water Quality Standard	Parameter	Guidelines	Limit
Numeric Standard for Class I and Classified Lakes	Nitrates (dissolved)	1.0 mg/L	Maximum allowed[1]
Guidelines for Goals in a Lake Improvement or Maintenance Program	NO3 as N	0.25 mg/L	Goal
	PO4 as P	0.02 mg/L	Goal

[1] "Up to 10% of samples may exceed"

3.0 TMDL TARGETS

A TMDL target is the value that is measured to judge the success of the TMDL effort. TMDL targets should be based on state water quality standards, but can also include site-specific values when no numeric criteria are specified in the standard. The following sections summarize water quality targets for Homme Dam based on its linkage to maintaining and attaining all of the reservoir's beneficial uses. When the specific target is met, then the reservoir will meet the applicable water quality standards, including its designated beneficial uses.

3.1 TSI Target Based on Chlorophyll-a

The state's narrative water quality standards (see Section 2.1) form the basis for aquatic life and recreation use assessment for Section 305(b) reporting and Section 303(d) TMDL listing. In the case of this TMDL, the state's narrative water quality standards also form the basis for setting the TMDL target. State water quality standards contain narrative criteria that require lakes and reservoirs to be "free from" substances "which are toxic or harmful to humans, animals, plants, or resident aquatic biota" or are "in sufficient amounts to be unsightly or deleterious." Narrative standards also prohibit the "discharge of pollutants" (e.g., organic enrichment, nutrients, or sediment), "which alone or in combination with other substances, shall impair existing or reasonable beneficial uses of the receiving waters."

The chlorophyll-a trophic status indicator is used by the NDDoH as the primary means to assess whether a lake or reservoir is meeting the narrative standards (NDDoH, 2011). Trophic status is a measure of the productivity of a lake or reservoir and is directly related to the level of nutrients (i.e., phosphorus and nitrogen) entering the lake or reservoir from its watershed and/or from the internal recycling of nutrients. Highly productive lakes, termed "hypereutrophic," contain excessive phosphorus and are characterized by dense growths of weeds, blue-green algal blooms, low transparency, and low dissolved oxygen (DO) concentrations. These lakes experience frequent fish kills and are generally characterized as having excessive rough fish populations (carp, bullhead, and sucker) and poor sport fisheries (Table 9). Due to the frequent algal blooms and excessive weed growth, these lakes are also undesirable for recreational uses such as swimming and boating.

Table 9. Water Quality and Beneficial Use Changes That Occur as the Amount of Algae (expressed as Chlorophyll-a concentration) Changes Along the Trophic State Gradient (from Carlson and Simpson, 1996).

TSI Score	Chlorophyll-a (ug/L)	Secchi Disk Transparency (m)	Total Phosphorus (ug/L)	Attributes	Fisheries & Recreation
<30	<0.95	>8	<6	**Oligotrophy**: Clear water, oxygen throughout the year in the hypolimnion	Salmonid fisheries dominate
30-40	0.95-2.6	8-4	6-12	Hypolimnia of shallower lakes may become anoxic	Salmonid fisheries in deep lakes only
40-50	2.6-7.3	4-2	12-24	**Mesotrophy**: Water moderately clear; increasing probability of hypolimnetic anoxia during summer	Hypolimnetic anoxia results in loss of salmonids. Walleye may predominate
50-60	7.3-20	2-1	24-48	**Eutrophy**: Anoxic hypolimnia, macrophyte problems possible	Warm-water fisheries only. Bass may dominate.
60-70	20-56	0.5-1	48-96	Blue-green algae dominate, algal scums and macrophyte problems	Nuisance macrophytes, algal scums, and low transparency may discourage swimming and boating.
70-80	56-155	0.25-0.5	96-192	**Hypereutrophy**: (light limited productivity). Dense algae and macrophytes	
>80	>155	<0.25	192-384	Algal scums, few macrophytes	Rough fish dominate; summer fish kills possible

Mesotrophic and eutrophic lakes, on the other hand, generally have lower phosphorus concentrations, low to moderate levels of algae and aquatic plant growth, high transparency, and adequate DO concentrations throughout the year. Mesotrophic lakes do not experience algal blooms, while eutrophic lakes may occasionally experience algal blooms of short duration, typically a few days to a week (Table 9).

Therefore, for purposes of this TMDL report, it can be concluded that hypereutrophic lakes do not fully support a sustainable sport fishery and are limited in recreational uses, whereas eutrophic and mesotrophic lakes fully support both aquatic life and recreation use.

Due to the relationship between trophic status indicators and the aquatic community (as reflected by the fishery) or between trophic status indicators and the frequency of algal blooms, trophic status is an effective indicator of aquatic life and recreation use support in lakes and reservoirs (Table 9).

While the three trophic state indicators, chlorophyll-*a*, Secchi disk transparency, and total phosphorus, used in Carlson's TSI each independently estimate algal biomass and should produce the same index value for a given combination of variable values, often they do not. While transparency and phosphorus may co-vary with trophic state, many times the changes in observed in a lake's transparency are not caused by changes in algal biomass, but may be due to particulate sediment. Total phosphorus may or may not be strongly related to algal biomass due to light limitation and/or nitrogen and carbon limitation. Therefore, neither transparency nor phosphorus is an independent estimator of trophic state (Carlson and Simpson, 1996). For these reasons, the NDDoH gives priority to chlorophyll-*a* as the primary trophic state indicator because this variable is the most accurate of the three at predicting algal biomass (Carlson, 1980).

The same conclusion was also reached by a multi-state project team consisting of lake managers and water quality specialists from North Dakota, South Dakota, Montana, Wyoming and EPA Region 8. This group concluded that for lakes and reservoirs in the plains region of EPA Region 8, an average growing season chlorophyll-a concentration of 20 µg/L or less should be the basis for nutrient criteria development for lakes and reservoirs in the plains region (including North Dakota) and that this chlorophyll-a target would be protective of all of a lake or reservoir's beneficial uses, including recreation and aquatic life (Houston Engineering, 2011). The report, prepared by Houston Engineering, also concluded that most lakes and reservoirs in the plains region typically have high total phosphorus concentrations, but maintain relatively low productivity, and that due to this condition, chlorophyll-a is a better measure of a lake or reservoirs trophic status than is total phosphorus (Houston Engineering, 2011).

Water quality data collected in the lake in 2010 and 2011 (see Table 2 in Appendix C) showed an average chlorophyll-a concentration of 16.9 µg/L (TSI Score=58.3) and an average Secchi transparency depth of 1.3 meters (TSI Score=56.4). Based on these data, Homme Dam is generally assessed as a eutrophic lake (Table 10).

Based only on the total phosphorus data and corresponding TSI value of 83.4, Homme Dam would be considered a hypereutrophic reservoir (Table 10, Figure 8). However, Carlson and Simpson (1996) suggest that if the phosphorus TSI value is higher than the chlorophyll-a and Secchi disk transparency TSI value (as is the case with Homme Dam), then algae does not dominate light attenuation, and some other factor, such as nitrogen limitation, zooplankton grazing, or toxics may be limiting algal biomass in the lake (Table 11).

Table 10. Carlson's Trophic State Indices for Homme Dam.

Parameter	Relationship	Units	TSI Value	Trophic Status
Chlorophyll-a	TSI (Chl-a) = 30.6 + 9.81[ln(Chl-a)]	µg/L	58.3	Eutrophic
Total Phosphorus (TP)	TSI (TP) = 4.15 + 14.42[(ln(TP)]	µg/L	83.4	Hypereutrophic
Secchi Depth (SD)	TSI (SD) = 60 - 14.41[ln(SD)]	Meters	56.4	Eutrophic

TSI < 30 - Oligotrophic (least productive)   TSI 30-50 Mesotrophic
TSI 50-65 Eutrophic   TSI > 65 - Hypereutrophic (most productive)

Table 11. Relationships Between TSI Variables and Conditions (from Carlson and Simpson, 1996).

Relationship Between TSI Variables	Conditions
TSI(Chl) = TSI(TP) = TSI(SD)	Algae dominate light attenuation; TN/TP ~ 33:1
TSI(Chl) > TSI(SD)	Large particulates, such as *Aphanizomenon* flakes, dominate
TSI(TP) = TSI(SD) > TSI(CHL)	Non-algal particulates or color dominate light attenuation
TSI(SD) = TSI(CHL) > TSI(TP)	Phosphorus limits algal biomass (TN/TP >33:1)
TSI(TP) >TSI(CHL) = TSI(SD)	Algae dominate light attenuation but some factor such as nitrogen limitation, zooplankton grazing or toxics limit algal biomass.

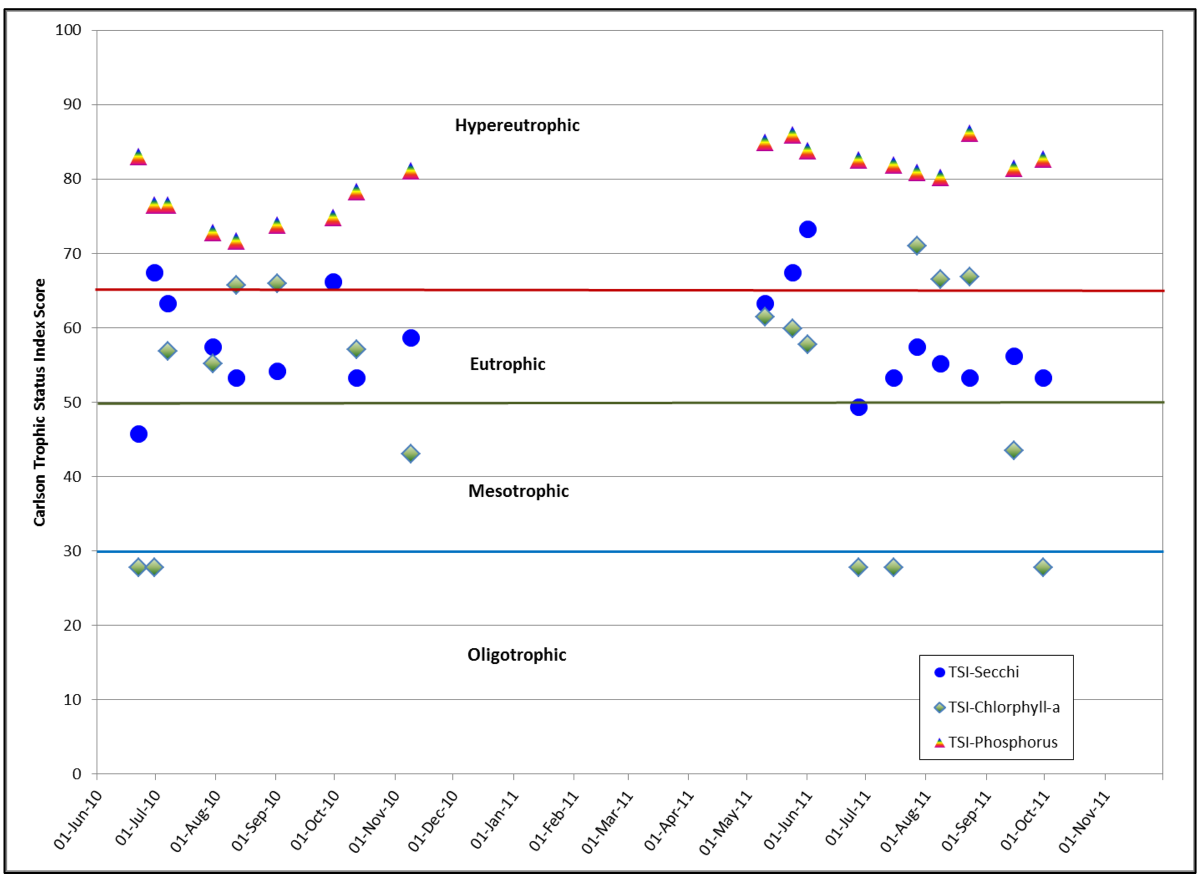

Figure 8. Temporal Distribution of Carlson's Trophic Status Index Scores for Homme Dam (multiple samples collected on same day are averaged).

As stated previously, the NDDoH has established an in-lake growing season average chlorophyll-a concentration goal of 20 µg/L for most lake and reservoir nutrient TMDLs, including this TMDL for Homme Dam. This chlorophyll-a goal corresponds to a chlorophyll-a TSI of 60 which is in the eutrophic range and, as such, will be a trophic state sufficient to maintain both aquatic life and recreation uses of most lakes and reservoirs in the state, including Homme Dam.

Through the use of a calibrated water quality model like CNET (see Section 5.2), the average growing season TP load corresponding to an average growing season chlorophyll-a concentration of 20 µg/L can be estimated. For this TMDL, a 40 percent reduction in the observed total phosphorus load, or 9,996 kg, is estimated to be needed to achieve the TMDL goal for Homme Dam. Since the observed the average growing season average chlorophyll-a concentration for Homme Dam is estimated to be 16.9 µg/L, the TMDL goal and the TMDL equation presented in Section 7.0 was developed assuming no future degradation of water quality within the lake (i.e., a lake protection strategy).

4.0 SIGNIFICANT SOURCES

There are no known point sources upstream of Homme Dam. The pollutants of concern originate from non-point sources.

5.0 TECHNICAL ANALYSIS

Establishing a relationship between in-stream water quality targets and pollutant source loading is a critical component of TMDL development. Identifying the cause-and-effect relationship between pollutant loads and the water quality response is necessary to evaluate the loading capacity of the receiving waterbody. The loading capacity is the amount of a pollutant that can be assimilated by the waterbody while still attaining and maintaining water quality standards. This section discusses the technical analysis used to estimate existing loads to Homme Dam and the predicted trophic response of the reservoir to reductions in loading capacity.

5.1 Tributary Load Analysis

The NDDoH provided the daily flow and tributary chemistry data files to use in estimating total phosphorus loads to Homme Dam over the growing season, defined as the period of time from April 1 through November 30. FLUX32 (http://www.wes.army.mil/el/elmodels/emiinfo.html) was used to facilitate the analysis, to reduce the gaged inflow and outflow data, and to estimate growing season phosphorus loads. FLUX32 is an interactive program used for analyzing streamflow data and estimating loads (mass transports) of nutrients and other water quality constituents passing a tributary sampling point over a given period of time.

The FLUX32 program was used to estimate the annual growing season total phosphorus (TP) load for the gaged area upstream of Homme Dam and the gaged outflow from the lake. Mean daily flow data were provided by the NDDoH for the years 2010 and 2011, as well as several flow measurements paired with corresponding TP measurements. Because the water quality goal for the lake is based upon a growing season mean chlorophyll-a concentration, the data analysis was performed for the months of April through November. The screen/filter option in FLUX32 was used to exclude data outside the defined growing season for both 2010 and 2011.

The basic approach of FLUX32 is to use one of several calculation techniques to map the flow/concentration relationship developed from the sample record onto the entire flow record. FLUX32 has the ability to stratify the data into groups based upon streamflow, date, and/or season for the purpose of reducing the error in the load estimate. To check for any relationships or trends in the data that would indicate that stratification of the data could be used to improve the results, various plots of the sample flows and concentrations were developed and analyzed.

5.2 BATHTUB/CNET Trophic Response Model

The CNET model was selected to simulate the eutrophication response within Homme Dam. CNET is a modified version of the BATHTUB water quality model (Walker, 1996, http://wwwalker.net/bathtub/index.htm). Both BATHTUB and CNET perform steady-state water and nutrient balance calculations in a spatially segmented hydraulic network. The model accounts for advective and diffusive transport and nutrient sedimentation. Eutrophication related water quality conditions are predicted using empirical relationships previously developed and tested for reservoirs.

CNET is a spreadsheet model currently available as a "beta" version from Dr. William W. Walker. The primary benefit of using CNET over BATHTUB is that the user can modify the CNET model to implement a Monte Carlo approach. To complete the Monte Carlo modeling, the CNET model was linked with a program called Crystal Ball. Crystal Ball is proprietary software developed by Oracle (http://www.oracle.com/us/products/applications/crystalball/index.html) and is applicable to Monte Carlo or stochastic simulation and analysis. Stochastic modeling is an approach where model parameters and forcing data (*e.g.,* precipitation) used in the equations to compute the annual mean concentration of total phosphorus (TP), chorophyll-a (chl-*a*), and Secchi Disk (SD) are allowed to vary according to their statistical distribution and therefore their probability of occurrence. This allows the effect of parameter uncertainty and normal variability in the inputs (*e.g.*, amount of surface runoff which varies annually depending upon the amount of precipitation) to be quantified when computing the mean concentration of TP, chl-*a*, and SD.

The CNET model was developed in three phases. The first two phases involve the analysis and reduction of the tributary and in-lake water quality data, respectively. The third phase involves model calibration. In the data reduction phase, the in-lake and tributary monitoring data collected as part of the project were summarized in a format which can serve as inputs to the model.

As described in Section 5.1, the tributary data were analyzed and reduced by the FLUX32 program. Output for the FLUX32 program is then used as input to the CNET model.

In addition to the estimated loads from the FLUX32 program, the CNET model requires information about each components of the water budget and nutrient mass balance in order to estimate in-lake water quality concentrations. The development of the water budget and nutrient mass balances can be found in Appendix B.

The reservoir water quality data needed to calibrate the model were reduced and summarized in Excel using three computational functions. These include: 1) the ability to display concentrations as a function of depth, location, or date; 2) summary statistics (mean, median, etc.); and 3) evaluation of the trophic status. The reservoir water quality data were summarized as the 2010 – 2011 growing season average.

When the input data from FLUX32 and Excel programs are entered into the CNET model, the user has the ability to compare predicted conditions (model output) to actual measured concentrations. The model is considered calibrated when the predicted concentrations for the trophic response variables are similar to observed concentrations based on the monitoring data. CNET then has the ability to predict total phosphorus concentration, chlorophyll-a concentration, and Secchi disk depth based on changes in total phosphorus loading.

The CNET model was calibrated to estimate the mean growing season (April through November) concentrations of total phosphorus, chlorophyll-a, and Secchi depth based on the observed growing season total phosphorus load of 16,660 kg. Further, it is estimated that about 16,367 kg of the total phosphorus load comes from surface water runoff, 270 kg from internal loading, and 23 kg from atmospheric deposition (see nutrient budget in Appendix B). Incremental reductions in the growing season total phosphorus loads were simulated using CNET to show the trophic effect of lowering loads to Homme Dam. A series of model scenarios were performed, where each scenario reflected an incremental reduction of 10% in the total growing season total phosphorus load to Homme Dam. Appendix C provides a more detailed description of the modeling process, including figures showing the effects of reducing April through November TP loads to Homme Dam.

The loading capacity of Homme Dam was computed using a stochastic approach based on the hydrology and water quality simulated by the CNET model. The loading capacity (maximum allowable load) for the reservoir was defined as the growing season TP load resulting in a seasonal mean Chl-a concentration for the 50^{th} percentile non-exceedance value of 16.9 μg/L. The mean seasonal chlorophyll-a concentration is shown by Figure 9. The curve nearest to the value 16.9 μg/L of chlorophyll-a for the 50 percentile value is used to estimate the loading capacity. The value of 16.9 μg/L of chlorophyll-a represents the growing season mean Chl-a eutrophication goal for nondegradation and corresponds to a TSI value of 58.3 (eutrophic). Figure 9 shows the curve with a chlorophyll-a concentration closest to 16.9 μg/l for the 50^{th} percentile value is for a total TP load of 9,996 during the April – November growing season. The results show the value of using a Monte Carlo approach where the underlying statistical distributions deviate considerably from a normal distribution.

5.3 AnnAGNPS Watershed Model

The Annualized Agricultural NonPoint Source Pollution (AnnAGNPS) model was developed by the USDA Agricultural Research Service and Natural Resource Conservation Service (NRCS). The AnnAGNPS model consists of a system of computer models used to predict nonpoint source pollution (NPS) loadings within agricultural watersheds. The continuous simulation surface runoff model contains programs for: 1) input generation and editing; 2) “annualized” pollutant loading model; and 3) output reformatting and analysis.

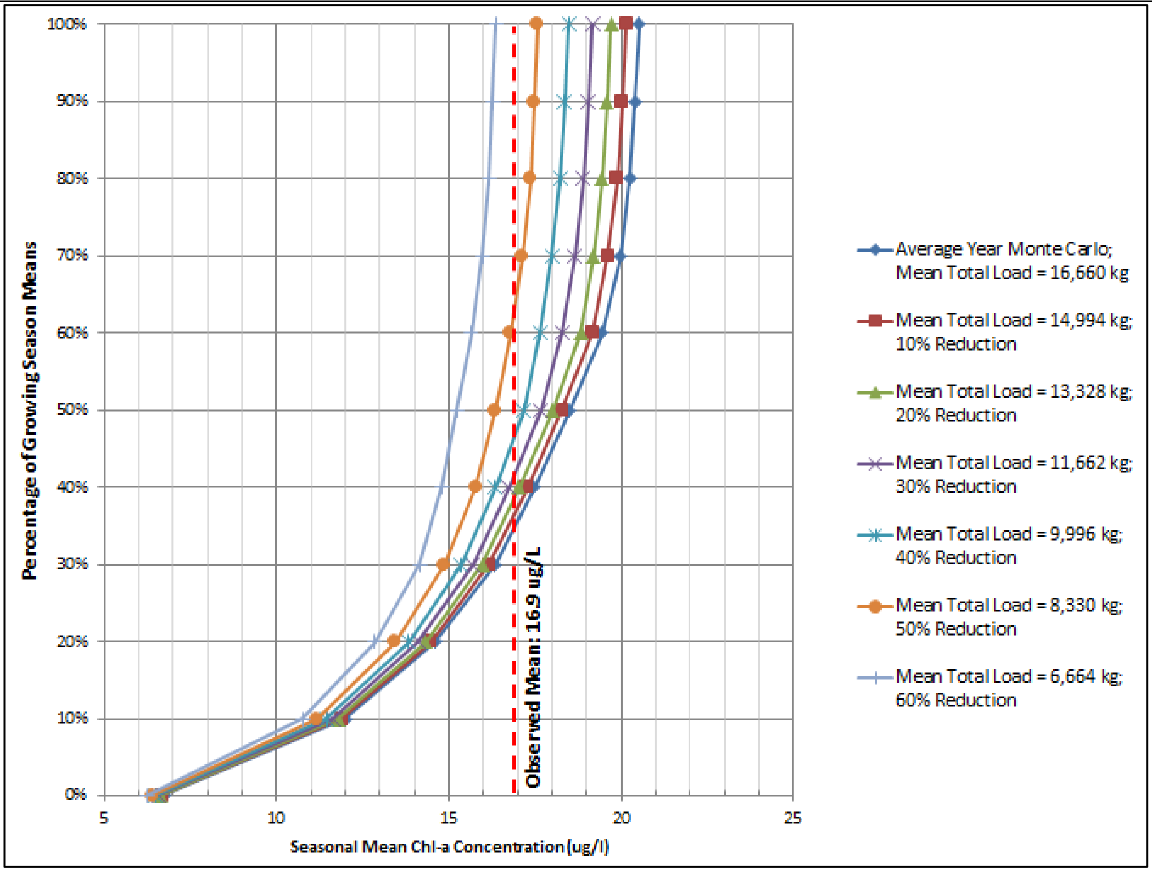

Figure 9. Homme Dam Frequency Distribution for Growing Season (April through November) Mean Chl-a Concentrations Resulting from Select Load Reduction Scenarios (2010 – 2011 condition = 16,660 kg/season).

The AnnAGNPS model uses batch processing, continual-simulation, and surface runoff pollutant loading to generate amounts of water, sediment, and nutrients moving from land areas (cells) and flowing into the watershed stream network at user specified locations (reaches) on a daily basis. The water, sediment, and chemicals travel throughout the specified watershed outlets. Feedlots, gullies, point sources, and impoundments are special components that can be included in the cells and reaches. Each component adds water, sediment, or nutrients to the reaches.

The AnnAGNPS model is able to partition soluble nutrients between surface runoff and infiltration. Sediment-attached nutrients are also calculated in the stream system. Sediment is divided into five particle size classes (clay, silt, sand, small aggregate, and large aggregate) and are moved separately through the stream reaches.

AnnAGNPS uses various models to develop an annualized load in the watershed. These models account for surface runoff, soil moisture, erosion, nutrients, and reach routing. Each model serves a particular purpose and function in simulating the NPS processes occurring in the watershed.

To generate surface runoff and soil moisture, the soil profile is divided into two layers. The top layer is used as the tillage layer and has properties that change (bulk density, etc.). While the remaining soil profile makes up the second layer with properties that remain static. A daily soil moisture budget is calculated based on rainfall, irrigation, and snow melt runoff, evapotranspiration, and percolation. Runoff is calculated using the NRCS Runoff Curve Number equation. These curve numbers can be modified based on tillage operations, soil moisture, and crop stage.

Overland sediment erosion was determined using a modified watershed-scale version of Revised Universal Soil Loss Equation (RUSLE) (Geter and Theurer, 1998).

A daily mass balance for nitrogen (N), phosphorus (P), and organic carbon (OC) are calculated for each cell. Major components of N and P considered include plant uptake N and P, fertilization, residue decomposition, and N and P transport. Soluble and sediment absorbed N and P are also calculated. Nitrogen and phosphorus are then separated into organic and mineral phases. Plant uptake N and P are modeled through a crop growth stage index. (Bosch et. al. 1998)

The reach routing model moves sediment and nutrients through the watershed. Sediment routing is calculated based upon transport capacity relationships using the Bagnold stream power equation (Bagnold, 1966). Routing of nutrients through the watershed is accomplished by subdividing them into soluble and sediment attached components and are based on reach travel time, water temperature, and decay constant. Infiltration is also used to further reduce soluble nutrients. Both the upstream and downstream points of the reach are calculated for equilibrium concentrations by using a first order equilibrium model.

AnnAGNPS uses 34 different categories of input data and over 400 separate input parameters to execute the model. The input data categories can be split into five major classifications: climatic data, land characterization, field operations, chemical characteristics, and feedlot operations. Climatic data includes precipitation, maximum and minimum air temperature, relative humidity, sky cover, and wind speed. Land characterization consists of soil characterization, curve number, RUSLE parameters, and watershed drainage characterization. Field operations contain tillage, planting, harvest, rotation, chemical operations, and irrigation schedules. Finally, feedlot operations require daily manure rates, times of manure removal, and residue amount from previous operations.

Input parameters are used to verify the model. Some input parameters may be repeated for each cell, soil type, landuse, feedlot, and channel reach. Default values are available for some input parameters, others can be simplified because of duplication. Daily climatic input data can be obtained through weather generators, local data, and/or both. Geographical input data including cell boundaries, land slope, slope direction, and landuse can be generated by GIS or DEM (Digital Elevation Models).

Output data is expressed through an event based report for stream reaches and a source accounting report for land or reach components. Output parameters are selected by the user for the desired watershed source locations (specific cells, reaches, feedlots, point sources, or gullies) for any simulation period. Source accounting for land or reach components are calculated as a fraction of a pollutant load passing through any reach in the stream network that came from the user identified watershed source locations. Event based output data is defined as event quantities for user selected parameters at desired stream reach locations.

AnnAGNPS was utilized for the Homme Dam Water Quality and Watershed Assessment project. The Homme Dam watershed delineation began with downloading a 30-meter digital elevation model (DEM) of Cavalier and Walsh Counties. Delineation is defined as drawing a boundary and dividing the land within the boundary into subwatersheds in such a matter that each subwatershed has uniformed hydrological parameters (land slope, elevation, etc.) (Figure 10).

Land use and soil digital images were then used to extract the dominate identification of landuse and soil for each subwatershed. This process is achieved by overlaying Landsat and soil images over the subwatershed file. Each dominate soil is then further identified by its physical and chemical soil properties found in a database called National Soils Information System (NASIS) developed by the NRCS. Dominate landuse identification input parameters were obtained using Revised Universal Soil Loss Equation (RUSLE).

A three year simulation period was run on the Homme Dam watershed at its present condition to provide a best estimation of the current land use practices applied to the soils and slopes of the watershed to obtain nutrient loads from the individual cells as well as the watershed as a whole. Crop rotations were determined from 2007, 2008, and 2009 crop data from the National Agricultural Statistical Service (NASS). Over 54 different crop rotations and 29 fertilizer application rates were used to simulate current watershed landuse conditions within the Homme Dam watershed.

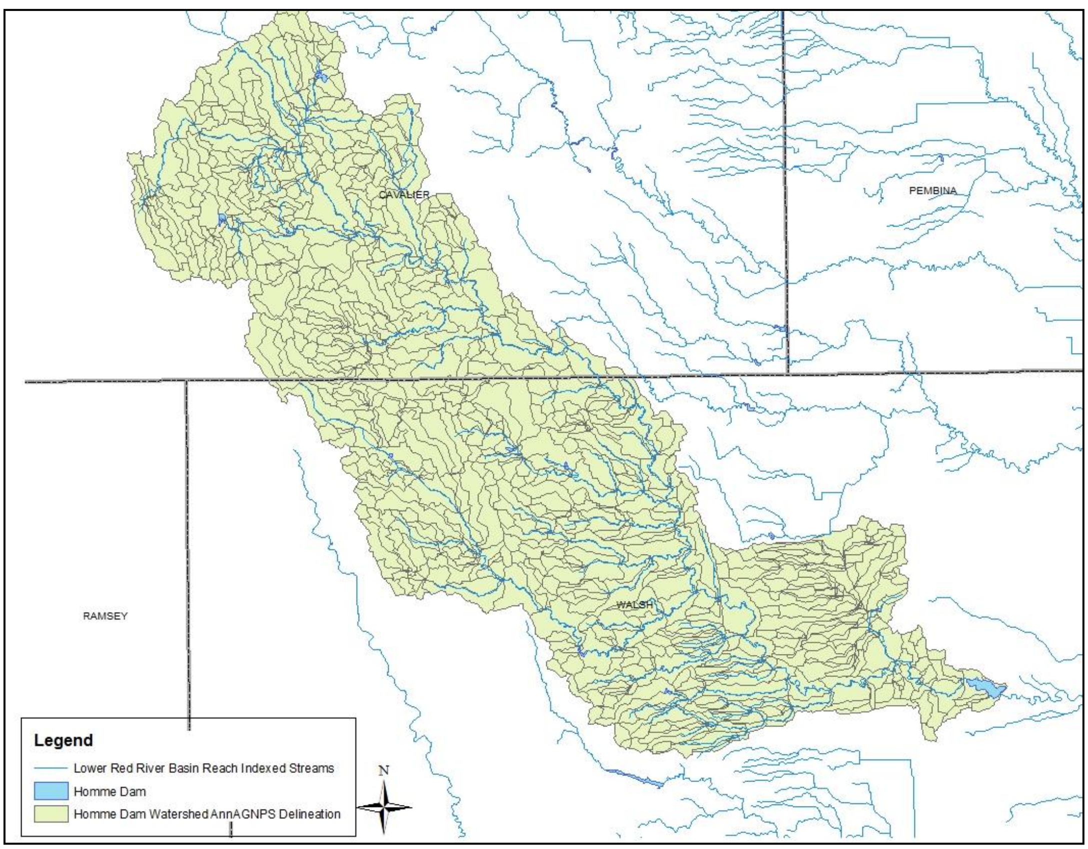

Figure 10. Homme Dam AnnAGNPS Delineated Watershed Area.

Climate data was derived from the North Dakota Agricultural Weather Network (NDAWN) weather station located in Langdon, ND from January 2007 through December 2009.

The compiled data was used to assess the watershed to identify "critical cells" located in the watershed for potential best management practice (BMP) implementation (Figure 11). Critical cells were determined to be cells in the watershed providing an estimated annual phosphorus yield of 0.117 lbs/acre/year or greater.

6.0 MARGIN OF SAFETY AND SEASONALITY

6.1 Margin of Safety

Section 303(d) of the Clean Water Act and EPA's regulations require that "TMDLs shall be established at levels necessary to attain and maintain the applicable narrative and numerical water quality standards with seasonal variations and a margin of safety that takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality." The margin of safety (MOS) can either be incorporated into conservative assumptions used to develop the TMDL (implicit) or added as a separate component of the TMDL (explicit). For the purposes of this nutrient TMDL, a MOS of 10 percent of the loading capacity will be used as an explicit MOS.

Assuming the existing annual growing season phosphorus load to Homme Dam from tributary sources and internal cycling is 16,660 kg, and the TMDL chlorophyll-a goal is the current mean concentration of 16.9 µg/L, then this would result in a TMDL target total phosphorus loading capacity of 9,996 kg of total phosphorus per year. Based on a 10 percent explicit margin of safety, the MOS for the Homme Dam TMDL would be 999.6 kg of phosphorus per year.

Monitoring and adaptive management during the implementation phase, along with post-implementation monitoring related to the effectiveness of the TMDL controls, will be used to ensure the attainment of the targets.

6.2 Seasonality

Section 303(d)(1)(C) of the Clean Water Act and the EPA's regulations require that a TMDL be established with seasonal variations. The Homme Dam TMDL addresses seasonality because the CNET and AnnAGNPS models incorporate seasonal differences in their prediction of annual total phosphorus and nitrogen loadings.

7.0 TMDL

Table 12 summarizes the nutrient TMDL for Homme Dam in terms of loading capacity, wasteload allocations, load allocations, and a margin of safety. The TMDL can be generically described by the following equation.

TMDL = LC = WLA + LA + MOS

where

LC loading capacity, or the greatest loading a waterbody can receive without violating water quality standards;

WLA wasteload allocation, or the portion of the TMDL allocated to existing or future point sources;

LA load allocation, or the portion of the TMDL allocated to existing or future non-point sources;

MOS margin of safety, or an accounting of the uncertainty about the relationship between pollutant loads and receiving water quality. The margin of safety can be provided implicitly through analytical assumptions or explicitly by reserving a portion of the loading capacity.

Based on data collected in 2010 and 2011, the existing annual growing season total phosphorus load to Homme Dam is estimated at 16,660 kg (Table 12). Assuming that not exceeding the current loading will result in Homme Dam attaining and maintaining an average growing season TMDL target mean chlorophyll-a concentration of 16.9 µg/L, the phosphorus TMDL or Loading Capacity is 9,996 kg per year. Assuming 10 percent of the loading capacity, 999.6 kg/growing season, is explicitly assigned to the MOS and there are no point sources in the watershed all of the remaining loading capacity, 8,996.4 kg/yr, is assigned to the load allocation (Table 12).

Table 12. Summary of the Total Phosphorus TMDL for Homme Dam.

Category	Total Phosphorus (kg/yr)	Explanation
Existing Load	16,660	From observed data
Loading Capacity	9,996	Total TP load from Monte Carlo modeling corresponding to 2010/2011 mean chlorophyll-a concentration of 16.9 µg/L
Wasteload Allocation	0	No point sources
Load Allocation	8,996.4	Entire loading capacity minus MOS is allocated to non-point sources
MOS	999.6	10% of the loading capacity (kg/yr) is reserved as an explicit margin of safety

In November 2006 EPA issued a memorandum “Establishing TMDL “Daily” Loads in Light of the Decision by the U.S. Court of Appeals for the D.C. Circuit in Friends of the Earth, Inc. v. EPA et. al., No. 05-5015 (April 25, 2006) and Implications for NPDES Permits,” which recommends that all TMDLs and associated load allocations and wasteload allocations include a daily time increment in conjunction with other appropriate temporal expressions that may be necessary to implement the relevant water quality standard. While the North Dakota Department of Health believes that the appropriate temporal expression for phosphorus loading to lakes and reservoirs is as an annual load, the phosphorus TMDL has also been expressed as a daily load. In order to express this phosphorus TMDL as a daily load the annual loading capacity of 9,996 kg/growing season was divided by 365 days. Based on this analysis, the phosphorus TMDL, expressed as an average daily load, is 27.4 kg/day with the load allocation equal to 24.6 kg/day and the MOS equal to 2.7 kg/day.

8.0 ALLOCATION

A 40 percent nutrient load reduction target was established for the Homme Dam watershed. This reduction was set based on the CNET/BATHTUB model, which predicted that under similar hydraulic conditions, an external nutrient load reduction of 40 percent would lower Carlson's cholorophyll-a TSI from 60 (equivalent to an average growing season chlorophyll-a concentration of 16.9 µg/L) to 58.3 (equivalent to an average growing season chlorophyll-a concentration of 16.8 µg/L).

Using the AnnAGNPS model, it was determined that cells with a phosphorus yield of 0.117lbs/acre/yr or greater as priority areas in the watershed (Figure 11). These cells are the critical cells which should be examined by an implementation project to determine the necessity and types of BMP's to be implemented. Based on the AnnAGNPS model, if BMP's are implemented on these critical areas, it is estimated that the phosphorus load would be reduced by 50 percent, thereby meeting the TMDL goal.

The TMDL in this report is a plan to improve water quality by implementing BMPs through a volunteer, incentive-based approach. This TMDL plan is put forth as a recommendation to what needs to be accomplished for Homme Dam and its watershed to meet and protect its beneficial uses. Water quality monitoring should continue to assess the effects of recommendations made in this TMDL. Monitoring may indicate that loading capacity recommendations be adjusted.

9.0 PUBLIC PARTICIPATION

To satisfy the public participation requirements of this TMDL, a letter was sent to the following participating agencies notifying them that the draft report was available for review and public comment. Those included in the mailing are as follows:

- Walsh County-Three Rivers Soil Conservation District;
- Walsh County Water Resource Board;
- North Dakota Game and Fish Department;
- US Army Corps of Engineers, St. Paul District;
- Natural Resource Conservation Service (State Office); and
- U.S. Environmental Protection Agency, Region VIII.

In addition to notifying specific agencies of this draft TMDL report's availability, the TMDL was posted on the North Dakota Department of Health, Division of Water Quality web site at http://www.ndhealth.gov/WQ/SW/Z2_TMDL/TMDLs_Under_PublicComment/B_Under_Public_Comment.htm. A 30 day public notice soliciting comment and participation was also published in the Walsh County Record.

Comments were only received from US EPA Region 8, which were provided as part of their normal public notice review (Appendix D). The NDDoH's response to these comments are provided in Appendix E.

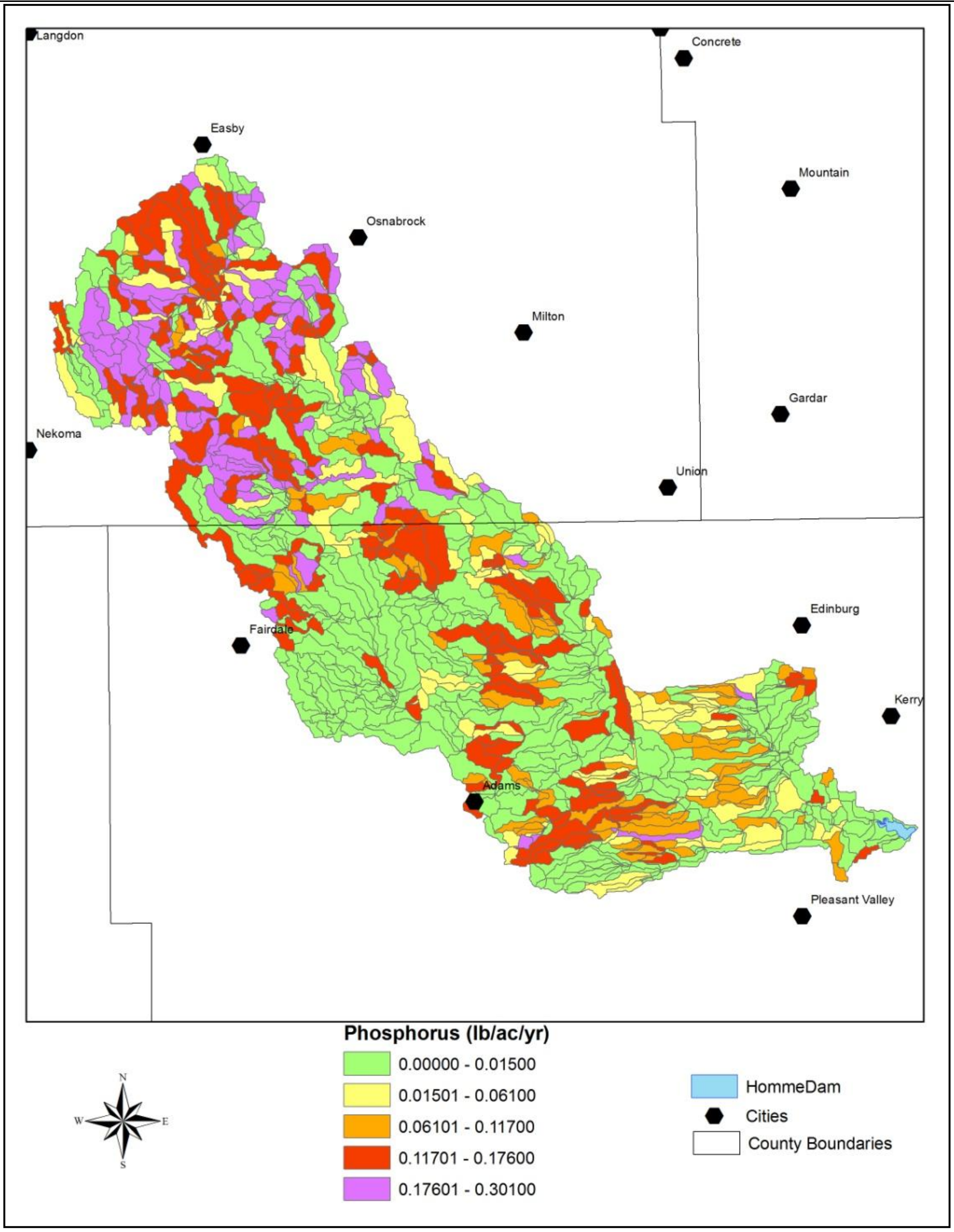

Figure 11. AnnAGNPS Model Identification of Critical Areas for BMP Implementation.

10.0 MONITORING

To insure that the BMPs implemented as a part of any watershed restoration plan will reduce phosphorus levels, water quality monitoring will be conducted in accordance with an approved Quality Assurance Project Plan (QAPP).

Specifically, monitoring will be conducted for all variables that are currently causing impairments to the beneficial uses of the waterbody. Once a watershed restoration plan (e.g. 319 PIP) is implemented, monitoring will be conducted in the lake/reservoir beginning two years after implementation and extending five years after the implementation project is complete.

11.0 TMDL IMPLEMENTATION STRATEGY

Implementation of TMDLs is dependent upon the availability of Section 319 NPS funds or other watershed restoration programs (e.g. USDA EQIP), as well as securing a local project sponsor and the required matching funds. Provided these three requirements are in place, a project implementation plan (PIP) is developed in accordance with the TMDL and submitted to the North Dakota Nonpoint Source Pollution Task Force and US EPA for approval. The implementation of the best management practices contained in the NPS PIP is voluntary. Therefore, success of any TMDL implementation project is ultimately dependent on the ability of the local project sponsor to find cooperating producers.

Monitoring is an important and required component of any PIP. As a part of the PIP, data are collected to monitor and track the effects of BMP implementation as well as to judge overall project success. Quality Assurance Project Plans (QAPPs) detail the strategy of how, when and where monitoring will be conducted to gather the data needed to document the TMDL implementation goal(s). As data are gathered and analyzed, watershed restoration tasks are adapted to place BMPs where they will have the greatest benefit to water quality.

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Appendix A
Flux Analysis for Homme Dam

Estimate of Total Phosphorus Load in Gaged Inflow and Outflow using FLUX

The NDDoH provided daily flow and tributary chemistry data files to use in estimating total phosphorus loads to Homme Dam over the growing season, defined as the period of time from April 1 through November 30. FLUX32[1] was used to facilitate the analysis, to reduce the gaged inflow and outflow data, and to estimate growing season loads. FLUX 32 is an interactive program used for analyzing streamflow data and estimating loads (mass transports) of nutrients and other water quality constituents passing a tributary sampling point over a given period of time.

The FLUX32 program was used to estimate the growing season total phosphorus (TP) load for the gaged area upstream of Homme Dam and the gaged outflow from the lake. Mean daily flow data were provided by the NDDoH for the years 2010 and 2011, as well as several flow measurements paired with corresponding TP measurements. Because the water quality goal for the lake is based upon a growing season mean chlorophyll-a concentration, the data analysis was performed for the months of April through November. The screen/filter option in FLUX32 was used to exclude data outside the defined growing season for both 2010 and 2011.

The basic approach of FLUX32 is to use one of several calculation techniques to map the flow/concentration relationship developed from the sample record onto the entire flow record. FLUX32 has the ability to stratify the data into groups based upon streamflow, date, and/or season for the purpose of reducing the error in the load estimate. To check for any relationships or trends in the data that would indicate that stratification of the data could be used to improve the results, various plots of the sample flows and concentrations were developed and analyzed (see below for the stratification methods employed to estimate the growing season loads). The following sections describe individual data analyses for the gaged inflow to and gaged outflow from Homme Dam.

Gaged Inflow to Homme Dam

The daily streamflow and chemistry data files provided by the NDDoH representing the gaged inflow to Homme Dam from the South Branch of Park River (Site 380121) consisted of two full years of mean daily flow measurements, along with a total of 44 paired streamflow and TP measurements over the growing season of April – November (14 in 2010 and 30 in 2011). The 2010 data contains paired streamflow and TP measurements from June through November, while the 2011 data contains paired data from for the entire growing season (April – November). **Figure 1** shows the 181.3 square mile gaged area, as well as the 24.5 square mile ungaged area draining to Homme Dam. **Figure 2** is a histogram comparing the frequency distributions between the mean daily flows and the sampled flows, which shows the extent to which the flow range was sampled.

[1] http://www.wes.army.mil/el/elmodels/emiinfo.html

Figure 1: Gaged and Ungaged Areas Draining to Homme Dam.

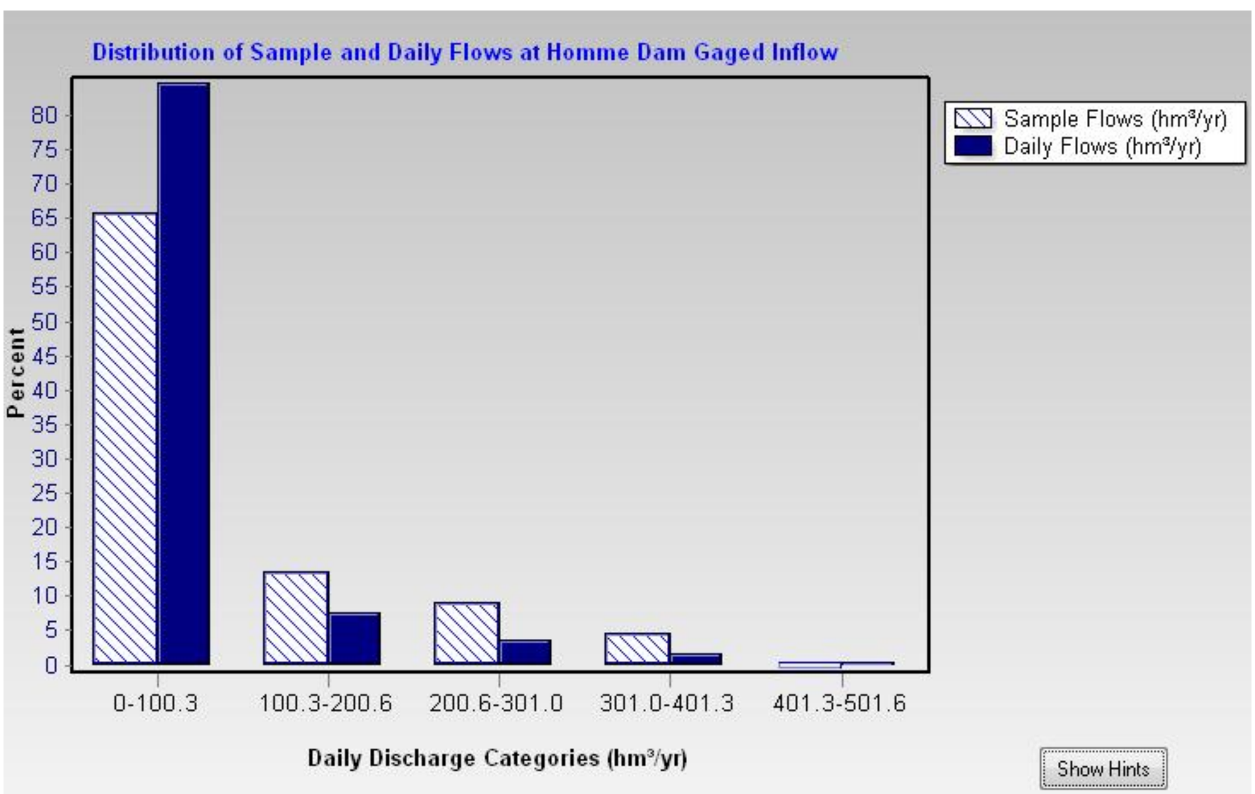


Figure 2: Distribution of Sample and Mean Daily Streamflows at the South Branch of the Park River (Site 380121) during the Growing Seasons of 2010 and 2011

Plots of the relationship between sampled streamflows and TP concentrations indicate potential statistical relationships between flow and concentration. FLUX32 calculations for various stratification schemes showed a slight benefit to stratifying the data based on splitting the flow at the mean.

FLUX32 includes six calculation techniques to "map" the streamflow/concentration relationship developed from the sample record onto the entire streamflow record to estimate the mass discharge and associated error statistics. It was found that Method 5 resulted in the lowest coefficient of variation (0.04) for the seasonal TP load, and therefore, is the "best" estimate. Method 5, similar to Method 4, is a regression method which adjusts the flow-weighted mean concentration for differences between the average sampled flow and the average total flow using the slope of concentration versus flow. Method 5, however, modifies the estimate by a factor accounting for differences in variance between the sampled and total flow distributions.[2] The resulting total TP load estimated for the combined April through November 2010 and 2011growing seasons at the gaged inlet to Homme Dam is 28,842 kg, with an estimated annual average growing season (April – November) TP load of 14,421 kg/year. The estimated growing season TP yield is 0.27 pounds/acre.

Gaged Outflow to Homme Dam

The mean daily outflow data from Homme Dam, as well as the paired sample and streamflow data over the years 2010 and 2011 provided by the NDDoH, were read into the FLUX32 Program. The data consisted of two full years of mean daily streamflow measurements leaving Homme Dam and a total of 44 paired streamflow and TP measurements over the growing season of April – November (14 in 2010 and 30 in 2011). The 2010 data contains paired streamflow and TP measurements from June through November, while the 2011 data contains paired data from for the entire growing season (April – November). **Figure 3** is a histogram comparing the frequency distributions between the mean daily flows and the sampled flows, which shows the extent to which the flow range was sampled.

[2] Walker, W. W. (1987). "Empirical methods for predicting eutrophication in impoundments; Report 4, Phase III: Applications manual," Technical Report E-8 1-9, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

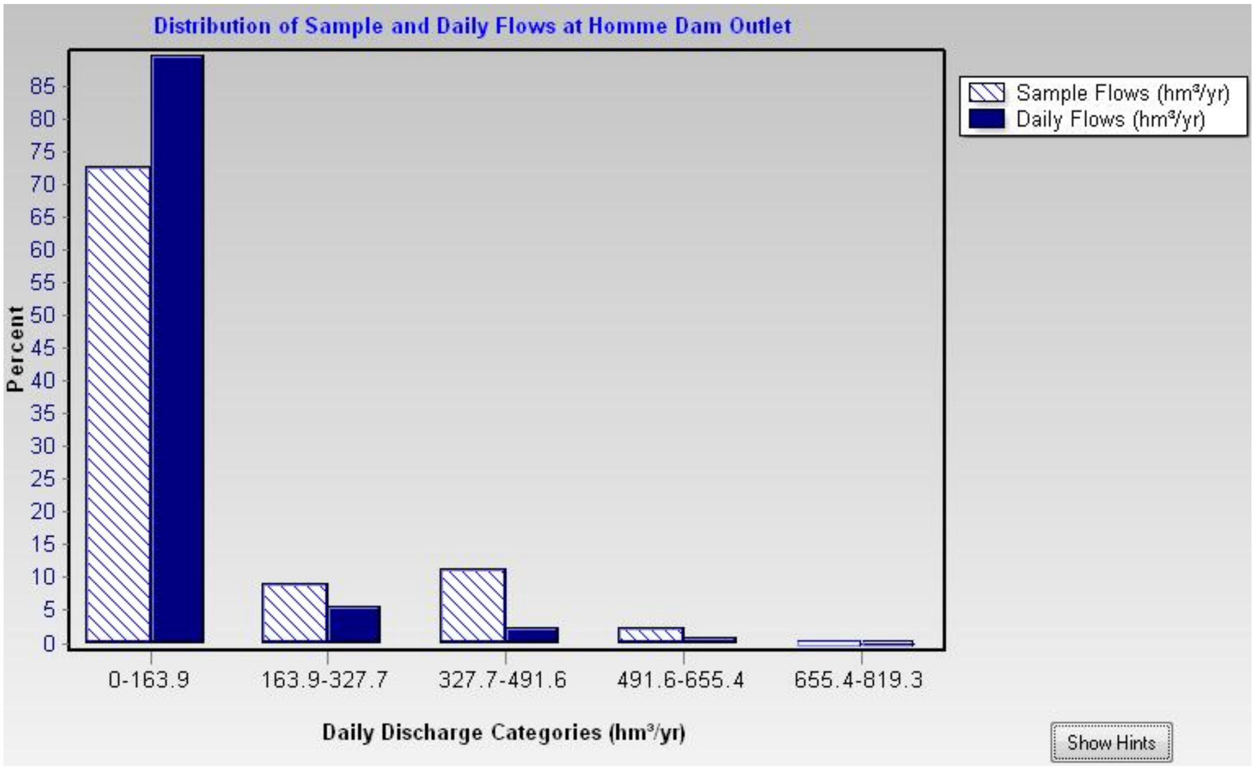


Figure 3: Distribution of Sample and Mean Daily Streamflows at the Outlet to Homme Dam during Growing Seasons of 2010 and 2011.

Plots of the relationship between sampled streamflows and TP concentrations indicate potential statistical relationships between flow and concentration. FLUX32 calculations for various stratification schemes showed a slight benefit to stratifying the data based on splitting the flow at the mean.

FLUX32 includes six calculation techniques to "map" the streamflow/concentration relationship developed from the sample record onto the entire streamflow record to estimate the mass discharge and associated error statistics. It was found that Method 5 resulted in the lowest coefficient of variation (0.04) for the seasonal TP load, and therefore, is the "best" estimate. The resulting total TP load estimated for the combined April through November 2010 and 2011 growing seasons at the gaged outlet to Homme Dam is 23,993 kg, with an estimated annual average growing season (April – November) TP load of 11,996 kg/year.

Homme Dam Gaged Inlet FLUX Results

FLOW AND LOAD SUMMARIES FOR TP

Method: C/Q Reg2(VarAdj) (5)

DISTRIBUTION OF SAMPLES VS. DAILY FLOWS

Stratum	Flows	Smpls	Evnts	Vol %	Daily Flow (hm³/yr)	Smpl Flow (hm³/yr)	TP (µg/L)	FLUX (kg/y)	SLOPE LgC/LgQ	R²	p > C/Q
1 Flow > 2x Mea	364	23	23	22.9	18.47332	26.88962	258.17	4660	0.08431	0.00	0.1523
2 Flow > 2x Mea	124	21	21	77.1	182.7487	232.5868	361.67	71275	0.2311	0.00	0.0086
Overall	488	44	44	100.0	60.21542	125.0633	307.57	21587	0.1434	0.00	0.0001

STRATUM BOUNDARIES(hm³/yr)

STRATUM	LOWER LIMIT	UPPER LIMIT
Flow > 2x Mean	0	60.2154
Stratum 2	60.2154	602

DAILY FLOW STATISTICS

Daily Flow Duration	488 Days = 1.336 Years
Daily Mean Flow Rate	60.22 (hm³/yr)
Daily Total Flow Volume	80.45 (Mega m³)
Daily Flow Date Range	04/01/2010 to 11/30/2011
Samples Date Range	06/09/2010 to 09/21/2011

LOAD ESTIMATES FOR TP

Method	Mass(kg)	Flux(kg/y)	Flux Variance	Flw Wgted Conc.(µg/L)	C.V.
1 Average Load	39109.828	29272.26	2.85905E07	486	0.1827
2 Flw Wghted Conc.	30055.192	22495.2	1.80574E06	374	0.05974
3 Flw Wghted IJC.	30245.282	22637.48	1.79462E06	376	0.05918
4 C/Q Reg1	28534.092	21356.72	961788	355	0.04592
5 C/Q Reg2(VarAdj)	28841.689	21586.94	686541	358	0.03838
6 C/Q Reg3(daily)	28889.099	21622.42	969117	359	0.04553
8 Time Series	29005.585	21709.61	N/A	361	N/A

Homme Dam Gaged Outlet FLUX Results

FLOW AND LOAD SUMMARIES FOR TP

Method: C/Q Reg2(VarAdj) (5)

DISTRIBUTION OF SAMPLES VS. DAILY FLOWS

Stratum	Flows	Smpls	Evnts	Vol %	Daily Flow (hm³/yr)	Smpl Flow (hm³/yr)	TP (µg/L)	FLUX (kg/y)	SLOPE LgC/LgQ	R²	p > C/Q
1 Stratum 2	372	24	24	26.5	25.96174	35.20207	206.79	5277	-0.2043	0.00	0.1849
2 Stratum 2	116	20	20	73.5	230.9367	312.6205	226.1	58623	0.3334	0.00	0.0019
Overall	488	44	44	100.0	74.6853	161.3014	215.57	17958	0.07111	0.00	0.1502

STRATUM BOUNDARIES(hm³/yr)

STRATUM	LOWER LIMIT	UPPER LIMIT
Stratum 2	0	74.6853
Stratum 2	74.6853	983.2

DAILY FLOW STATISTICS

Daily Flow Duration	488 Days = 1.336 Years
Daily Mean Flow Rate	74.69 (hm³/yr)
Daily Total Flow Volume	99.78 (Mega m³)
Daily Flow Date Range	04/01/2010 to 11/30/2011
Samples Date Range	06/09/2010 to 09/21/2011

LOAD ESTIMATES FOR TP

Method	Mass(kg)	Flux(kg/y)	Flux Variance	Flw Wgted Conc.(µg/L)	C.V.
1 Average Load	33998.79	25446.84	2.97118E07	341	0.2142
2 Flw Wghted Conc.	25106.903	18791.59	2.34523E06	252	0.08149
3 Flw Wghted IJC.	25359.707	18980.81	2.4432E06	254	0.08235
4 C/Q Reg1	23521.339	17604.85	857792	236	0.05261
5 C/Q Reg2(VarAdj)	23992.76	17957.7	509505	240	0.03975
6 C/Q Reg3(daily)	24044.22	17996.21	719951	241	0.04715
8 Time Series	24169.886	18090.27	N/A	242	N/A

Appendix B
Homme Dam Hydrology and Nutrient Budgets

Hydrology Budget for Existing Conditions

For input into the water quality model, a hydrology budget for Homme Dam was developed for the average annual growing season (April - November) for the years 2010 and 2011. **Table 1** lists the terms in the hydrology budget along with the corresponding data sources and estimation method for each term. **Figure 1** shows the resulting volumes for each term of the hydrologic budget.

Table 1: Hydrology Budget Terms and Data Sources / Estimation Methods.

Hydrology Budget Term	Data Source / Estimation Method
Precipitation to Lake Surface	46-year average for period of record from National Climatic Data Center station near Park River, ND (Station ND326857). Multiplied by surface area of lake to estimate volume.
Gaged Surface Water Runoff	Average of 2010/2011, April-November streamflow data provided by NDDoH
Ungaged Surface Water Runoff	Unit runoff from gaged streamflow provided by NDDoH applied to the ungaged drainage area
Lake Evaporation	47-year average for period of record from National Climatic Data Center station near Park River, ND (Station ND326857). Multiplied by surface area of lake to estimate volume.
Groundwater	No estimate – this term is lumped into error term
Surface Water Outflow	Average of 2010/2011 outflow data provided by NDDoH
Net Groundwater, Retained Water & Error	By difference of water in minus water out

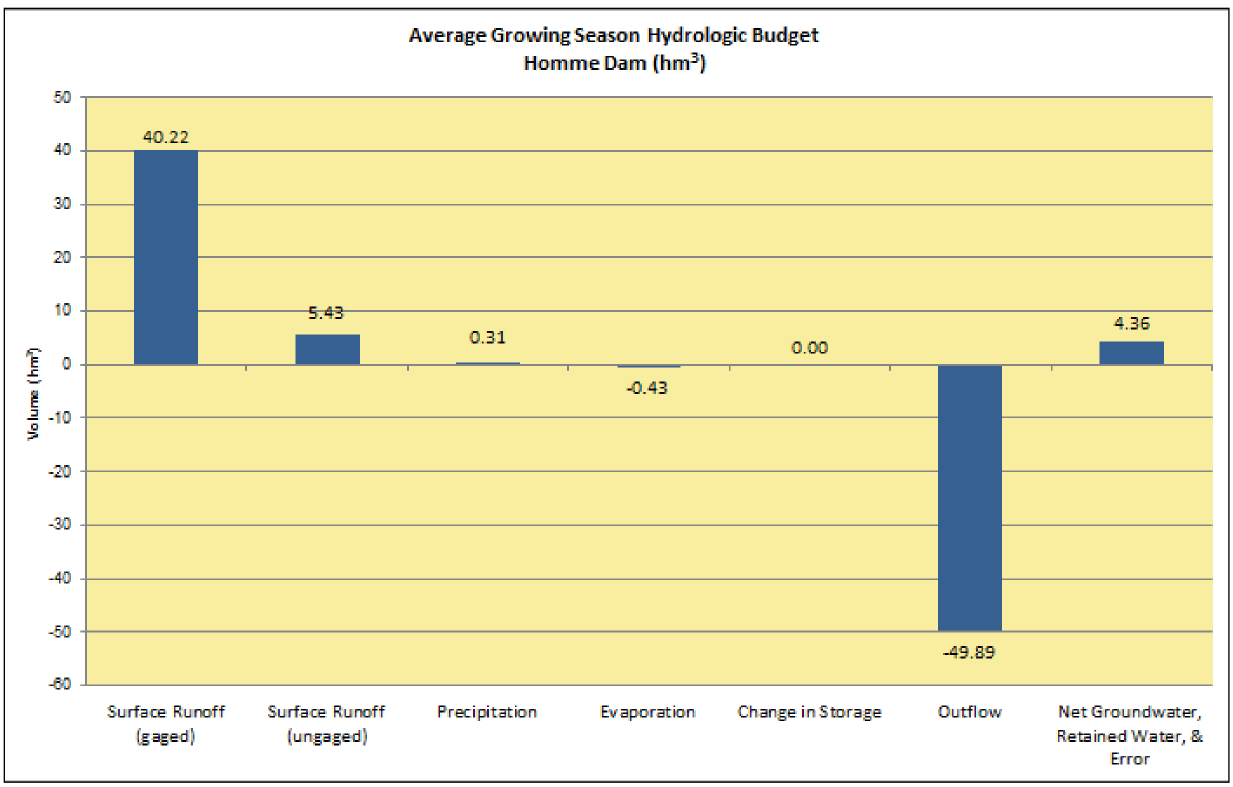


Figure 1: Homme Dam April through November Hydrologic Budget (Average of 2010 and 2011).

The 2010 and 2011 average unit runoff in inches over the growing season for the gaged inlet (181.3 mi^2) was estimated at 3.37 inches. For comparison, **Table 2** shows the average growing season (April - November) unit runoff computed for four nearby USGS Gages.

Table 2: Unit Runoff over Growing Season for nearby USGS Gages

USGS Gage	Period of Record	Drainage Area (mi^2)	% Contributing Area	Average Unit Runoff (inches)
USGS 05088000 SOUTH BRANCH PARK RIVER NR PARK RIVER, ND	1940 – 1949	214	100 %	1.97
USGS 05089100 MIDDLE BRANCH PARK RIVER NR UNION, ND	1966 – 1981	15.3	100 %	1.65
USGS 05083600 MIDDLE BRANCH FOREST RIVER NR WHITMAN, ND	1961 – 1989	47.7	81 %	0.72
USGS 05084000 FOREST RIVER NR FORDVILLE, ND	1940 – 2010	456	74 %	1.06

Total Phosphorus Mass Balance for Existing Conditions

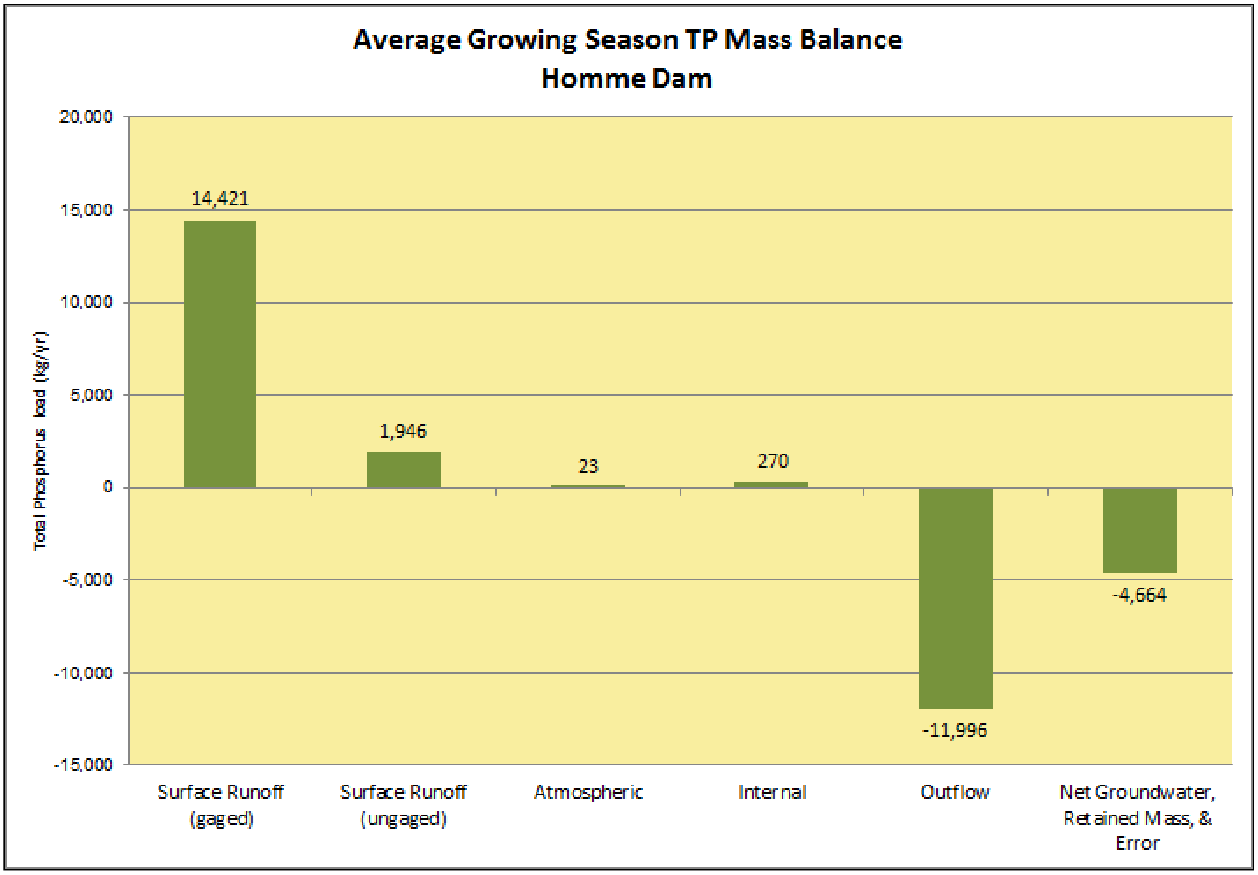
For input into the water quality model, a total phosphorus mass balance for Homme Dam was developed for the average annual growing season (April – November). **Table 3** shows the estimated terms for the TP budget and the corresponding data sources and estimation methods. **Figure 2** shows the resulting loads for each mass balance term. The percentage of the total phosphorus load retained by Homme Dam is 28 % assuming the net groundwater, retained mass and error term is in fact retained mass.

Table 3: Total Phosphorus Mass Balance Terms and Data Sources / Estimation Methods

TP Mass Balance Term	Data Source / Estimation Method
Gaged Surface Water Runoff	FLUX estimated values based on data provided by NDDoH
Ungaged Surface Water Runoff	Unit yield computed from the FLUX estimated load for the gaged drainage area applied to the ungaged drainage area
Atmospheric Deposition to the Lake Surface	Values from NDDoH Atmospheric Deposition Program [3]
Internal Loading	Median predicted release rate for 30 Minnesota lakes (1.48 mg/m^2-day)
Groundwater	No estimate – this term is lumped into error term
Surface Water Outflow	FLUX estimated values based on data provided by NDDoH
Net Groundwater, Retained mass & Error	By difference of mass in minus mass out

[3] "Ambient Air Quality, Precipitation Chemistry and Atmospheric Deposition in North Dakota, 1980-1984." North Dakota State Department of Health. Mark R. Deutschman and Michael J. Ell, October, 1986.

Figure 2: Homme Dam April through November Total Phosphorus Mass Balance (Average of 2010 and 2011).



Appendix C
A Calibrated Trophic Response Model (CNET) for Homme Dam

Homme Dam

Existing Conditions BATHTUB/CNET Model and Estimate of Loading Capacity

The CNET model was selected to simulate the eutrophication response within Homme Dam. CNET is a modified version of the BATHTUB water quality model (http://wwwalker.net/bathtub/index.htm), which performs water and nutrient balance calculations in a steady state. CNET is a spreadsheet model currently available as a "beta" version from Dr. William W. Walker. The primary benefit of using CNET over BATHTUB is that the user can modify the CNET model to implement a Monte Carlo approach. To complete the Monte Carlo modeling, the CNET model was linked with a program called Crystal Ball. Crystal Ball is proprietary software developed by Oracle (http://www.oracle.com/us/products/applications/crystalball/index.html) and is applicable to Monte Carlo or stochastic simulation and analysis. Stochastic modeling is an approach where model parameters and input values (*e.g.*, precipitation) used in the equations to compute the annual mean concentration of total phosphorus (TP), chorophyll-a (chl-*a*), and Secchi Disk (SD) are allowed to vary according to their statistical distribution and therefore their probability of occurrence. This allows the effect of parameter uncertainty and normal variability in the inputs (*e.g.*, amount of surface runoff which varies annually depending upon the amount of precipitation) to be quantified when computing the summer season mean concentration of TP, chl-*a*, and SD.

The Crystal Ball software performed multiple probabilistic simulations of the water quality model. Many trial values (1,000 trials in this study case) were generated, with each trial representing a different permutation of model parameters and input values within the bounds established by the statistical distributions. The many trials resulted in a computed distribution of annual mean TP concentrations rather than a single, fixed output based upon only one possible combination of model parameters and inputs. **Table 1** shows the values which were allowed to vary in the Monte Carlo simulation and the statistical distribution for each parameter. The other necessary inputs to the CNET model (the internal loading and groundwater + error terms, for example) were held constant throughout all model simulations.

The input parameters to the CNET model consist of the volumes and loads resulting from the hydrologic budget and TP mass balance, both based on 2010 and 2011 growing season averages, as described in this memo. Prior to completing the Monte Carlo modeling analysis, the Homme Lake CNET model was calibrated to the average 2010/2011 mean growing season in-lake measured TP, chl-*a*, and SD, as provided by the NDDoH. **Table 2** presents the details of the in-lake water quality data.

Table 1: Model Inputs used in the Monte Carlo Analysis.

Model Input	Statistical Distribution	Basis for Distribution	Distribution Truncated at Extreme Values?	Correlation	
				Considered?	Input Correlated With
Precipitation	Weibull	1949 – 1994 NCDC station near Park River, ND (ND326857)	Yes	Yes	Evaporation- -
Evaporation	Beta	1949 – 1995 NCDC station near Park River, ND (ND326857)	Yes	Yes	Precipitation
Atmospheric Load	Uniform	Distribution Assumed	No	No	- -
Surface Runoff Volume	Weibull	1940 – 2010 Apr–Nov volume USGS 05084000 Forest River NR Fordville, ND	Yes	Yes	Surface Runoff Load
Surface Runoff Load	Weibull	Assumed same distribution as Runoff Volume	Yes	Yes	Surface Runoff Volume

Table 2: 2010/2011 Growing Season In-Lake Water Quality Data

Statistic	TP (µg/L)			Chl-A (µg/L)			Secchi Depth (m)		
	2010	2011	Ave.	2010	2011	Ave.	2010	2011	Ave.
n	27	29	- -	9	10	- -	9	10	- -
Average	338	233	286	13.3	20.5	16.9	1.3	1.3	1.3
Minimum	194	117	156	0.8	0.8	0.8	0.6	0.4	0.5
Maximum	884	904	894	36.7	61.4	49.1	2.7	2.1	2.4
Median	302	184	243	12.2	17.9	15.1	1.2	1.4	1.3
25th Percentile	276	162	219	0.8	3.7	2.2	0.8	0.9	0.9
50th Percentile	302	184	243	12.2	19.8	16.0	1.2	1.4	1.3
75th Percentile	366	219	293	14.8	38.7	26.8	1.6	1.6	1.6
Std.Dev	143	175	159	14.3	20.7	17.5	0.7	0.5	0.6

The following CNET models were used in the simulations:

- Total phosphorus sedimentation model: First-order settling;
- Chlorophyll-*a* response model: P, Light, Flushing; and
- Secchi-disk Transparency response model: Secchi vs. Chl-a and Turbidity.

The goal of the CNET model calibration was to adjust each sedimentation and response models' calibration coefficient to reduce the errors between observed and simulated values. **Table 3** shows the results of model calibration.

Table 3: CNET Model Calibration Results for the Average 2010-2011 Growing Seasons

Parameter	Calibration Coefficient	Measured (2010)	Modeled	Absolute Difference	Percent Difference
Total Phosphorus	0.3	286 ppb	285 ppb	-1.0 ppb	-0.3 %
Chlorophyll-a	1.1	16.9 ppb	16.9 ppb	0.0 ppb	0.0 %
Secchi Disk	1.59	1.3 meters	1.3 meters	0.0 meters	0.0 %

Eutrophication Response

Based on guidance provided by the NDDoH, an in-lake growing season average Chl-a concentration goal of 20 µg/L has been established for Homme Dam. Based on the in-lake measured data for 2010 and 2011, the growing season average chlorophyll-a concentration for Homme Dam is an estimated to be 16.9 µg/L. Therefore, the TMDL equation was developed assuming no future degradation of water quality within the lake (i.e., a lake protection strategy); i.e., the loading capacity associated with a mean chlorophyll-a concentration of 16.9 µg/l.

Incremental reductions in the growing season loads were simulated to show the effect of lowering TP loads to Homme Dam. A series of model scenarios were performed, where each scenario reflected an incremental reduction of 10% of the total growing season load to Homme Dam. **Figure 2** in **Appendix B** shows the 2010-2011 average TP mass balance for Homme Dam (i.e., developed over the average 2010 and 2011 growing season, from April through November used in the CNET model). These results show that Homme Dam currently receives an estimated total growing season TP load of 16,660 kg. About 16,367 kg of that TP comes from surface water runoff; 270 kg from internal loading, and 23 kg from atmospheric deposition. The total TP loads entering the lake were incrementally reduced by 10%, 20%, 30%, 40%, 50%, 60% within the CNET model to evaluate the lake's eutrophication response.

Figures 1-6 show the effects of reducing April through November TP loads to Homme Dam for the mean TP, Chl-*a* and Secchi disk depth within the lake (based on the CNET model). Results are presented both in terms of the seasonal mean concentrations, as shown by the column graphs, and the results of the Monte Carlo analysis. The Monte Carlo analysis results are presented as a series of lines, where each line represents a statistical distribution of the seasonal mean value for a specific TP load.

The loading capacity of Homme Dam was computed using a stochastic approach based on the hydrology and water quality simulated by the CNET model. The loading capacity (maximum allowable load) for the reservoir was defined as the growing season TP load resulting in a seasonal mean Chl-a concentration for the 50th percentile non-exceedance value of 16.9 μg/L. The mean seasonal chlorophyll-a concentration is shown by **Figure 4**. The curve nearest to the value 16.9 μg/L of chlorophyll-a for the 50 percentile value is used to estimate the loading capacity. The value of 16.9 μg/L of chlorophyll-a represents the growing season mean Chl-a eutrophication goal for nondegradation and corresponds to a TSI value of 58.3 (eutrophic). **Figure 4** shows the curve with a chlorophyll-a concentration closest to 16.9 μg/l for the 50th percentile value is for a total TP load of 9,996 during the April – November growing season. The results show the value of using a Monte Carlo approach where the underlying statistical distributions deviate considerably from a normal distribution.

Calibration of the CNET model occurred using the hydrologic budget and mass balance for the average growing season condition for the 2010/2011 period; i.e., a total phosphorus growing season mean total load of 16,660 kg. Calibration consisted of adjusting select model coefficients to achieve the average 2010/2011 growing season total phosphorus, chlorophyll-a, and secchi disk mean values. The CNET model was calibrated under "steady-state" model conditions, rather than the Monte Carlo existing conditions model. The Monte Carlo analysis was then implemented using the calibrated steady-state model (this is why the total phosphorus load monitored of 16,660 kg is greater than the Monte Carlo total phosphorus load). Unlike the steady-state model (which uses single inputs), the Monte Carlo model uses statistical distributions for several model inputs. Because many of these inputs are described by non-normal statistical distributions, results from the Monte Carlo analysis, which theoretically better reflect the range of environmental conditions, show a lower total load of 9,996 kg corresponding to the measured 2010/2011 chlorophyll-a concentration of 16.9 μg/l. Establishing the loading capacity using the growing season value of 9,996 kg is considered to more accurately reflect the true mean value and is more protective of the resource.

Figure 1: Homme Dam Growing Season (April through November) Mean TP Concentrations under Select Load Reduction Scenarios; average 2010/2011 Condition = 16,660 kg/season.

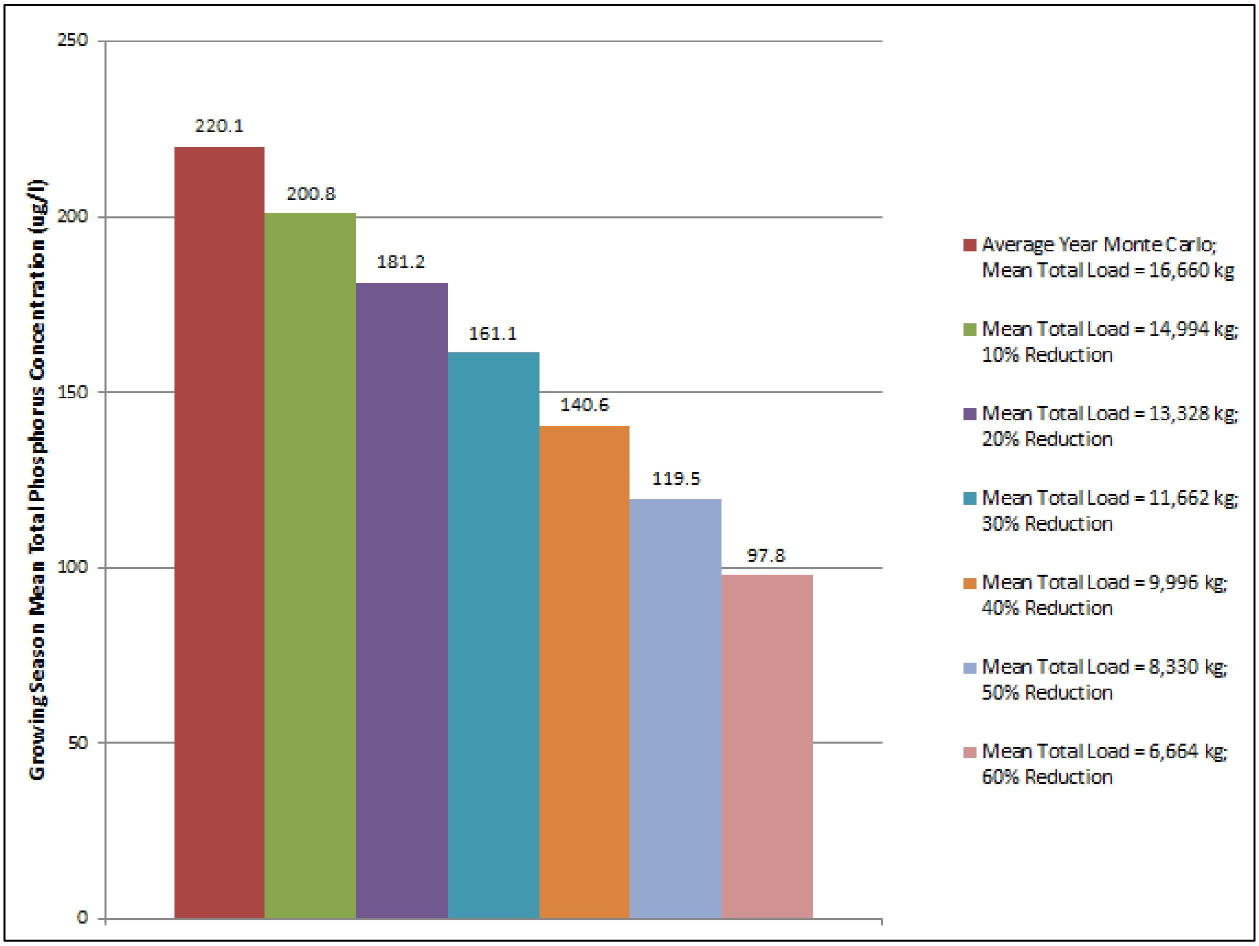


Figure 2: Homme Dam Frequency Distribution of Growing Season (April through November) Mean TP Concentrations Resulting from Select Load Reduction Scenarios; average 2010/2011 Condition = 16,660 kg/season.

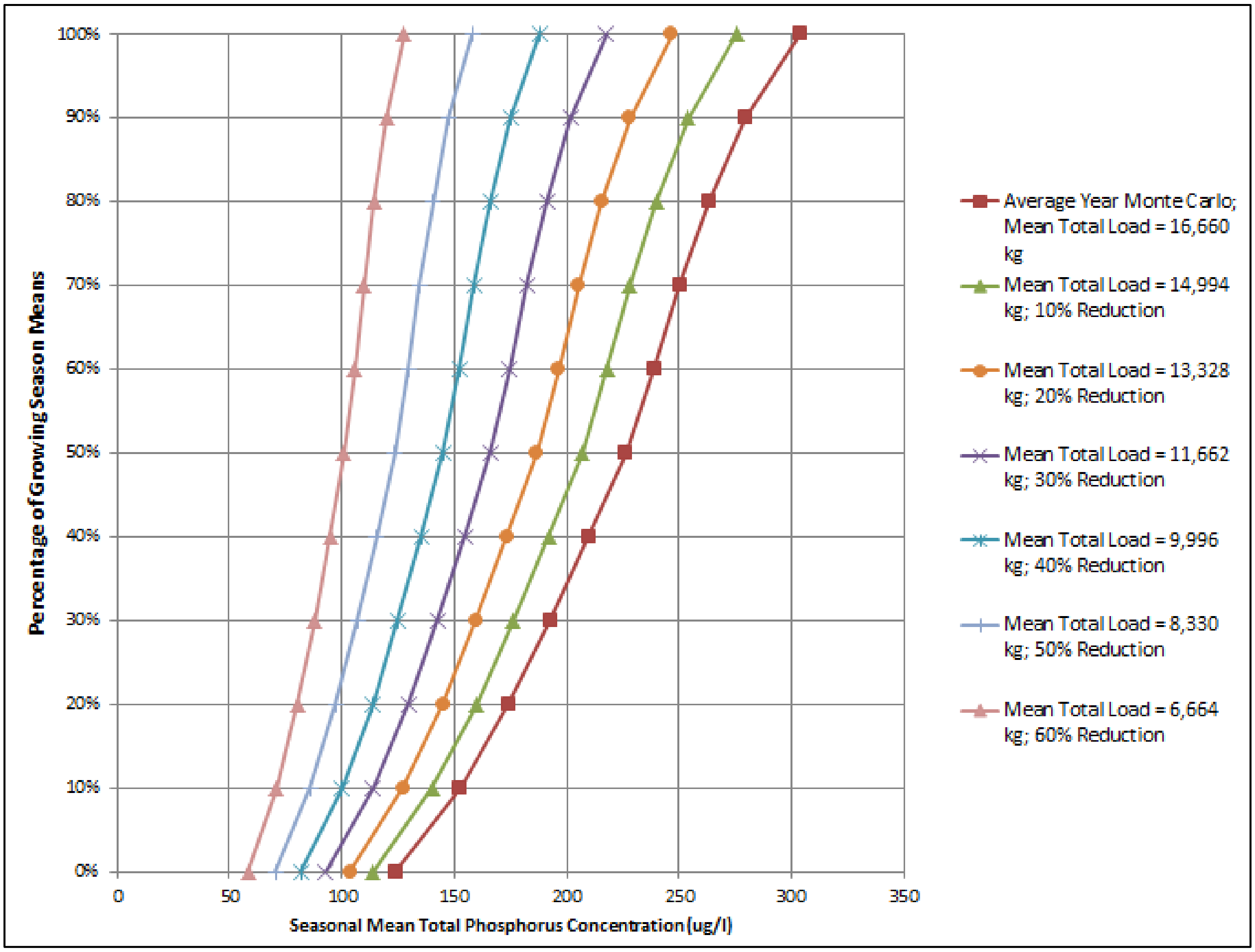


Figure 3: Homme Dam Growing Season (April through November) Mean Chl-a Concentrations under Select TP Load Reduction Scenarios; average 2010/2011 Condition = 16,660 kg/season.

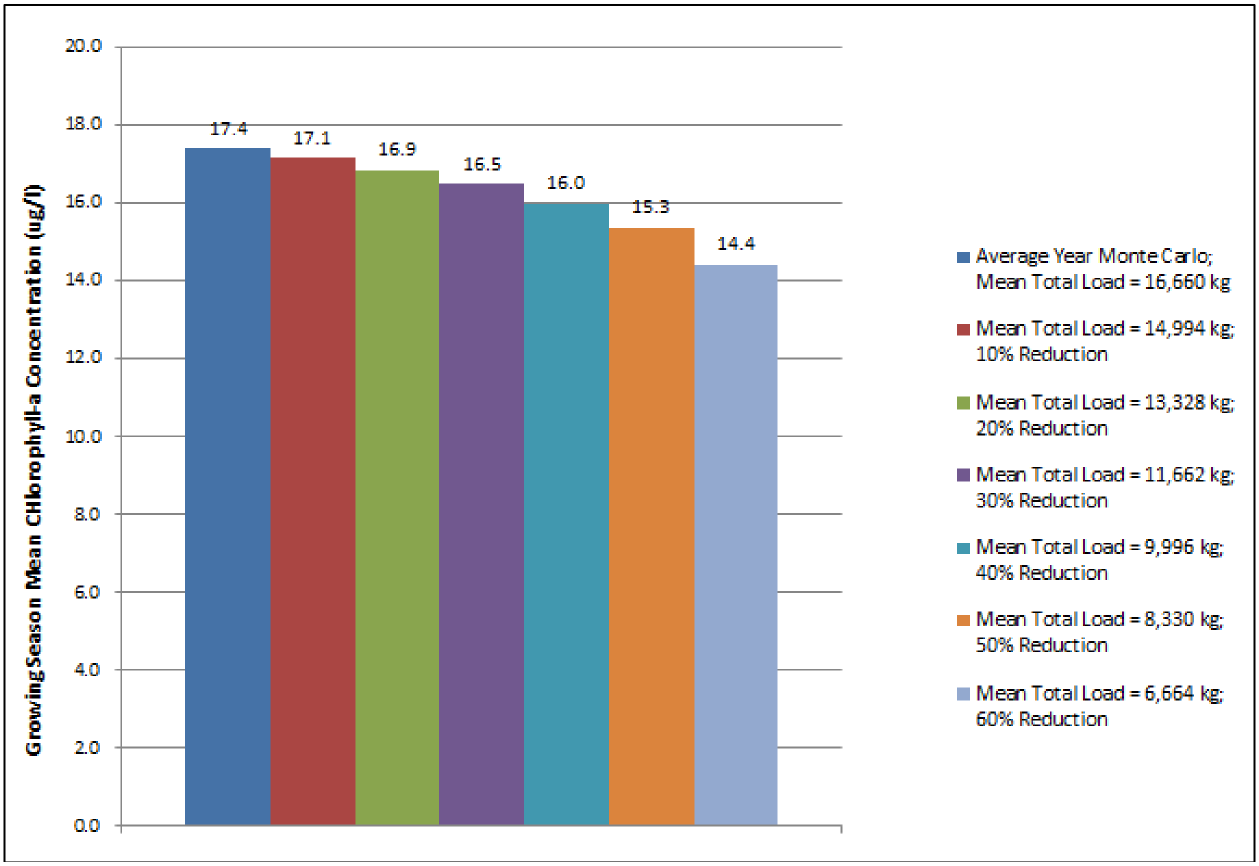


Figure 4: Homme Dam Frequency Distribution for Growing Season (April through November) Mean Chl-a Concentrations Resulting from Select Load Reduction Scenarios; average 2010/2011 Condition = 16,660 kg/season.

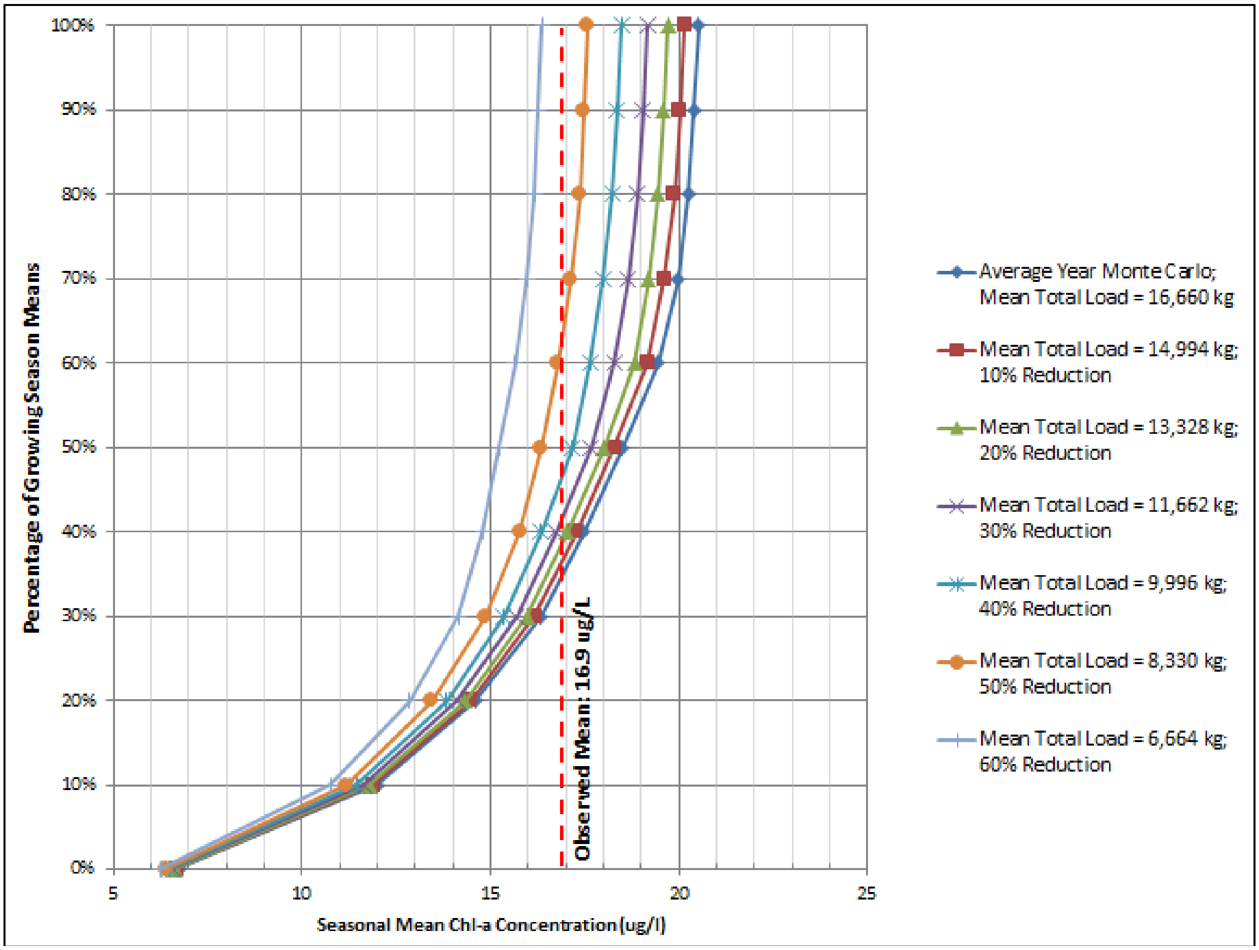


Figure 5: Homme Dam Growing Season (April through November) Mean Secchi Disk Depth under Select Load Reduction Scenarios; average 2010/2011 Condition = 16,660 kg/season.

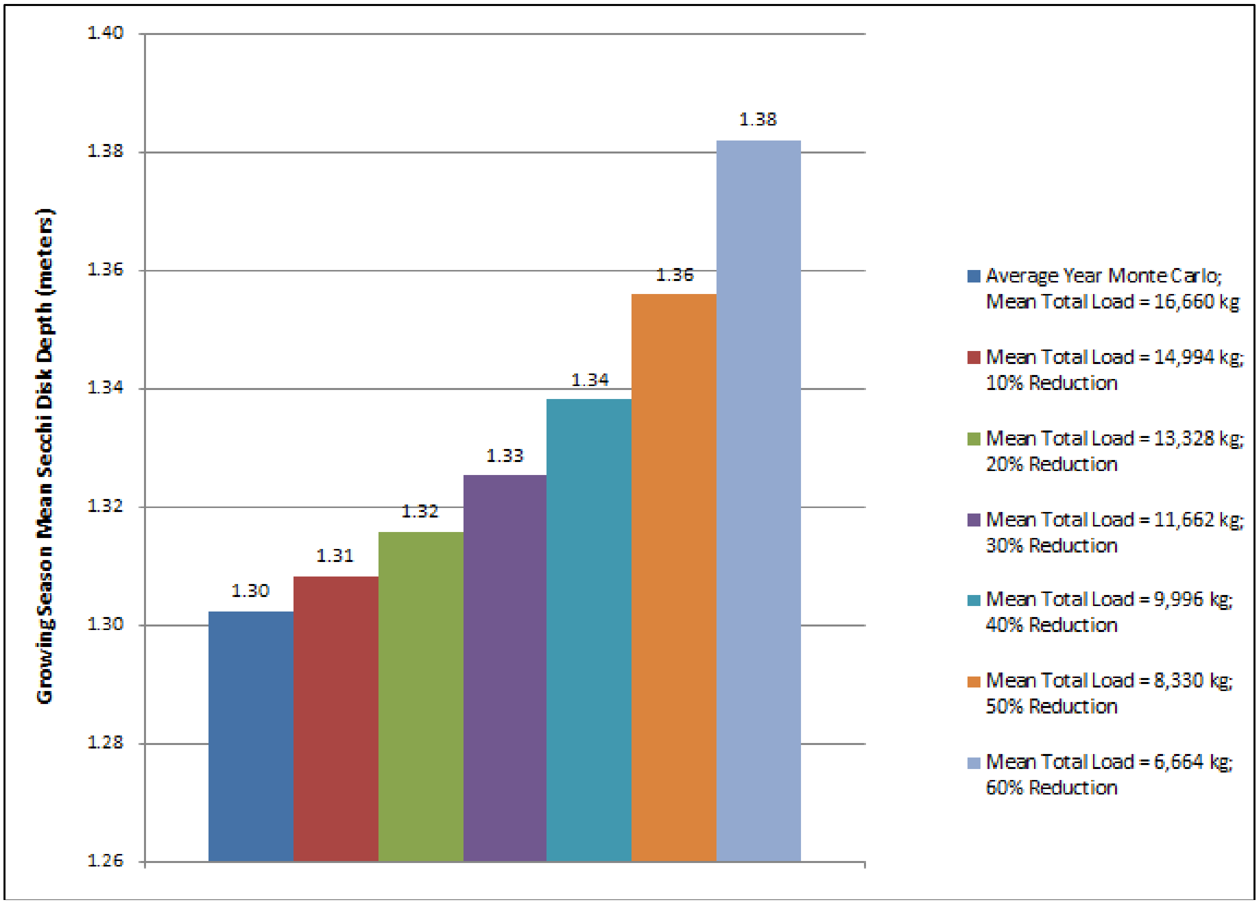
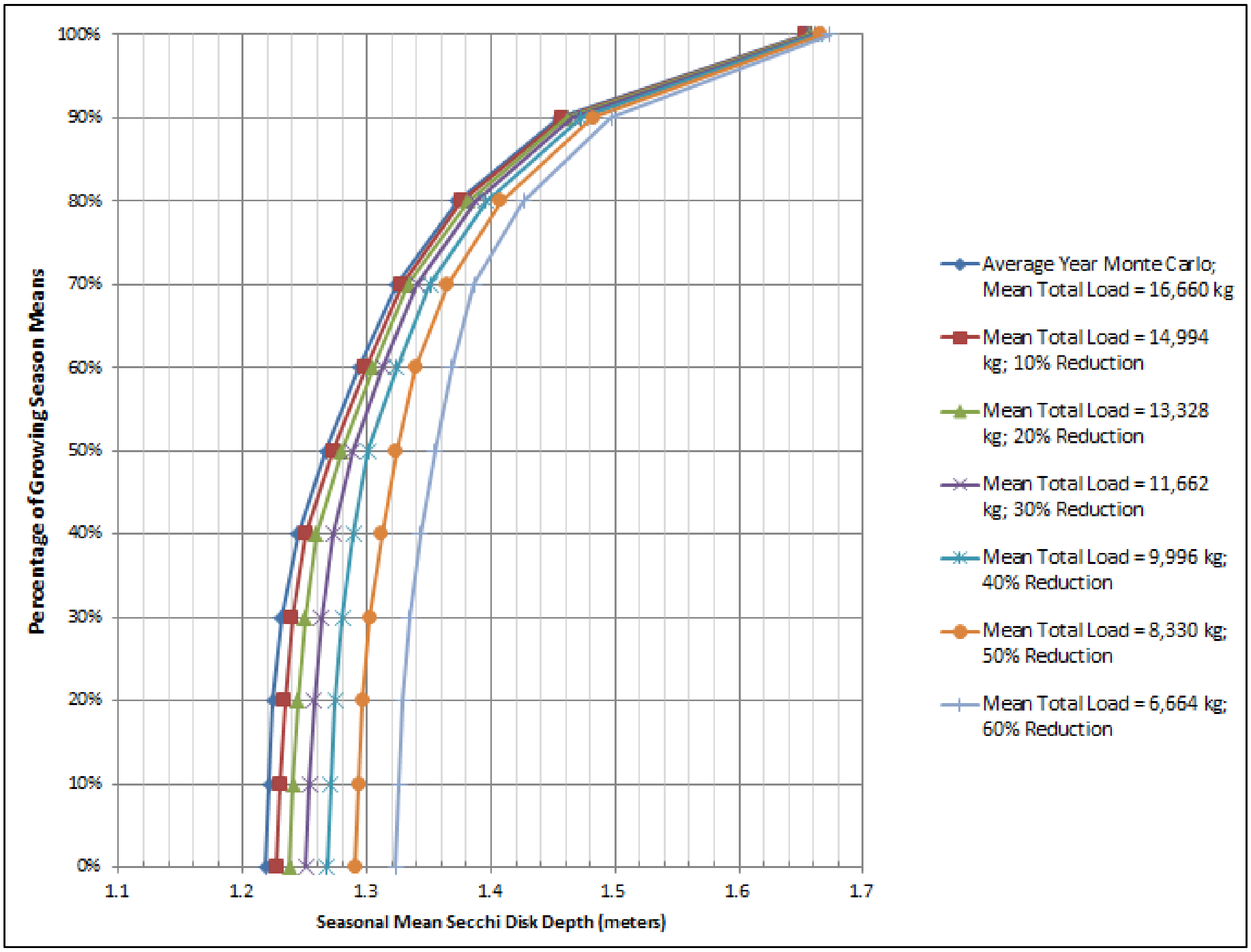


Figure 6: Homme Dam Frequency Distribution of Growing Season (April through November) Mean Secchi Disk Depth Resulting from Select Load Reduction; average 2010/2011 Condition = 16,660 kg/season.



Appendix D
US EPA Region 8 TMDL Review Form and Decision Document

EPA REGION 8 TMDL REVIEW FORM AND DECISION DOCUMENT

TMDL Document Info:

Document Name:	**Nutrient TMDL for Homme Dam in Walsh County, North Dakota**
Submitted by:	**Mike Ell, North Dakota Department of Health**
Date Received:	**August 17, 2012**
Review Date:	**September 20, 2012**
Reviewer:	**Vern Berry, US Environmental Protection Agency**
Rough Draft / Public Notice / Final Draft?	**Public Notice**
Notes:	

Reviewers Final Recommendation(s) to EPA Administrator (used for final draft review only):

☐ Approve
☐ Partial Approval
☐ Disapprove
☐ Insufficient Information

Approval Notes to the Administrator:

This document provides a standard format for EPA Region 8 to provide comments to state TMDL programs on TMDL documents submitted to EPA for either formal or informal review. All TMDL documents are evaluated against the TMDL review elements identified in the following 8 sections:

1. Problem Description
   a. TMDL Document Submittal
   b. Identification of the Waterbody, Impairments, and Study Boundaries
   c. Water Quality Standards
2. Water Quality Target
3. Pollutant Source Analysis
4. TMDL Technical Analysis
   a. Data Set Description
   b. Waste Load Allocations (WLA)
   c. Load Allocations (LA)
   d. Margin of Safety (MOS)
   e. Seasonality and variations in assimilative capacity
5. Public Participation
6. Monitoring Strategy
7. Restoration Strategy
8. Daily Loading Expression

Under Section 303(d) of the Clean Water Act, waterbodies that are not attaining one or more water quality standard (WQS) are considered “impaired.” When the cause of the impairment is determined to be a pollutant, a TMDL analysis is required to assess the appropriate maximum allowable pollutant loading rate. A TMDL document consists of a technical analysis conducted to: (1) assess the maximum pollutant loading rate that a waterbody is able to assimilate while maintaining water quality standards; and (2) allocate that assimilative capacity among the known sources of that pollutant**.** A well written TMDL document will describe a path forward that may be used by those who implement the TMDL recommendations to attain and maintain WQS.

Each of the following eight sections describes the factors that EPA Region 8 staff considers when reviewing TMDL documents. Also included in each section is a list of EPA's review elements relative to that section, a brief summary of the EPA reviewer's findings, and the reviewer's comments and/or suggestions. Use of the verb "must" in this review form denotes information that is required to be submitted because it relates to elements of the TMDL required by the CWA and by regulation. Use of the term "should" below denotes information that is generally necessary for EPA to determine if a submitted TMDL is approvable.

This review form is intended to ensure compliance with the Clean Water Act and that the reviewed documents are technically sound and the conclusions are technically defensible.

1. Problem Description

A TMDL document needs to provide a clear explanation of the problem it is intended to address. Included in that description should be a definitive portrayal of the physical boundaries to which the TMDL applies, as well as a clear description of the impairments that the TMDL intends to address and the associated pollutant(s) causing those impairments. While the existence of one or more impairment and stressor may be known, it is important that a comprehensive evaluation of the water quality be conducted prior to development of the TMDL to ensure that all water quality problems and associated stressors are identified. Typically, this step is conducted prior to the 303(d) listing of a waterbody through the monitoring and assessment program. The designated uses and water quality criteria for the waterbody should be examined against available data to provide an evaluation of the water quality relative to all applicable water quality standards. If, as part of this exercise, additional WQS problems are discovered and additional stressor pollutants are identified, consideration should be given to concurrently evaluating TMDLs for those additional pollutants. If it is determined that insufficient data is available to make such an evaluation, this should be noted in the TMDL document.

1.1 TMDL Document Submittal

When a TMDL document is submitted to EPA requesting review or approval, the submittal package should include a notification identifying the document being submitted and the purpose of the submission.

Review Elements:

☒ Each TMDL document submitted to EPA should include a notification of the document status (e.g., pre-public notice, public notice, final), and a request for EPA review.

☐ Each TMDL document submitted to EPA for final review and approval should be accompanied by a submittal letter that explicitly states that the submittal is a final TMDL submitted under Section 303(d) of the Clean Water Act for EPA review and approval. This clearly establishes the State's/Tribe's intent to submit, and EPA's duty to review, the TMDL under the statute**.** The submittal letter should contain such identifying information as the name and location of the waterbody and the pollutant(s) of concern, which matches similar identifying information in the TMDL document for which a review is being requested.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information ☐ N/A

Summary: *The notification of the availability of the public notice draft TMDL document was submitted to EPA via a letter received on August 17, 2012. The letter includes the details of the public notice, explains how to obtain a copy of the TMDL, and requests the submittal of comments to NDDoH by September 15, 2012.*

Comments: *No comments.*

1.2 Identification of the Waterbody, Impairments, and Study Boundaries

The TMDL document should provide an unambiguous description of the waterbody to which the TMDL is intended to apply and the impairments the TMDL is intended to address. The document should also clearly delineate the physical boundaries of the waterbody and the geographical extent of the watershed area studied. Any additional information needed to tie the TMDL document back to a current 303(d) listing should also be included. Review Elements: ☒ The TMDL document should clearly identify the pollutant and waterbody segment(s) for which the TMDL is being established. If the TMDL document is submitted to fulfill a TMDL development requirement for a waterbody on the state's current EPA approved 303(d) list, the TMDL document submittal should clearly identify the waterbody and associated impairment(s) as they appear on the State's/Tribe's current EPA approved 303(d) list, including a full waterbody description, assessment unit/waterbody ID, and the priority ranking of the waterbody. This information is necessary to ensure that the administrative record and the national TMDL tracking database properly link the TMDL document to the 303(d) listed waterbody and impairment(s). ☒ One or more maps should be included in the TMDL document showing the general location of the waterbody and, to the maximum extent practical, any other features necessary and/or relevant to the understanding of the TMDL analysis, including but not limited to: watershed boundaries, locations of major pollutant sources, major tributaries included in the analysis, location of sampling points, location of discharge gauges, land use patterns, and the location of nearby waterbodies used to provide surrogate information or reference conditions. Clear and concise descriptions of all key features and their relationship to the waterbody and water quality data should be provided for all key and/or relevant features not represented on the map ☒ If information is available, the waterbody segment to which the TMDL applies should be identified/geo-referenced using the National Hydrography Dataset (NHD). If the boundaries of the TMDL do not correspond to the Waterbody ID(s) (WBID), Entity ID information or reach code (RCH_Code) information should be provided. If NHD data is not available for the waterbody, an alternative geographical referencing system that unambiguously identifies the physical boundaries to which the TMDL applies may be substituted.

Recommendation:
☐ Approve ☒ Partial Approval ☐ Disapprove ☐ Insufficient Information

Summary:
Physical Setting and Listing History:
The Homme Dam reservoir is located on the South Branch of the Park River, two miles west of Park River, North Dakota. Homme Dam construction was completed in 1950 and when filled with water created a 185-acre reservoir designed for flood control and water supply benefits. The reservoir is located in Walsh County and receives water from a watershed drainage area of approximately 131,699 acres. Homme Dam is part of the Park River sub-basin which drains to the larger Red River basin watershed.

CHAPTER 33-16-02.1, Standards of Quality for Waters of the State, Appendix II, promulgated pursuant to the North Dakota Century Code 61-28-04, assigns the following classifications for Homme Dam. The bene□cial water uses and parameter limitations designated for Class I *streams shall apply to all classi□ed lakes and reservoirs. For lakes not listed, the following default classi□cation applies: Class 4.*

Homme Dam; ND-09020310-001-L_00; Class 3.

***Impairment status**:*
The 2012 North Dakota Integrated Report identifies Homme Dam as not supporting the following beneficial uses:

Assessment Unit	Designated Use / Support Status	Impairment Cause	TMDL Priority
Homme Dam ND-09020310-001-L_00	*Fish and Other Aquatic Biota / Fully Supporting but Threatened*	*Nutrient / Eutrophication Biological Indicators*	*High*
	Fish and Other Aquatic Biota / Fully Supporting but Threatened	*Sedimentation / Siltation*	*High*
	Recreation / Fully Supporting but Threatened	*Nutrient / Eutrophication Biological Indicators*	*High*

Comments: *The 2012 303(d) list shows Homme Dam as 194 acres in size. We understand that lake levels fluctuate based on yearly and seasonal precipitation patterns, however in general the TMDL should reflect the most recent listing. We suggest revising the TMDL to be consistent with the 2012 303(d) list or provide a brief explanation of why the two values are different. Table 2 in the TMDL document should also be updated to reflect the 2012 303(d) list (i.e., rather than referencing the 2010 list) and TMDL priority (i.e., it's listed as "high" priority in 2012).*

We suggest adding a sentence to Section 1.1, Clean Water Act Section 303(d) Listing Information, that addresses the sedimentation / siltation impairment in Homme Dam and include any plans for development of a TMDL to address the sediment impairment.

1.3 Water Quality Standards

TMDL documents should provide a complete description of the water quality standards for the waterbodies addressed, including a listing of the designated uses and an indication of whether the uses are being met, not being met, or not assessed. If a designated use was not assessed as part of the TMDL analysis (or not otherwise recently assessed), the documents should provide a reason for the lack of assessment (e.g., sufficient data was not available at this time to assess whether or not this designated use was being met).

Water quality criteria (WQC) are established as a component of water quality standard at levels considered necessary to protect the designated uses assigned to that waterbody. WQC identify quantifiable targets and/or qualitative water quality goals which, if attained and maintained, are intended to ensure that the designated uses for the waterbody are protected. TMDLs result in maintaining and attaining water quality standards by determining the appropriate maximum pollutant loading rate to meet water quality criteria, either directly, or through a surrogate measurable target. The TMDL document should include a description of all applicable water quality criteria for the impaired designated uses and address whether or not the criteria are being attained, not attained, or not evaluated as part of the analysis. If the criteria were not evaluated as part of the analysis, a reason should be cited (e.g. insufficient data were available to determine if this water quality criterion is being attained).

Review Elements:

☒ The TMDL must include a description of the applicable State/Tribal water quality standard, including the designated use(s) of the waterbody, the applicable numeric or narrative water quality criterion, and the anti-degradation policy. (40 C.F.R. §130.7(c)(1)).

☒ The purpose of a TMDL analysis is to determine the assimilative capacity of the waterbody that corresponds to the existing water quality standards for that waterbody, and to allocate that assimilative capacity between the identified sources. Therefore, <u>all TMDL documents must be written to meet the existing water quality standards</u> for that waterbody (CWA §303(d)(1)(C)). *Note: In some circumstances, the load reductions determined to be necessary by the TMDL analysis may prove to be infeasible and may possibly indicate that the existing water quality standards and/or assessment methodologies may be erroneous. However, the TMDL must still be determined based on existing water quality standards. Adjustments to water quality standards and/or assessment methodologies may be evaluated separately, from the TMDL.*

☒ The TMDL document should describe the relationship between the pollutant of concern and the water quality standard the pollutant load is intended to meet. This information is necessary for EPA to evaluate whether or not attainment of the prescribed pollutant loadings will result in attainment of the water quality standard in question.

☒ If a standard includes multiple criteria for the pollutant of concern, the document should demonstrate that the TMDL value will result in attainment of all related criteria for the pollutant. For example, both acute and chronic values (if present in the WQS) should be addressed in the document, including consideration of magnitude, frequency and duration requirements.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

Summary: *Homme Dam is classified as a Class 3 warm water fishery. Class 3 fisheries are defined as waterbodies "capable of supporting natural reproduction and growth of warm water fishes (i.e. largemouth bass and bluegill) and associated aquatic biota. Some cool water species may also be present." All classified lakes in North Dakota are assigned aquatic life, recreation, irrigation, livestock watering, and wildlife beneficial uses. The North Dakota State Water Quality Standards state that lakes shall use the same numeric criteria as Class 1 streams, including the State standard for dissolved nitrate as N, of 1.0 mg/L, where up to 10 percent of samples may exceed the 1.0 mg/L, and State guideline nutrient goals for lakes and reservoirs.*

Table 8. Numeric Standards Applicable for North Dakota Lakes and Reservoirs.

State Water Quality Standard	Parameter	Guidelines	Limit
Numeric Standard for Class I and Classified Lakes	Nitrates (dissolved)	1.0 mg/L	Maximum allowed[1]
Guidelines for Goals in a Lake Improvement or Maintenance Program	NO3 as N	0.25 mg/L	Goal
	PO4 as P	0.02 mg/L	Goal

[1] "Up to 10% of samples may exceed"

Homme Dam is impaired for nutrients / eutrophication / biological indicators. The North Dakota Department of Health has set narrative water quality standards that apply to all surface waters of the state. The NDDoH narrative standards that apply to nutrients include:

> *"All waters of the state shall be free from substances attributable to municipal, industrial, or other discharges or agricultural practices in concentrations or combinations which are toxic or harmful to humans, animals, plants, or resident aquatic biota." (See NDAC 33-16-02-08.1.a.(4))*

> *"No discharge of pollutants, which alone or in combination with other substances, shall:*
> *1. Cause a public health hazard or injury to environmental resources;*
> *2. Impair existing or reasonable beneficial uses of the receiving waters; or*
> *3. Directly or indirectly cause concentrations of pollutants to exceed applicable standards of the receiving waters." (See NDAC 33-16-02-08.1.e.)*

In addition to the narrative standards, the NDDH has set a biological goal for all surface waters of the state:

> *"The biological condition of surface waters shall be similar to that of sites or waterbodies determined by the department to be regional reference sites." (See NDAC 33-16-02-08.2.a.)*

Other applicable water quality standards are included on pages 10 - 11 of the TMDL report.

Comments: *No comments.*

2. Water Quality Targets

TMDL analyses establish numeric targets that are used to determine whether water quality standards are being achieved. Quantified water quality targets or endpoints should be provided to evaluate each listed pollutant/water body combination addressed by the TMDL, and should represent achievement of applicable water quality standards and support of associated beneficial uses. For pollutants with numeric water quality standards, the numeric criteria are generally used as the water quality target. For pollutants with narrative standards, the narrative standard should be translated into a measurable value. At a minimum, one target is required for each pollutant/water body combination. It is generally desirable, however, to include several targets that represent achievement of the standard and support of beneficial uses (e.g., for a sediment impairment issue it may be appropriate to include a variety of targets representing water column sediment such as TSS, embeddedness, stream morphology, up-slope conditions and a measure of biota).

Review Elements:

☒ The TMDL should identify a numeric water quality target(s) for each waterbody pollutant combination. The TMDL target is a quantitative value used to measure whether or not the applicable water quality standard is attained. *Generally, the pollutant of concern and the numeric water quality target are, respectively, the chemical causing the impairment and the numeric criteria for that chemical (e.g., chromium) contained in the water quality standard. Occasionally, the pollutant of concern is different from the parameter that is the subject of the numeric water quality target (e.g., when the pollutant of concern is phosphorus and the numeric water quality target is expressed as a numerical dissolved oxygen criterion). In such cases, the TMDL should explain the linkage between the pollutant(s) of concern, and express the quantitative relationship between the TMDL target and pollutant of concern. In all cases, TMDL targets must represent the attainment of current water quality standards.*

☒ When a numeric TMDL target is established to ensure the attainment of a narrative water quality criterion, the numeric target, the methodology used to determine the numeric target, and the link between the pollutant of concern and the narrative water quality criterion should all be described in the TMDL document. Any additional information supporting the numeric target and linkage should also be included in the document.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

Summary: *The main water quality target for this TMDL is based on interpretation of narrative provisions found in the State's water quality standards. In North Dakota, algal blooms can limit contact and immersion recreation beneficial uses. Also algal blooms can deplete oxygen levels which can affect aquatic life uses. TSI measurements can be used to estimate how much algal production may occur in lakes. Therefore, TSI is used as a measure of the narrative standard in order to determine whether beneficial uses are being met.*

The NDDoH has established an in-lake growing season average chlorophyll-a concentration goal of 20 µg/L for most lake and reservoir nutrient TMDLs, including this TMDL for Homme Dam. This chlorophyll-a goal corresponds to a chlorophyll-a TSI of 60 which is in the eutrophic range and, as such, will be a trophic state sufficient to maintain both aquatic life and recreation uses of most lakes and reservoirs in the state, including Homme Dam.

Due to the relationship between trophic status indicators and the aquatic community (as reflected by the fishery) or between trophic status indicators and the frequency of algal blooms, trophic status is an effective indicator of aquatic life and recreation use support in lakes and reservoirs. While the three trophic state indicators, chlorophyll-a, Secchi disk transparency, and total phosphorus, used in Carlson's TSI each independently estimate algal biomass and should produce the same index value for a given combination of variable values, often they do not. Transparency and phosphorus may co-vary with trophic state, many times the changes in observed in a lake's transparency are not caused by changes in algal biomass, but may be due to particulate sediment. Total phosphorus may or may not be strongly related to algal biomass due to light limitation and/or nitrogen and carbon limitation. Therefore, neither transparency nor phosphorus is an independent estimator of trophic state. For these reasons, the NDDoH gives priority to chlorophyll-a as the primary trophic state indicator because this variable is the most accurate of the three at predicting algal biomass.

The same conclusion was also reached by a multi-state project team consisting of lake managers and water quality specialists from North Dakota, South Dakota, Montana, Wyoming and EPA Region 8. This group concluded that for lakes and reservoirs in the plains region of EPA Region 8, an average growing season chlorophyll-a concentration of 20 µg/L or less should be the basis for nutrient criteria development for lakes and reservoirs in the plains region (including North Dakota) and that this chlorophyll-a target would be protective of all of a lake or reservoir's beneficial uses, including recreation and aquatic life. A report, prepared by Houston Engineering, concluded that most lakes and reservoirs in the plains region typically have high total phosphorus concentrations, but maintain relatively low productivity, and that due to this condition, chlorophyll-a is a better measure of a lake or reservoirs trophic status than is total phosphorus.

Water quality data collected in the lake in 2010 and 2011 (see Table 2 in Appendix C) showed an average chlorophyll-a concentration of 16.9 µg/L (TSI Score=58.3) and an average Secchi transparency depth of 1.3 meters (TSI Score=56.4). Based on these data, Homme Dam is generally assessed as a eutrophic lake.

Comments: *No comments.*

3. Pollutant Source Analysis

A TMDL analysis is conducted when a pollutant load is known or suspected to be exceeding the loading capacity of the waterbody. Logically then, a TMDL analysis should consider all sources of the pollutant of concern in some manner. The detail provided in the source assessment step drives the rigor of the pollutant load allocation. In other words, it is only possible to specifically allocate quantifiable loads or load reductions to each identified source (or source category) when the relative load contribution from each source has been estimated. Therefore, the pollutant load from each identified source (or source category) should be specified and quantified. This may be accomplished using site-specific monitoring data, modeling, or application of other assessment techniques. If insufficient time or resources are available to accomplish this step, a phased/adaptive management approach may be appropriate. The approach should be clearly defined in the document.

Review Elements:

☒ The TMDL should include an identification of the point and nonpoint sources of the pollutant of concern, including the geographical location of the source(s) and the quantity of the loading, e.g., lbs/per day. This information is necessary for EPA to evaluate the WLA, LA and MOS components of the TMDL.

☒ The level of detail provided in the source assessment should be commensurate with the nature of the watershed and the nature of the pollutant being studied. Where it is possible to separate natural background from nonpoint sources, the TMDL should include a description of both the natural background loads and the nonpoint source loads.

☒ Natural background loads should not be assumed to be the difference between the sum of known and quantified anthropogenic sources and the existing *in situ* loads (e.g. measured in stream) unless it can be demonstrated that the anthropogenic sources of the pollutant of concern have been identified, characterized, and quantified.

☒ The sampling data relied upon to discover, characterize, and quantify the pollutant sources should be included in the document (e.g. a data appendix) along with a description of how the data were analyzed to characterize and quantify the pollutant sources. A discussion of the known deficiencies and/or gaps in the data set and their potential implications should also be included.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

***<u>Summary</u>**: The TMDL document includes the landuse breakdown for the watershed based on the 2007 National Agricultural Statistics Service (NASS) data. In 2007, the dominant land use in the watershed that drains Homme Dam was agriculture. Approximately 58 percent of the landuse in the watershed was cropland, 22 percent was grassland/pastureland, and the remaining 9 percent was wetlands, and the remaining 11 percent was either forest, developed space, barren or fallow/idle cropland. The majority of the crops grown consisted of spring wheat, canola, barley, sunflowers and soybeans.*

TMDL identifies the major sources of phosphorus as coming from nonpoint source agricultural landuses within the watershed. There are no known point sources upstream of Homme Dam. A nutrient loading analysis was performed using the Annualized Agricultural Nonpoint Source (AnnAGNPS) model which looked at various agricultural land uses and land management *practices in the watershed (see Section 5.3 AnnAGNPS Watershed Model in the TMDL document). A three year simulation period was run on the Homme Dam watershed at its present condition to provide a best estimation of the current land use practices applied to the soils and slopes of the watershed to obtain nutrient loads from the individual cells as well as the watershed as a whole. Crop rotations were determined from 2007, 2008, and 2009 crop data from the National Agricultural Statistical Service. Over 54 different crop rotations and 29 fertilizer application rates were used to simulate current watershed landuse conditions within the Homme Dam watershed. The compiled data was used to assess the watershed to identify "critical cells" located in the watershed for potential best management practice (BMP) implementation (see Figure 11 in the TMDL document). Critical cells were determined to be cells in the watershed providing an estimated annual phosphorus yield of 0.117 lbs/acre/year or greater.*

Comments: *No comments.*

4. TMDL Technical Analysis

TMDL determinations should be supported by an analysis of the available data, discussion of the known deficiencies and/or gaps in the data set, and an appropriate level of technical analysis**.** This applies to **all** of the components of a TMDL document. It is vitally important that the technical basis for **all** conclusions be articulated in a manner that is easily understandable and readily apparent to the reader.

A TMDL analysis determines the maximum pollutant loading rate that may be allowed to a waterbody without violating water quality standards. The TMDL analysis should demonstrate an understanding of the relationship between the rate of pollutant loading into the waterbody and the resultant water quality impacts. This stressor → response relationship between the pollutant and impairment and between the selected targets, sources, TMDLs, and load allocations needs to be clearly articulated and supported by an appropriate level of technical analysis. Every effort should be made to be as detailed as possible, and to base all conclusions on the best available scientific principles.

The pollutant loading allocation is at the heart of the TMDL analysis. TMDLs apportion responsibility for taking actions by allocating the available assimilative capacity among the various point, nonpoint, and natural pollutant sources. Allocations may be expressed in a variety of ways, such as by individual discharger, by tributary watershed, by source or land use category, by land parcel, or other appropriate scale or division of responsibility.

The pollutant loading allocation that will result in achievement of the water quality target is expressed in the form of the standard TMDL equation:

$$TMDL = \sum WLAs + \sum LAs + MOS$$

Where:

TMDL	=	Total Maximum Daily Load (also called the Loading Capacity)
LAs	=	Load Allocations
WLAs	=	Wasteload Allocations
MOS	=	Margin Of Safety

Review Elements:

☒ A TMDL must identify the loading capacity of a waterbody for the applicable pollutant, taking into consideration temporal variations in that capacity. EPA regulations define loading capacity as the greatest amount of a pollutant that a water can receive without violating water quality standards (40 C.F.R. §130.2(f)).

☒ The total loading capacity of the waterbody should be clearly demonstrated to equate back to the pollutant load allocations through a balanced TMDL equation. In instances where numerous LA, WLA and seasonal TMDL capacities make expression in the form of an equation cumbersome, a table may be substituted as long as it is clear that the total TMDL capacity equates to the sum of the allocations.

☒ The TMDL document should describe the methodology and technical analysis used to establish and quantify the cause-and-effect relationship between the numeric target and the identified pollutant sources. In many instances, this method will be a water quality model.

☒ It is necessary for EPA staff to be aware of any assumptions used in the technical analysis to understand and evaluate the methodology used to derive the TMDL value and associated loading allocations. Therefore, the TMDL document should contain a description of any important assumptions (including the basis for those assumptions) made in developing the TMDL, including but not limited to:

(1) the spatial extent of the watershed in which the impaired waterbody is located and the spatial extent of the TMDL technical analysis;
(2) the distribution of land use in the watershed (e.g., urban, forested, agriculture);
(3) a presentation of relevant information affecting the characterization of the pollutant of concern and its allocation to sources such as population characteristics, wildlife resources, industrial activities etc…;
(4) present and future growth trends, if taken into consideration in determining the TMDL and preparing the TMDL document (e.g., the TMDL could include the design capacity of an existing or planned wastewater treatment facility);
(5) an explanation and analytical basis for expressing the TMDL through surrogate measures, if applicable. Surrogate measures are parameters such as percent fines and turbidity for sediment impairments; chlorophyll *a* and phosphorus loadings for excess algae; length of riparian buffer; or number of acres of best management practices.

☒ The TMDL document should contain documentation supporting the TMDL analysis, including an inventory of the data set used, a description of the methodology used to analyze the data, a discussion of strengths and weaknesses in the analytical process, and the results from any water quality modeling used. This information is necessary for EPA to review the loading capacity determination, and the associated load, wasteload, and margin of safety allocations.

☒ TMDLs must take critical conditions (e.g., steam flow, loading, and water quality parameters, seasonality, etc…) into account as part of the analysis of loading capacity (40 C.F.R. §130.7(c)(1)). TMDLs should define applicable critical conditions and describe the approach used to determine both point and nonpoint source loadings under such critical conditions. In particular, the document should discuss the approach used to compute and allocate nonpoint source loadings, e.g., meteorological conditions and land use distribution.

☐ Where both nonpoint sources and NPDES permitted point sources are included in the TMDL loading allocation, and attainment of the TMDL target depends on reductions in the nonpoint source loads, the TMDL document must include a demonstration that nonpoint source loading reductions needed to implement the load allocations are actually practicable [40 CFR 130.2(i) and 122.44(d)].

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

Summary: *The technical analysis should describe the cause and effect relationship between the identified pollutant sources, the numeric targets, and achievement of water quality standards. It should also include a description of the analytical processes used, results from water quality modeling, assumptions and other pertinent information. The technical analysis for the Homme Dam watershed TMDL describes how the nutrient loads were derived in order to meet the applicable water quality standards for the 303(d) impaired waterbody.*

In order to determine the cause and effect relationship between the water quality target and the identified sources, various models and loading analysis were utilized. The FLUX model was used to facilitate the analysis and reduction of the tributary inflow and the reservoir outflow water quality data for nutrients and sediment, as well as flow data into and out of Homme Dam. Output from the FLUX program was then used as an input file to calibrate the CNET/BATHTUB eutrophication response model. The CNET/BATHTUB model was used to evaluate and predict the effects of various nutrient reduction scenarios, and the subsequent eutrophication response in Homme Dam reservoir.

The CNET model was selected to simulate the eutrophication response within Homme Dam. CNET is a modified version of the BATHTUB water quality model. Both BATHTUB and CNET perform steady-state water and nutrient balance calculations in a spatially segmented hydraulic network. The model accounts for advective and diffusive transport and nutrient sedimentation. Eutrophication related water quality conditions are predicted using empirical relationships previously developed and tested for reservoirs. CNET is a spreadsheet model currently available as a "beta" version from Dr. William W. Walker. The primary benefit of using CNET over BATHTUB is that the user can modify the CNET model to implement a Monte Carlo approach. This allows the effect of parameter uncertainty and normal variability in the inputs (e.g., amount of surface runoff which varies annually depending upon the amount of precipitation) to be quantified when computing the mean concentration of TP, chl-a, and SD.

The loading capacity of Homme Dam was computed using a stochastic approach based on the hydrology and water quality simulated by the CNET model. The loading capacity for the *reservoir was defined as the growing season TP load resulting in a seasonal mean Chl-a concentration for the 50th percentile non-exceedance value of 16.9 µg/L. The curve nearest to the value 16.9 µg/L of chlorophyll-a for the 50 percentile value is used to estimate the loading capacity. The value of 16.9 µg/L of chlorophyll-a represents the growing season mean Chl-a eutrophication goal for nondegradation and corresponds to a TSI value of 58.3.*

Through the use CNET, the average growing season TP load, corresponding to an average growing season chlorophyll-a concentration of 20 µg/L, can be estimated. For this TMDL, a 40 percent reduction in the observed total phosphorus load, or 9,996 kg, is estimated to be needed to achieve the TMDL goal for Homme Dam. Section 5.2 and Appendix C of the TMDL document contain additional details of how the CNET model was used to in development of the nutrient TMDL for Homme Dam.

Comments: *No Comments.*

4.1 Data Set Description

TMDL documents should include a thorough description and summary of all available water quality data that are relevant to the water quality assessment and TMDL analysis. An inventory of the data used for the TMDL analysis should be provided to document, for the record, the data used in decision making. This also provides the reader with the opportunity to independently review the data. The TMDL analysis should make use of all readily available data for the waterbody under analysis unless the TMDL writer determines that the data are not relevant or appropriate. For relevant data that were known but rejected, an explanation of why the data were not utilized should be provided (e.g., samples exceeded holding times, data collected prior to a specific date were not considered timely, etc…).

Review Elements:

☒ TMDL documents should include a thorough description and summary of all available water quality data that are relevant to the water quality assessment and TMDL analysis such that the water quality impairments are clearly defined and linked to the impaired beneficial uses and appropriate water quality criteria.

☒ The TMDL document submitted should be accompanied by the data set utilized during the TMDL analysis. If possible, it is preferred that the data set be provided in an electronic format and referenced in the document. If electronic submission of the data is not possible, the data set may be included as an appendix to the document.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

Summary: *The Homme Dam TMDL data description and summary are included in the Available Water Quality Data section (Section 1.4). Recent water quality monitoring was conducted from June 2010 – September 2011 and sampling at one tributary inlet site, at the outlet from Homme Dam and at one reservoir site located in deepest area of the reservoir. Tables 6 and 7 summarize the water quality data collected in the reservoir.*

Comments: *No Comments.*

4.2 Waste Load Allocations (WLA):

Waste Load Allocations represent point source pollutant loads to the waterbody. Point source loads are typically better understood and more easily monitored and quantified than nonpoint source loads. Whenever practical, each point source should be given a separate waste load allocation. All NPDES permitted dischargers that discharge the pollutant under analysis directly to the waterbody should be identified and given separate waste load allocations. The finalized WLAs are required to be incorporated into future NPDES permit renewals.

Review Elements:

☒ EPA regulations require that a TMDL include WLAs, which identify the portion of the loading capacity allocated to individual existing and future point source(s) (40 C.F.R. §130.2(h), 40 C.F.R. §130.2(i)). In some cases, WLAs may cover more than one discharger, e.g., if the source is contained within a general permit. If no allocations are to be made to point sources, then the TMDL should include a value of zero for the WLA.

☐ All NPDES permitted dischargers given WLA as part of the TMDL should be identified in the TMDL, including the specific NPDES permit numbers, their geographical locations, and their associated waste load allocations.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

***Summary**: There are no permitted point sources in the Homme Dam watershed. Therefore the WLA for this TMDL is zero (see Table 11 in the TMDL document).*

***Comments**: No comments.*

4.3 Load Allocations (LA):

Load allocations include the nonpoint source, natural, and background loads. These types of loads are typically more difficult to quantify than point source loads, and may include a significant degree of uncertainty. Often it is necessary to group these loads into larger categories and estimate the loading rates based on limited monitoring data and/or modeling results. The background load represents a composite of all upstream pollutant loads into the waterbody. In addition to the upstream nonpoint and upstream natural load, the background load often includes upstream point source loads that are not given specific waste load allocations in this particular TMDL analysis. In instances where nonpoint source loading rates are particularly difficult to quantify, a performance-based allocation approach, in which a detailed monitoring plan and adaptive management strategy are employed for the application of BMPs, may be appropriate.

Review Elements:

☒ EPA regulations require that TMDL expressions include LAs which identify the portion of the loading capacity attributed to nonpoint sources and to natural background. Load allocations may range from reasonably accurate estimates to gross allotments (40 C.F.R. §130.2(g)). Load allocations may be included for both existing and future nonpoint source loads. Where possible, load allocations should be described separately for natural background and nonpoint sources.

☒ Load allocations assigned to natural background loads should not be assumed to be the difference between the sum of known and quantified anthropogenic sources and the existing *in situ* loads (e.g., measured in stream) unless it can be demonstrated that the anthropogenic sources of the pollutant of concern have been identified and given proper load or waste load allocations.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

<u>Summary</u>: *The Technical Analysis section of the TMDL describes how the phosphorus loading capacity for the reservoir was derived and allocated to sources in the watershed. There are no point sources in the watershed upstream of Homme Dam; therefore most of the loading capacity was allocated to nonpoint sources in the watershed. Ten percent of the loading capacity was allocated as an explicit margin of safety. See Table 11 in the TMDL document for the specific allocation values.*

<u>Comments</u>: *No comments.*

4.4 Margin of Safety (MOS):

Natural systems are inherently complex. Any mathematical relationship used to quantify the stressor → response relationship between pollutant loading rates and the resultant water quality impacts, no matter how rigorous, will include some level of uncertainty and error. To compensate for this uncertainty and ensure water quality standards will be attained, a margin of safety is required as a component of each TMDL. The MOS may take the form of a explicit load allocation (e.g., 10 lbs/day), or may be implicitly built into the TMDL analysis through the use of conservative assumptions and values for the various factors that determine the TMDL pollutant load → water quality effect relationship. Whether explicit or implicit, the MOS should be supported by an appropriate level of discussion that addresses the level of uncertainty in the various components of the TMDL technical analysis, the assumptions used in that analysis, and the relative effect of those assumptions on the final TMDL. The discussion should demonstrate that the MOS used is sufficient to ensure that the water quality standards would be attained if the TMDL pollutant loading rates are met. In cases where there is substantial uncertainty regarding the linkage between the proposed allocations and achievement of water quality standards, it may be necessary to employ a phased or adaptive management approach (e.g., establish a monitoring plan to determine if the proposed allocations are, in fact, leading to the desired water quality improvements).

Review Elements:

☒ TMDLs must include a margin of safety (MOS) to account for any lack of knowledge concerning the relationship between load and wasteload allocations and water quality (CWA §303(d) (1) (C), 40 C.F.R. §130.7(c)(1)). EPA's 1991 TMDL Guidance explains that the MOS may be implicit (i.e., incorporated into the TMDL through conservative assumptions in the analysis) or explicit (i.e., expressed in the TMDL as loadings set aside for the MOS).

☐ <u>If the MOS is implicit</u>, the conservative assumptions in the analysis that account for the MOS should be identified and described. The document should discuss why the assumptions are considered conservative and the effect of the assumption on the final TMDL value determined.

☒ If the MOS is explicit, the loading set aside for the MOS should be identified. The document should discuss how the explicit MOS chosen is related to the uncertainty and/or potential error in the linkage analysis between the WQS, the TMDL target, and the TMDL loading rate.

☐ If, rather than an explicit or implicit MOS, the TMDL relies upon a phased approach to deal with large and/or unquantifiable uncertainties in the linkage analysis, the document should include a description of the planned phases for the TMDL as well as a monitoring plan and adaptive management strategy.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

Summary: *The Homme Dam TMDL includes an explicit MOS derived by calculating 10 percent of the loading capacity.*

Comments*: No comments.*

4.5 Seasonality and variations in assimilative capacity:

The TMDL relationship is a factor of both the loading rate of the pollutant to the waterbody and the amount of pollutant the waterbody can assimilate and still attain water quality standards. Water quality standards often vary based on seasonal considerations. Therefore, it is appropriate that the TMDL analysis consider seasonal variations, such as critical flow periods (high flow, low flow), when establishing TMDLs, targets, and allocations.

Review Elements:

☒ The statute and regulations require that a TMDL be established with consideration of seasonal variations. The TMDL must describe the method chosen for including seasonal variability as a factor. (CWA §303(d)(1)(C), 40 C.F.R. §130.7(c)(1)).

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

Summary*: Section 303(d)(1)(C) of the Clean Water Act and the EPA's regulations require that a TMDL be established with seasonal variations. The Homme Dam TMDL addresses seasonality because the CNET and AnnAGNPS models incorporate seasonal differences in their prediction of annual total phosphorus and nitrogen loadings.*

Comments*: No comments.*

5. Public Participation

EPA regulations require that the establishment of TMDLs be conducted in a process open to the public, and that the public be afforded an opportunity to participate. To meaningfully participate in the TMDL process it is necessary that stakeholders, including members of the general public, be able to understand the problem and the proposed solution. TMDL documents should include language that explains the issues to the general public in understandable terms, as well as provides additional detailed technical information for the scientific community. Notifications or solicitations for comments regarding the TMDL should be made available to the general public, widely circulated, and clearly identify the product as a TMDL and the fact that it will be submitted to EPA for review. When the final TMDL is submitted to EPA for approval, a copy of the comments received by the state and the state responses to those comments should be included with the document.

Review Elements:

☒ The TMDL must include a description of the public participation process used during the development of the TMDL (40 C.F.R. §130.7(c)(1)(ii)).

☐ TMDLs submitted to EPA for review and approval should include a summary of significant comments and the State's/Tribe's responses to those comments.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

Summary: *The TMDL document includes a summary of the public participation process that has occurred. It describes the opportunities the public had to be involved in the TMDL development process. Letters notifying stakeholders of the availability of the draft TMDL document were mailed to stakeholders in the watershed during public comment. Also, the draft TMDL document was posted on NDoDH's Water Quality Division website, and a public notice for comment was published in local newspapers.*

Comments: *No comments.*

6. Monitoring Strategy

TMDLs may have significant uncertainty associated with the selection of appropriate numeric targets and estimates of source loadings and assimilative capacity. In these cases, a phased TMDL approach may be necessary. For Phased TMDLs, it is EPA's expectation that a monitoring plan will be included as a component of the TMDL document to articulate the means by which the TMDL will be evaluated in the field, and to provide for future supplemental data that will address any uncertainties that may exist when the document is prepared.

Review Elements:

☐ When a TMDL involves both NPDES permitted point source(s) and nonpoint source(s) allocations, and attainment of the TMDL target depends on reductions in the nonpoint source loads, the TMDL document should include a monitoring plan that describes the additional data to be collected to determine if the load reductions provided for in the TMDL are occurring.

☐ Under certain circumstances, a phased TMDL approach may be utilized when limited existing data are relied upon to develop a TMDL, and the State believes that the use of additional data or data based on better analytical techniques would likely increase the accuracy of the TMDL load calculation and merit development of a second phase TMDL. EPA recommends that a phased TMDL document or its implementation plan include a monitoring plan and a scheduled timeframe for revision of the TMDL. These elements would not be an intrinsic part of the TMDL and would not be approved by EPA, but may be necessary to support a rationale for approving the TMDL. http://www.epa.gov/owow/tmdl/tmdl_clarification_letter.pdf

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

Summary: *To insure that the BMPs implemented as a part of any watershed restoration plan will reduce phosphorus levels, water quality monitoring will be conducted in accordance with an approved Quality Assurance Project Plan. Specifically, monitoring will be conducted for all variables that are currently causing impairments to the beneficial uses of the waterbody. Once a watershed restoration plan (e.g. 319 PIP) is implemented, monitoring will be conducted in the lake/reservoir beginning two years after implementation and extending five years after the implementation project is complete.*

The TMDL in this report is a plan to improve water quality by implementing BMPs through a volunteer, incentive-based approach. This TMDL plan is put forth as a recommendation to what needs to be accomplished for Homme Dam and its watershed to meet and protect its beneficial uses. Water quality monitoring should continue to assess the effects of recommendations made in this TMDL. Monitoring may indicate that loading capacity recommendations be adjusted.

Comments: *No comments.*

7. Restoration Strategy

The overall purpose of the TMDL analysis is to determine what actions are necessary to ensure that the pollutant load in a waterbody does not result in water quality impairment. Adding additional detail regarding the proposed approach for the restoration of water quality is not currently a regulatory requirement, but is considered a value added component of a TMDL document. During the TMDL analytical process, information is often gained that may serve to point restoration efforts in the right direction and help ensure that resources are spent in the most efficient manner possible. For example, watershed models used to analyze the linkage between the pollutant loading rates and resultant water quality impacts might also be used to conduct "what if" scenarios to help direct BMP installations to locations that provide the greatest pollutant reductions. Once a TMDL has been written and approved, it is often the responsibility of other water quality programs to see that it is implemented. The level of quality and detail provided in the restoration strategy will greatly influence the future success in achieving the needed pollutant load reductions.

Review Elements:

☐ EPA is not required to and does not approve TMDL implementation plans. However, in cases where a WLA is dependent upon the achievement of a LA, "reasonable assurance" is required to demonstrate the necessary LA called for in the document is practicable. A discussion of the BMPs (or other load reduction measures) that are to be relied upon to achieve the LA(s), and programs and funding sources that will be relied upon to implement the load reductions called for in the document, may be included in the implementation/restoration section of the TMDL document to support a demonstration of "reasonable assurance".

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

Summary: *Implementation of this TMDL is dependent upon the availability of Section 319 NPS funds or other watershed restoration programs (e.g. USDA EQIP), as well as securing a local project sponsor and the required matching funds. Provided these three requirements are in place, a project implementation plan (PIP) will be developed in accordance with the TMDL and submitted to the North Dakota Nonpoint Source Pollution Task Force and US EPA for approval. The implementation of the BMPs contained in the NPS PIP is voluntary. Therefore, success of any TMDL implementation project is ultimately dependent on the ability of the local project sponsor to find cooperating producers.*

Comments: *No comments.*

8. Daily Loading Expression

The goal of a TMDL analysis is to determine what actions are necessary to attain and maintain WQS. The appropriate averaging period that corresponds to this goal will vary depending on the pollutant and the nature of the waterbody under analysis. When selecting an appropriate averaging period for a TMDL analysis, primary concern should be given to the nature of the pollutant in question and the achievement of the underlying WQS. However, recent federal appeals court decisions have pointed out that the title TMDL implies a "daily" loading rate. While the most appropriate averaging period to be used for developing a TMDL analysis may vary according to the pollutant, a daily loading rate can provide a more practical indication of whether or not the overall needed load reductions are being achieved. When limited monitoring resources are available, a daily loading target that takes into account the natural variability of the system can serve as a useful indicator for whether or not the overall load reductions are likely to be met. Therefore, a daily expression of the required pollutant loading rate is a required element in all TMDLs, in addition to any other load averaging periods that may have been used to conduct the TMDL analysis. The level of effort spent to develop the daily load indicator should be based on the overall utility it can provide as an indicator for the total load reductions needed.

Review Elements:

☒ The document should include an expression of the TMDL in terms of a daily load. However, the TMDL may also be expressed in temporal terms other than daily (e.g., an annual or monthly load). If the document expresses the TMDL in additional "non-daily" terms the document should explain why it is appropriate or advantageous to express the TMDL in the additional unit of measurement chosen.

Recommendation:
☒ Approve ☐ Partial Approval ☐ Disapprove ☐ Insufficient Information

Summary: *The Homme Dam nutrient TMDL includes a daily phosphorus load expressed as 27.4 kg per day. The NDDoH believes that describing the phosphorus load as an annual load is more realistic and protective of the waterbody. Most phosphorus based eutrophication models use annual phosphorus loads, because seasonality and unpredictable precipitation patterns make a daily load unrealistic. EPA recognizes that, under the specific circumstances, the state may deem the annual load the most appropriate timeframe (i.e., the TSI water quality target is based on an interpretation of narrative water quality standards which naturally does not include an averaging period). EPA notes that the Homme Dam TMDL calculations for phosphorus include an approximated daily load derived through simple division of the annual load by the number of days in a year. This should be considered an "average" daily load that typically will not match the actual phosphorus load reaching the reservoir on a given day.*

Comments: *No comments.*

Appendix E
NDDoH's Response to Comments Received from US EPA Region 8

<u>US EPA Region 8 Comments:</u> The 2012 303(d) list shows Homme Dam as 194 acres in size. We understand that lake levels fluctuate based on yearly and seasonal precipitation patterns, however in general the TMDL should reflect the most recent listing. We suggest revising the TMDL to be consistent with the 2012 303(d) list or provide a brief explanation of why the two values are different. Table 2 in the TMDL document should also be updated to reflect the 2012 303(d) list (i.e., rather than referencing the 2010 list) and TMDL priority (i.e., it's listed as "high" priority in 2012).

We suggest adding a sentence to Section 1.1, Clean Water Act Section 303(d) Listing Information, that addresses the sedimentation / siltation impairment in Homme Dam and include any plans for development of a TMDL to address the sediment impairment.

<u>NDDoH Response to Comments:</u> Section 1.1 and the accompanying Table 2 have been revised to reflect the most recent 2012 Section 303(d) listing information, including the lake's size as 194-acres and the TMDL priority as "high". In addition, an additional paragraph has been added to the end of Section 1.1 describing plans for the sediment TMDL.