UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 Sixth Avenue, Suite 900
Seattle, WA 98101-3140

OFFICE OF
WATER AND WATERSHEDS

Ms. Michelle Bonnet, Director
Water Division
Department of Environmental Conservation
555 Cordova Street
Anchorage, Alaska 99501-2617

JUN 14 2012

Re: Approval of the Big Lake Petroleum Hydrocarbons TMDL

Dear Ms. Bonnet:

Alaska Department of Environmental Conservation (ADEC) submitted the Big Lake Total Maximum Daily Load (TMDL) for petroleum hydrocarbons to the U.S. Environmental Protection Agency on May 10, 2012. Following our review, the EPA is pleased to approve the petroleum hydrocarbons TMDL for Big Lake [Alaska ID Number 20505-401] in Big Lake, Alaska.

Our review indicates that these allocations have been established at a level that, when fully implemented, will lead to the attainment of the water quality criteria addressed by this TMDL. Therefore ADEC does not need to include Big Lake on the next 303(d) list of impaired waters for the pollutants covered by this TMDL.

We greatly appreciate the opportunity to work with your staff throughout the development of this TMDL and implementation plan. In particular, we are impressed by the commitment and hard work shown by Laura Eldred of ADEC in developing this TMDL. We do wish to acknowledge the close coordination which ADEC has had with the community in the watershed throughout the development of the TMDL.

By the EPA's approval, this TMDL is now incorporated into the State's Water Quality Management Plan under Section 303(e) of the Clean Water Act. We look forward to continuing to work collaboratively on water quality issues in Big Lake. If you have any questions, please feel free to call me at (206) 553-4198, or Martha Turvey of my staff at (206) 553-1354.

Sincerely,

Michael A. Bussell, Director
Office of Water and Watersheds

cc: Laura Eldred, Restoration and Protection Section, ADEC
Cindy Gilder, Manager Restoration and Protection Section, ADEC
Nancy Sonafrank, Program Manager, WQ Standards Assessment/Restoration Program, ADEC

Alaska Department of Environmental Conservation
555 Cordova Street
Anchorage, Alaska 99501

Total Maximum Daily Load for Petroleum Hydrocarbons in the Waters of Big Lake in Big Lake, Alaska

FINAL

May 2012

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TABLES

FIGURES

ACRONYMS

AAC	Alaska Administrative Code
ADEC	Alaska Department of Environmental Conservation
ADNR	Alaska Department of Natural Resources
ADF&G	Alaska Department of Fish and Game
APDES	Alaska Pollutant Discharge Elimination System
BLCAC	Big Lake Citizen's Advisory Committee
BLCC	Big Lake Community Council
BMP	best management practice
BTEX	benzene, toluene, ethylbenzene, and xylene
CFR	Code of Federal Regulations
cfs	cubic feet per second
DRO	diesel range organics
EPA	U.S. Environmental Protection Agency
LA	load allocation
LC	loading capacity
LUST	leaking underground storage tank
Mat-Su	Matanuska-Susitna
µg/L	micrograms per liter
MOS	margin of safety
MS4	municipal separate storm sewer system
MSGP	Multi-Sector General Permit
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
PAH	polycyclic aromatic hydrocarbons
RRO	residual range organics
TAH	total aromatic hydrocarbons
TAqH	total aqueous hydrocarbons
TMDL	Total Maximum Daily Load
USGS	United States Geological Survey
VOC	volatile organic compound
WLA	wasteload allocation

Total Maximum Daily Load (TMDL) for Petroleum Hydrocarbons in Big Lake, Alaska

TMDL at a Glance:

Water Quality Limited?	Yes
Alaska ID Number:	20505-401
Criteria of Concern:	Petroleum Hydrocarbons; specifically Total Aromatic Hydrocarbons (TAH)
Designated Uses Affected:	Water Supply: Aquaculture; Growth and Propagation of Fish, Shellfish, Other Aquatic Life, and Wildlife
Major Source(s):	Motorized Watercraft
Loading Capacity:	10 micrograms per liter (µg/L) TAH
Wasteload Allocation:	Not Applicable
Load Allocation:	10 µg/L TAH
Margin of Safety:	Implicit through conservative assumptions
Future Growth:	10 µg/L TAH
Necessary Reduction:	Varies by allocation area (see below)

Sample Site	Total Aromatic Hydrocarbons measured as concentrations (µg/L)					Percent Reduction to Load Allocation
	Loading Capacity Concentration	Wasteload Allocation	Load Allocation	Future Growth	Maximum Observed	
BL-2	10	NA	10	10	16.1	38.0%
BL-3	10	NA	10	10	17.7	43.6%
BL-4	10	NA	10	10	69.6	85.6%
BL-5	10	NA	10	10	15.1	33.9%
BL-6	10	NA	10	10	26.7	62.5%
BL-7	10	NA	10	10	19.0	47.4%
BL-8	10	NA	10	10	20.3	50.7%
BL-10	10	NA	10	10	75.7	86.8%
BL-26	10	NA	10	10	17.0	41.1%
BL-27	10	NA	10	10	16.7	40.0%

Note: Applicable water quality criteria for petroleum hydrocarbons apply year round in Big Lake. However, impairment has only been observed during summer months. Therefore, noted reductions to meet the load allocation and loading capacity apply only during summer months when impairment occurs.

Executive Summary

The amount of petroleum hydrocarbons found in areas of Big Lake during the summer months is over the State of Alaska's water quality standard. To address this, Alaska Department of Environmental Conservation (ADEC) has developed a total maximum daily load (TMDL). A TMDL basically represents a pollutant budget for a waterbody. It identifies the maximum amount of a pollutant that can enter the waterbody while still meeting water quality standards. This report documents the TMDL for Big Lake, Alaska, for petroleum hydrocarbons.

Big Lake, a naturally occurring lake, is located in the Matanuska-Susitna (Mat-Su) Borough of Southcentral Alaska. The lake is approximately 15 road miles from Wasilla and 60 miles from Anchorage, with the unincorporated community of Big Lake located on the lake's eastern shore. Big Lake is an important recreational resource for the residents of Southcentral Alaska, providing opportunities for year-round fishing, boating and swimming in the summer and snowmachine usage in the winter. The lake's shoreline is developed with seasonal and year-round residential homes, cabins, and condominiums. Lake usage greatly increases on weekends as residents of nearby communities utilize their personal properties, the three private marinas, the two state recreation sites located at Big Lake or the Borough's public boat launch in the west basin.

ADEC performed water quality monitoring in Big Lake in 2004 and 2005, and the data showed that the shallow waters (less than 5 meters) of Big Lake had elevated levels of petroleum hydrocarbons. Specifically, total aromatic hydrocarbons (TAH) exceeded the water quality criterion of 10 µg/L (micrograms per liter) during the summer months. Based on these data, ADEC added Big Lake to the Section 303(d) list of impaired waters in 2006. The 303(d) list represents those waters in the state that do not meet applicable water quality standards. Additional water quality monitoring in 2009 verified the 303(d) listing and the elevated TAH concentrations. Compounds in petroleum hydrocarbons are highly toxic and tend to accumulate in the fats and oils of organisms. This can impact or kill aquatic organisms such as insects that serve as a food source for fish and wildlife. The negative effects of petroleum can move up the food chain from the aquatic insects to fish to wildlife and potentially to humans. Impaired water can also affect fish and wildlife through direct contact and consumption. Because petroleum hydrocarbons contain known cancer causing compounds (carcinogens) such as Benzene and Benzo(a)pyrene, controlling their concentration in Big Lake is important not only to protecting the environment but ultimately human health.

The primary source of petroleum hydrocarbons to Big Lake is motorized watercraft. Results from monitoring conducted in 2004, 2005 and 2009 show that elevated concentrations of petroleum hydrocarbons occurred at times and locations of increased motorized watercraft usage on Big Lake, including on high use weekends and near marinas, boat launches and other high traffic areas in the east basin. The hydrocarbons can come from gasoline leaks and spills but most of it likely results from the combustion process of gasoline motors, which are designed to directly release unburned fuel out of the exhaust into the water during combustion. This is especially the case with 2-cycle motors. More gasoline motors on the lake at any given time increases the amount of gasoline being released.

The TMDL to address the impairment by petroleum products in Big Lake is expressed as a concentration, equivalent to Alaska's numeric water quality criterion for TAH of 10 µg/L.

Because there are currently no permitted sources discharging petroleum hydrocarbons to Big Lake, the wasteload allocation (WLA) for this TMDL is not applicable. The concentration-based load allocation (LA) for nonpoint sources is set at the loading capacity of 10 µg/L. To account for continued growth in surrounding areas and likely increased recreational use of the lake, the TMDL also establishes an allocation for future sources equivalent to the LA of 10 µg/L to ensure that any future point and nonpoint sources also meet established water quality targets.

Efforts to address the petroleum-related impairment in Big Lake are already underway. There is currently a coordinated effort with the Big Lake community and other local, regional and federal stakeholders to develop an action plan to improve Big Lake water quality. The stakeholder-led process is focused on identifying community supported and implemented actions that address the most critical issues and areas and that also contribute to the long-term health of the lake. To date, key actions include the development of an education campaign that describes and encourages clean boating and fueling practices. In addition, local marinas are encouraged to participate in the Clean Harbors statewide certification program, with one marina already working towards their certification.

1. Overview

Section 303(d)(1)(C) of the Clean Water Act and the U.S. Environmental Protection Agency's (EPA) implementing regulations (40 CFR Part 130) require the establishment of a Total Maximum Daily Load (TMDL) to achieve state water quality standards when a waterbody is water quality-limited and implementation of technology-based controls or other pollution controls are insufficient for attaining water quality standards. A TMDL identifies the amount of a pollutant that a waterbody can receive and still maintain compliance with applicable water quality standards. This is achieved by establishing discharge limits, or loads, for existing and future discharges of the pollutant. TMDLs also include an appropriate margin of safety to account for any uncertainty or lack of knowledge regarding the pollutant loads and the response of the receiving water. The mechanisms used to implement a TMDL to address water quality problems can include a combination of best management practices (BMPs) and/or effluent limits and monitoring through EPA's National Pollutant Discharge Elimination System (NPDES) permits (or in Alaska, the Alaska Pollutant Discharge Elimination System [APDES]).

Alaska Department of Environmental Conservation (ADEC) first listed Big Lake[1] on its 303(d) list in 2006 as water quality-limited for petroleum hydrocarbons. Table 1-1 summarizes the information included in Alaska's approved 2010 303(d) list for Big Lake. In particular, the shallow water column (i.e., less than 5 meters [m] from the surface) in the 1,250 acres of the lake's East Basin experiences non-attainment of water quality criteria for total aromatic hydrocarbons (TAH). The non-attainment affects the designated uses of water supply for aquaculture and growth and propagation of fish, shellfish, other aquatic life, and wildlife. The non-attainment also is seasonal in nature with an estimated duration of May 15 to September 15. The source of the petroleum hydrocarbons is motorized watercraft. The 303(d) listing is supported by water quality monitoring in 2004, 2005, and 2009 that confirmed exceedances of applicable criteria and demonstrated a direct correlation between elevated TAH concentrations and high watercraft usage (ADEC 2008).

Table 1-1: Big Lake 303(d) listing information from ADEC's 2010 Integrated Report

Alaska ID Number	Waterbody	Area of Concern	Water Quality Standard	Pollutant Parameters	Pollutant Sources
20505-401	Big Lake	1,250 acres	Petroleum Hydrocarbons	Total Aromatic Hydrocarbons	Motorized Watercraft
Big Lake was Section 303(d) listed in 2006 for non-attainment of the petroleum hydrocarbons (TAH) water quality standard. DEC collected water quality information at Big Lake in the open water months in 2004, 2005 and 2009. Petroleum hydrocarbon (TAH) sampling was conducted in the water column at multiple sites, depths, and degrees of motorized watercraft activity throughout the lake. Sampling sites in areas that received heavier use by motorized watercraft consistently exceeded the WQS for TAH and the concentrations are likely influenced by a combination of good weather and time of season. The sample events that coincided with the higher mean air temperatures are likely also prime recreational dates based on the increased motorized watercraft usage at these times. Specifically, the areas of impairment together equal an estimated 1,250 acres and are seasonal in nature, from May 15 to September 15 with particular impairment issues on two holiday weekends (Memorial Day and Independence Day). The following specific areas in the east basin are the areas of impairment: harbors and marinas, launch areas, and traffic lanes. Sampling was conducted outside these specific areas and exceedances were not identified. Two reports support the impairment listing: Big Lake and Lake Lucille Water Quality Monitoring Final Report (September 2, 2004) and Big Lake Water Quality Monitoring Report (June 15, 2006), both prepared by Oasis Environmental, Inc., for DEC. A third report, Water Quality Monitoring, Big Lake (January 2009) is currently being finalized by Oasis Environmental for DEC. Although no water quality samples were collected below 5 meters, it is considered unlikely that petroleum contaminated sediment is a concern. The source of petroleum is motorized watercraft. Management measures will focus on reducing petroleum hydrocarbon inputs at harbors and marinas, launch areas, and traffic lanes of the east basin on busy holiday weekends.					

[1] Unless otherwise stated, throughout this document "Big Lake" refers to the actual lake and not the community of the same name.

2. Background Information

2.1. Setting

Big Lake, a naturally occurring lake, is located in the Matanuska-Susitna (Mat-Su) Borough of south-central Alaska (Figure 2-1). The lake is approximately 13 miles from Wasilla and 20 miles from Anchorage; however, by road, the distances are approximately 15 miles to Wasilla and 58 miles to Anchorage. The unincorporated community of Big Lake, population 3,350 (2010), is located on the eastern shore of the lake.

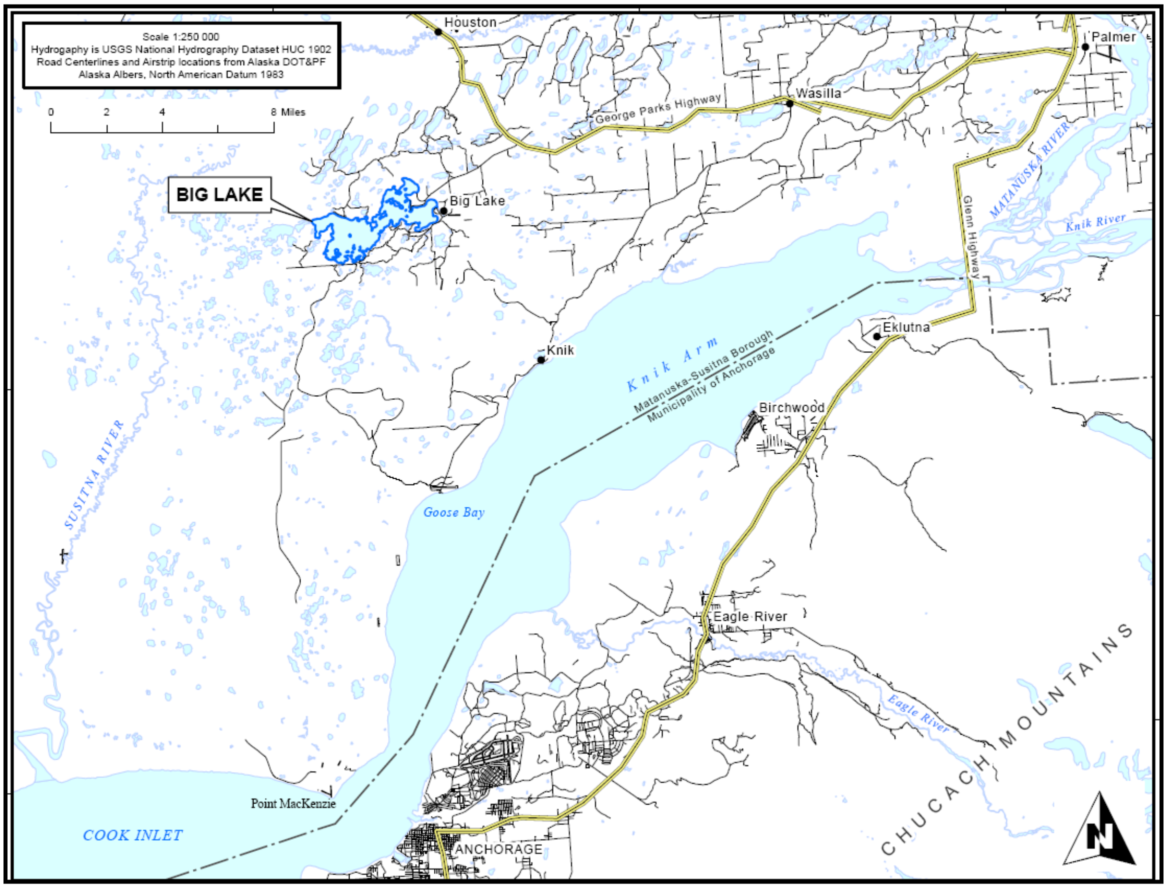


Figure 2-1: Big Lake Location

The climate of the Big Lake area is defined as a transitional zone between the maritime influences of Cook Inlet and the continental influence that begins near the Talkeetna Mountains and Alaska Range. Therefore, weather patterns fluctuate regularly and are not sharply defined (USGS 1995).

Local vegetation consists of low-land spruces and hardwoods and low brush muskeg. Soils are generally poorly drained (USGS 1995).

2.2. History and Usage

The *Lake Management Plan for Big Lake* (BLCAC 1998) and the *Big Lake Community Council Area Comprehensive Plan Update* (Big Lake Planning Team et al. 2009) include information on the history and culture of Big Lake and the surrounding area; highlights are included here.

The first inhabitants in the area of Big Lake were the Athabascan Dena'ina Indians. Archeological records suggest the Big Lake area was heavily used by Alaska's original people. Evidence includes the remnants of extensive encampments in many locations around the area, mostly near where streams entered or exited local lakes. In the 1830s, native populations fished, hunted and gathered in the Big Lake area until a smallpox epidemic introduced by Russian traders decimated Athabaskan populations in the area.

In the 1890s, gold was discovered in Willow Creek approximately 20 miles from Big Lake, making the area a transitory route for merchandise to and from the mines, and around 1899, the Boston and Klondike Company made the first sled trail north into the Talkeetna Mountains from Knik via the community of Big Lake. The area included a few homesteaders throughout the early 1900s and was used for hunting by residents of nearby railroad towns such as Anchorage, Palmer and Wasilla. During World War II, the lake was used by the military for recreation and as a training site for army float-plane pilots.

By the early 1950s, approximately 100 lakeshore cabins were established at Big Lake, and it was considered the most popular fishing and boating lake in the Anchorage area. By the early 1960s, the Big Lake area hosted a few year-round residences and five commercial lodges and boat liveries as well as more than 600 cabins. Throughout the 1960s, 70s and 80s state agencies and local residents experienced increasing concerns over Big Lake's water levels, potential contamination and fish populations. Problematic activities included raw sewage from nearby cabins being discharged into the lake, garbage being emptied into the lake, inadequate or improperly constructed septic tanks, residents bulldozing beaver dams and dumping rocks and boulders at inlets, and conflicting opinions and actions on regulating the lake's water level. In the mid-1970s the Big Lake Hatchery was constructed to restore the watershed's historic sockeye salmon production, and the number of seasonal and permanent lakeshore homes had grown to approximately 450. Throughout the 1980s there was continued concern and discussion about the use of the lake and optimal lake level and associated water control options.

In the mid-1980s, increased attention was placed on the importance of Big Lake as an aquatic resource and limnological studies were initiated to evaluate the water quality as well as the impact of residential and commercial development on water quality (Woods 1992).

Today Big Lake is an important recreational resource for the residents of south-central Alaska. The most common activities include year-round fishing, boating and swimming in the summer, and snow machine usage in the winter. The lake's shoreline is developed with seasonal and year-round residential homes, cabins, and condominiums, although road access is not complete around the entire lake. Lake usage greatly increases on weekends as residents of nearby communities utilize either their personal properties or the two state recreation sites located at Big Lake (Figure 2-2) or the borough's public boat launch in the west basin. As described in the *Big Lake Community Council Area Comprehensive Plan Update* (Big Lake Planning Team et al. 2009), the Big Lake area has undergone rapid growth in the past 20 years with population growth slowing in recent years but still at a pace that equals or exceeds the rest of the state. The population of the Big Lake community in 2010 was 3,350, representing an average annual growth of 2.7% during the preceding decade, as compared to an average annual growth rate of nearly 8% between 1990 and 2000 and of 26% between 1980 and 1990. For the area around Big Lake, early growth was driven by its reputation as a recreational playground with more recent population increases reflecting the area's transition into a commuter suburb and retirement community. Continued growth in the community of Big Lake and nearby areas will lead to continued and likely increased use of the lake for recreation and transportation as well as increased development in the surrounding watershed.

Figure 2-2: North Shore State Recreation Area, Big Lake (Source: ADEC)

2.3. Fish and Wildlife

Big Lake supports a variety of fish species including arctic char, burbot, northern pike, and rainbow trout. In addition, Big Lake is a passage for anadromous fish species. Coho salmon and sockeye salmon traverse Big Lake on their way to spawn in Fish Creek, within Big Lake, and upstream in Meadow Creek and other connected drainages.

Big Lake also provides ample habitat for various wildlife. The resource supports both terrestrial wildlife and waterfowl, including moose, fox, owls, eagles, beavers, muskrats, various waterfowl species, and various migratory bird species (Figure 2-3).

Figure 2-3: Duck Brood on Big Lake, Summer 2009 (Source: ADEC)

2.4. Lake Characteristics

Figure 2-4 presents Big Lake and the surrounding area. Big Lake covers an area of approximately 12 square miles, or approximately 3,000 acres. The East Basin accounts for approximately 1,250 acres, and the West Basin contains the 1,750-acre balance. The basins are connected by a constriction in the center of the lake.

The lake contains 22 islands and has a shore length of approximately 17 miles, excluding islands. The surface elevation is about 144 feet above mean sea level. The average depth of the lake is approximately 9 m (USGS 1995). Meadow Creek in the northern portion of the East Basin is the major inlet, and Fish Creek in the eastern portion of the East Basin is the major outlet.

Depth profiles of temperature during recent water quality monitoring have shown significant variation in the depth and thickness of the thermocline. The thermocline, defined as temperature change of 1 degree Celsius (°C) or more per meter, has begun as shallow as 1 m immediately following spring breakup in May and as deep as 8 m on Labor Day. The thickness of the thermocline will vary from 1 m at spring breakup to 5 m in July (OASIS 2010a). The depth of the thermocline is important to document because it is assumed that mixing of the water column begins to cease within the increasingly colder, denser water of the thermocline. In other words, any hydrocarbons in the warmer, overlying epilimnion will be prevented from mixing deeper into the lake by the denser water encountered in the thermocline.

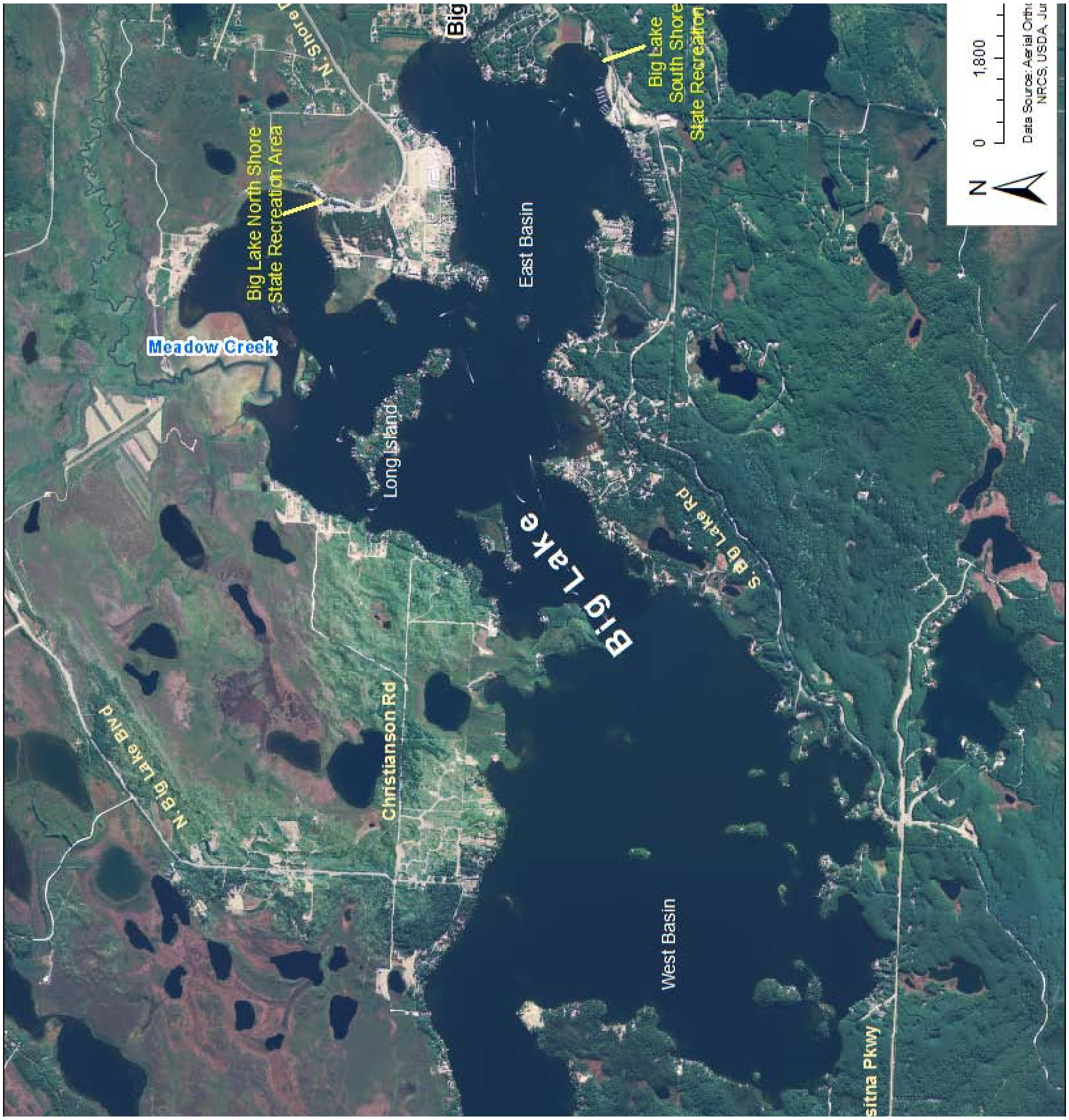


Figure 2-4: Big Lake and Surrounding Area

3. Water Quality Standards and TMDL Target

Water quality standards designate the "uses" to be protected (e.g., water supply, recreation, aquatic life) and the "criteria" for their protection (e.g., how much of a pollutant can be present in a waterbody without impairing its designated uses). TMDLs are developed to meet applicable water quality standards, which may be expressed as numeric water quality criteria or narrative criteria for the support of designated uses. The TMDL target identifies the numeric goals or endpoints for the TMDL that equate to attainment of the water quality standards. The TMDL target may be equivalent to a numeric water quality standard where one exists, or it may represent a quantitative interpretation of a narrative standard. This section reviews the applicable water quality standards and identifies an appropriate target for calculation of the TMDL for petroleum hydrocarbons in Big Lake.

3.1. Applicable Water Quality Standards

Title 18, Chapter 70 of the Alaska Administrative Code (AAC) establishes water quality standards for the waters of Alaska, including the designated uses to be protected and the water quality criteria necessary to protect the uses. Designated uses established in the State of Alaska Water Quality Standards (18 AAC 70.020) for fresh waters of the state include (1) water supply, (2) water recreation, and (3) growth and propagation of fish, shellfish, other aquatic life, and wildlife, and are applicable to all fresh waters, unless specifically exempted. Water quality criteria for petroleum hydrocarbon for all uses are applicable to Big Lake and are listed in Table 3-1.

Table 3-1: Alaska Water Quality Criteria for Oil & Grease and Petroleum Hydrocarbons in Fresh Waters

Designated Use	Description of Criteria
Petroleum hydrocarbons, oils and grease	
(A) Water Supply	
(i) drinking, culinary, and food processing	May not cause a visible sheen upon the surface of the water. May not exceed concentrations that individually or in combination impart odor or taste as determined by organoleptic tests.
(ii) agriculture, including irrigation and stock watering	May not cause visible sheen upon the surface of the water.
(iii) aquaculture	Total aqueous hydrocarbons (TAqH) in the water column may not exceed 15 µg/L. Total aromatic hydrocarbons (TAH) in the water column may not exceed 10 µg/L. There may be no concentrations of petroleum hydrocarbons, animal fats, or vegetable oils in shoreline or bottom sediments that cause deleterious effects to aquatic life. Surface waters and adjoining shorelines must be virtually free from floating oil, film, sheen, or discoloration.
(iv) industrial	May not make the water unfit or unsafe for the use.
(B) Water Recreation	
(i) contact recreation	May not cause a film, sheen, or discoloration on the surface or floor of the waterbody or adjoining shorelines. Surface waters must be virtually free from floating oils.
(ii) secondary recreation	Same as contact recreation above
(C) Growth and propagation of fish, shellfish, other aquatic life, and wildlife	Total aqueous hydrocarbons (TAqH) in the water column may not exceed 15 µg/L (see note a). Total aromatic hydrocarbons (TAH) in the water column may not exceed 10 µg/L (see note a). There may be no concentrations of petroleum hydrocarbons, animal fats, or vegetable oils in shoreline or bottom sediments that cause deleterious effects to aquatic life. Surface waters and adjoining shorelines must be virtually free from floating oil, film, sheen, or discoloration.

Source: 18 AAC 70.020

3.2. TMDL Target

Petroleum products can cause a wide range of impairments to aquatic life and habitat, including lethal or sublethal effects to aquatic organisms. Compounds in petroleum hydrocarbons are highly toxic, and due to the lipophilic nature of petroleum products, they tend to reside in the fats and oils of organisms. This allows aquatic organisms and wildlife to be exposed to petroleum hydrocarbons through direct contact as well as through consumption of other organisms that serve as food sources, potentially negatively affecting the health of fish and wildlife. Petroleum hydrocarbons contain known carcinogens such as benzene and benzo(a)pyrene. The effects of exposure to these compounds might not be immediately seen in aquatic life but can manifest later depending on several environmental and biological factors.

Water quality monitoring in 2004 and 2005 demonstrated that the shallow waters (less than 5 m) of Big Lake included elevated levels of petroleum hydrocarbons, and specifically TAH (which is the sum of benzene, toluene, ethylbenzene, and xylenes) exceeded the water quality criterion of 10 µg/L. Based on these data, ADEC listed Big Lake on the 303(d) list in 2006 for non-attainment of the TAH water quality criterion. Additional water quality monitoring in 2009 verified the 303(d) listing and elevated TAH concentrations.

Monitoring data also show that polycyclic aromatic hydrocarbons (PAH) were not detectable in the water column. PAH includes heavier compounds present in diesel and oil, while TAH includes the compounds benzene, toluene, ethylbenzene and xylene, which are constituents of gasoline. Measuring TAH therefore captures contamination from most watercraft used on the lake.

In addition, oily sheens have not been persistently observed in the lake. Community members have noted an occasional sheen in the area of the North Shore State Recreation Area after busy weekends when the winds are low. No sheening was observed during the summer sampling in 2004, 2005 and 2009, including intensive sampling during 2009.

Because PAHs are nondetectable in the sampling conducted, and TAqH is the sum of TAH and PAH, the TAH criterion of 10 µg/L is more protective than the TAqH criterion of 15 µg/L in Big Lake. Therefore the TMDL target for Big Lake is equivalent to the TAH state water quality criterion of 10 µg/L.

4. Water Quality Analysis

Water quality monitoring for petroleum hydrocarbons was conducted in Big Lake in 2004 (May – June), 2005 (May – September) and 2009 (May – September). A total of 324 samples for analysis of petroleum hydrocarbons were collected from 16 sample sites during the three years of monitoring. The majority of the samples, 225 of them, were collected from the 0.15 m sample depth, which has been shown to be the most polluted sample interval for water quality (OASIS 2010b) [2]. Initial monitoring in 2004 included analyzing samples for TAH and PAHs, but PAH samples were below the reporting limit at all of the sampling sites and depths. Subsequent monitoring in 2005 and 2009 analyzed only TAH in water samples. Sediment samples were not collected as part of these studies.

Figure 4-1 presents the locations of the sampling sites in Big Lake, and Table 4-1 presents summary statistics of all the surface samples (at 0.15 m depth), by sample site, for the three years of water quality monitoring. Table 4-2 shows summary statistics by sample site and year for the surface samples.

[2] All analyses in this section are based on “surface” samples—those collected at the 0.15-meter depth. OASIS (2010b) includes data for all depths.

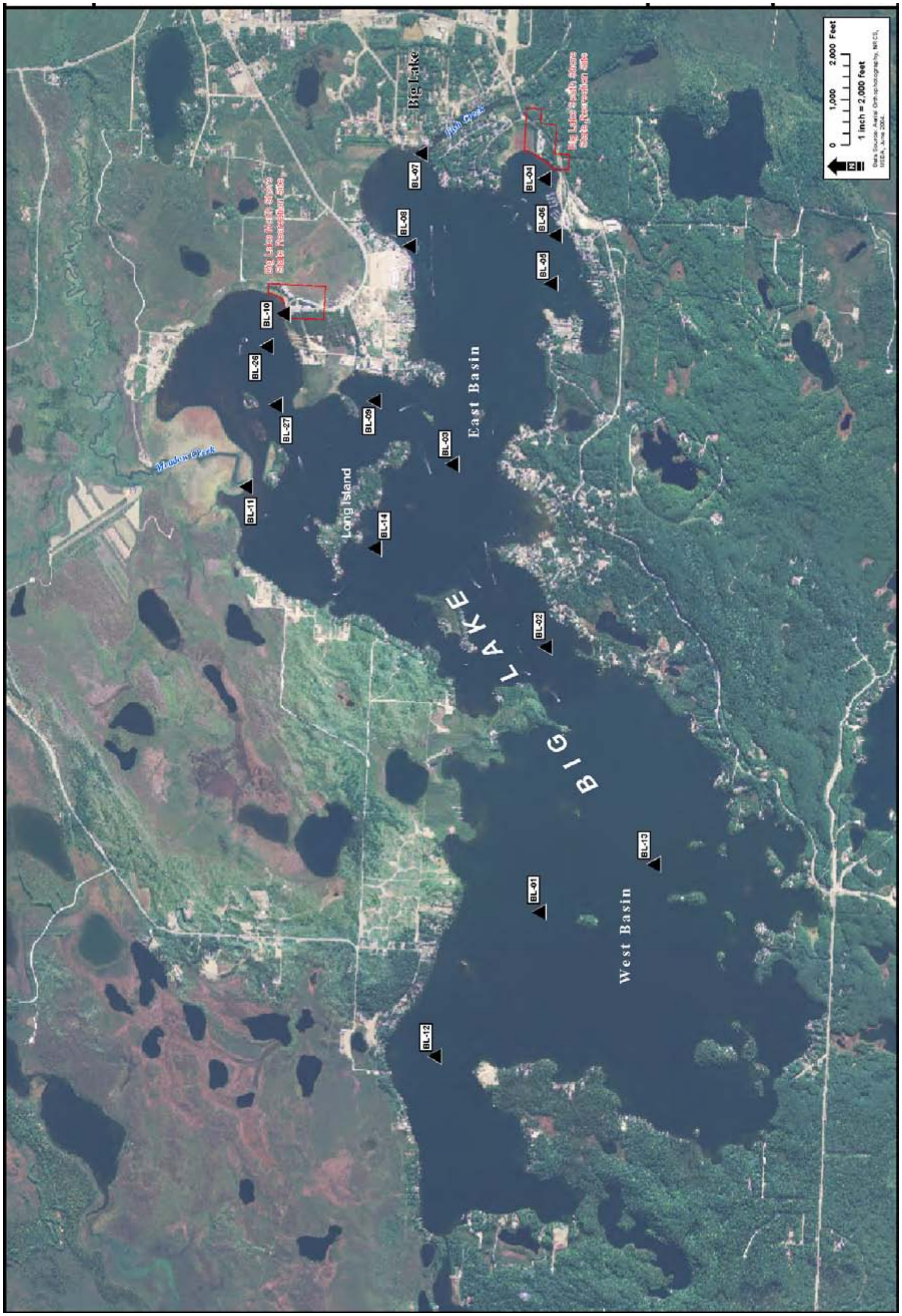


Figure 4-1: Sites Sampled for Petroleum Hydrocarbons in Big Lake

Table 4-1: Summary Statistics for TAH in All Surface Samples

Station	2004	2005	2009	Description	**Count of Samples**	**Minimum**	**Average**	**Maximum**	**Percent of Samples >10 µg/L**
BL-1	X	X	X	Historical USGS sampling site at the deepest area of the west basin. Serves as a control site.	21	0.16	1.68	8.52	0%
BL-2	X		X	Major traffic lane between two basins.	16	0.16	6.36	16.14	38%
BL-3	X		X	Historical USGS sampling site at the deepest area of the east basin. There is boat traffic in this area.	16	0.16	5.62	17.73	25%
BL-4	X		X	Center of furthest east section of lake, near the South Shore State Recreation Site. This area is the most heavily used basin in the lake.	15	0.16	13.67	69.6	40%
BL-5	X		X	Traffic lane for the residences in the bay to the southwest.	16	0.16	5.47	15.14	25%
BL-6	X	X	X	Near Southport Marina and residences.	21	0.16	8.15	26.7	38%
BL-7	X	X	X	Near outlet of Fish Creek. This is a popular fishing area as well as a high use traffic lane.	21	0.16	4.90	19	14%
BL-8	X	X	X	Near Burkeshore Marina and extensive residential development.	22	0.16	8.22	20.3	45%
BL-9	X			Residential area and lodge.	3	0.16	1.15	1.8	0%
BL-10	X	X	X	Near the North Shore State Recreation Site. This area is heavily used for launching boats, swimming, camping, and operating personal watercraft.	23	0.16	23.82	75.675	65%
BL-11	X		X	In the east basin near the mouth of Meadow Creek, the lake's major inlet.	16	0.16	0.64	3.49	0%
BL-12	X			Narrow area in west basin. Traffic associated with Klondike Restaurant and Mud and Flat lakes.	3	0.16	0.91	2.4	0%
BL-13	X			Near residential development on islands in west basin.	3	0.16	0.16	0.16	0%
BL-14	X			Near residential development on Long Island.	3	0.16	1.89	3.6	0%
BL-26			X	In the middle of the bay near the North Shore State Recreation Site and west of location BL-10. Added in 2009 to assess attenuation of hydrocarbons commonly detected at sample site BL-10.	13	0.16	5.87	16.98	31%
BL-27			X	In the main traffic lane for users leaving North Shore State Recreation Site. Added in 2009 to assess the area between the north bay and east basin.	13	0.16	6.84	16.66	38%
Total					225				29%

Note: Of the 225 samples collected, 177 samples had detected and reported concentrations. For data analysis, samples with non-detected concentrations are represented as one-half of the method detection limit (MDL). Because TAH represents the sum of the concentrations of benzene, toluene, ethylbenzene, and xylene (BTEX), the non-detect samples were represented as half of the maximum of the MDLs for those parameters. Therefore, they are included as 0.16 µg/L, based on the 0.32-µg/L MDL for xylene.

Table 4-2: Summary Statistics of TAH Samples in All Surface Samples by Year

Station	2004					2005					2009				
	Count	Min	Avg	Max	% > 10 µg/L	Count	Min	Avg	Max	% > 10 µg/L	Count	Min	Avg	Max	% > 10 µg/L
BL-1	3	0.16	0.16	0.16	0%	5	0.16	0.25	0.53	0%	13	0.16	2.59	8.52	0%
BL-2	3	0.16	4.11	12	33%	–	–	–	–	–	13	0.27	6.88	16.14	38%
BL-3	3	0.16	3.09	6.4	0%	–	–	–	–	–	13	0.16	6.20	17.73	31%
BL-4	3	0.16	3.69	8.3	0%	–	–	–	–	–	12	0.16	16.16	69.6	50%
BL-5	3	0.16	4.82	11	33%	–	–	–	–	–	13	0.16	5.62	15.14	23%
BL-6	3	3	7.00	15	33%	5	1.1	2.78	7.1	0%	13	0.16	10.48	26.7	54%
BL-7	3	3.1	8.73	19	33%	5	1	2.52	5.5	0%	13	0.16	4.94	14.34	15%
BL-8	3	3.6	9.30	17	33%	6	0.16	5.51	13	33%	13	0.16	9.22	20.3	54%
BL-9	3	0.16	1.15	1.8	0%	–	–	–	–	–	–	–	–	–	–
BL-10	3	9.9	13.30	18	67%	7	0.16	21.37	63	57%	13	0.24	27.57	75.68	69%
BL-11	3	0.16	0.16	0.16	0%	–	–	–	–	–	13	0.16	0.75	3.49	0%
BL-12	3	0.16	0.91	2.4	0%	–	–	–	–	–	–	–	–	–	–
BL-13	3	0.16	0.16	0.16	0%	–	–	–	–	–	–	–	–	–	–
BL-14	3	0.16	1.89	3.6	0%	–	–	–	–	–	–	–	–	–	–
BL-26	–	–	–	–	–	–	–	–	–	–	13	0.16	5.87	16.98	31%
BL-27	–	–	–	–	–	–	–	–	–	–	13	0.16	6.84	16.66	38%
Total	42				17%	28				21%	155				34%

Note: Many samples were reported as “not detected.” For data analysis, samples with non-detected concentrations are represented as one-half of the MDL. Because TAH represents the sum of the concentrations of benzene, toluene, ethylbenzene, and xylene (BTEX), the non-detect samples were represented as half of the maximum of the MDLs for those parameters. Therefore, they are included as 0.16 µg/L, based on the 0.32-µg/L MDL for xylene.

– not sampled

The 2004 preliminary water quality monitoring of Big Lake was conducted by ADEC based on community concerns regarding potential nonpoint source impacts. In particular, sampling focused on nutrients and bacteria from area septic systems, but sampling also was conducted for petroleum hydrocarbons. As shown in Table 4-2, 14 sites were sampled. Samples were collected at depths of 0.15 m, 0.5 m, 1.5 m, and 5 m at four of the sites, and at 0.15 m at the remaining ten sites. Sampling occurred on two dates in May and one date in June. The results showed that concentrations of bacteria and nutrients were insignificant, while concentrations of TAH exceeded the 10-µg/L water quality criterion at some of the sites on the busier use days. In particular, TAH concentrations were highest at sites with more traffic from motorized watercraft (OASIS 2004).

Based on the 2004 preliminary results, ADEC increased the sampling effort to six dates in 2005 during the open water months (May–September). Sample analysis again included bacteria and nutrients, but petroleum hydrocarbons were the focus based on the results from 2004. The six days included weekdays, weekends, and holidays. The data from 2005 again showed concentrations of TAH continually exceeded water quality criteria at sample sites that experience more traffic from motorized watercraft (OASIS 2006).

Based on data collected in 2004 and 2005, ADEC determined it necessary to list Big Lake on the 303(d) list as water quality-limited for petroleum hydrocarbons. Figure 4-2 highlights the sample sites where exceedance of the TAH water quality criteria occurred in 2004 and 2005. A single TAH sample was taken in late August 2008 by a community member with funding provided by other community members. This sample was collected near BL-8 on a low watercraft activity date and showed TAH concentrations below detection limits.

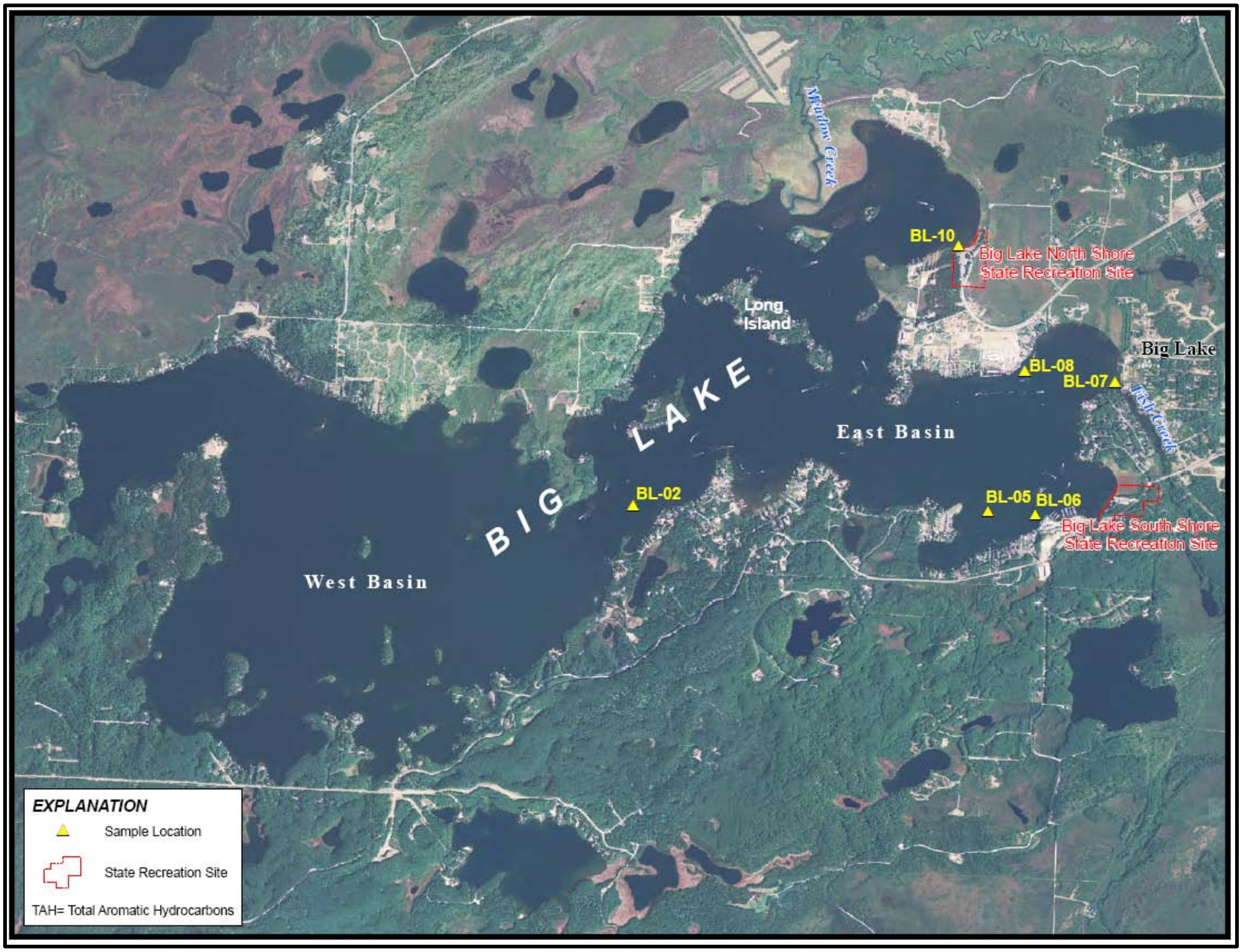


Figure 4-2: 2004 and 2005 Sample Sites that Exceeded TAH Criteria

In 2009, ADEC conducted another round of water quality monitoring for petroleum hydrocarbons based on concerns voiced by the community of Big Lake regarding the representativeness of the sample results from 2004 and 2005. The scope of work involved collecting water samples from 12 sample sites on 13 different days. This was accomplished by using a combination of standard sampling events, where each sample location was sampled once per day, and intensive sampling events, where three sample locations were sampled five times during a single day. The standard sampling events allowed for a daily snapshot of hydrocarbon concentrations throughout Big Lake, while the intensive sampling events provided a trend of hydrocarbon concentrations during the course of the day and for 3-4 consecutive days during historically high use times (i.e., holiday weekends). In addition, observations were made of motorized watercraft usage on four of the intensive sample days (OASIS 2010a). (Data from 2009 intensive monitoring days are not included in this summary analysis. A detailed reporting and analysis of all 2009 data are included in OASIS 2010a.)

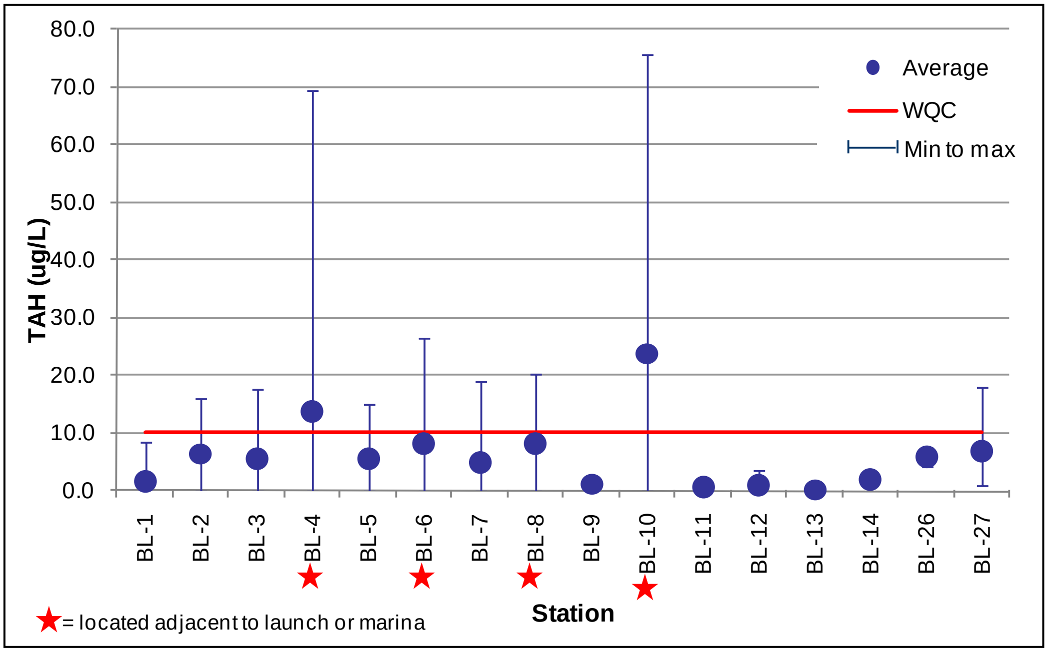
Figure 4-3 shows the range of TAH concentrations measured at each sampling site over the three years of monitoring (2004, 2005 and 2009). The figure shows the average concentration for each station along with ranges showing the minimum and maximum concentrations measured. Figure 4-4 presents the percent of samples exceeding the TAH water quality criterion at each sampling site for all three years of monitoring (2004, 2005 and 2009). The figure also includes for each station the number of samples that met the water quality criterion and the number that exceeded. Figure 4-3 and Figure 4-4 note which sampling stations are located adjacent to launch areas or marinas, where boat traffic is highest.

Figure 4-5 shows the range of TAH concentrations measured on each sampling date over the three years of monitoring. The figure shows the average and median concentrations for each sampling date along with ranges showing the minimum and maximum concentrations measured. Figure 4-6 presents the percent of samples exceeding the TAH water quality criterion on each sampling date over the three years of monitoring. The figure also includes for each station the number of samples that met the water quality criterion and the number that exceeded. Figure 4-5 and Figure 4-6 note which sampling dates were holiday weekends, times when lake use is highest, and also which dates were weekdays, when lake use is relatively low. (Statistics presented in Figure 4-3 through Figure 4-6 are based on only those samples with reported concentrations and not reported as "not quantified.")

Figure 4-7 presents a map depicting the percent of samples exceeding the TAH criterion and maximum TAH concentrations for each sampling site.

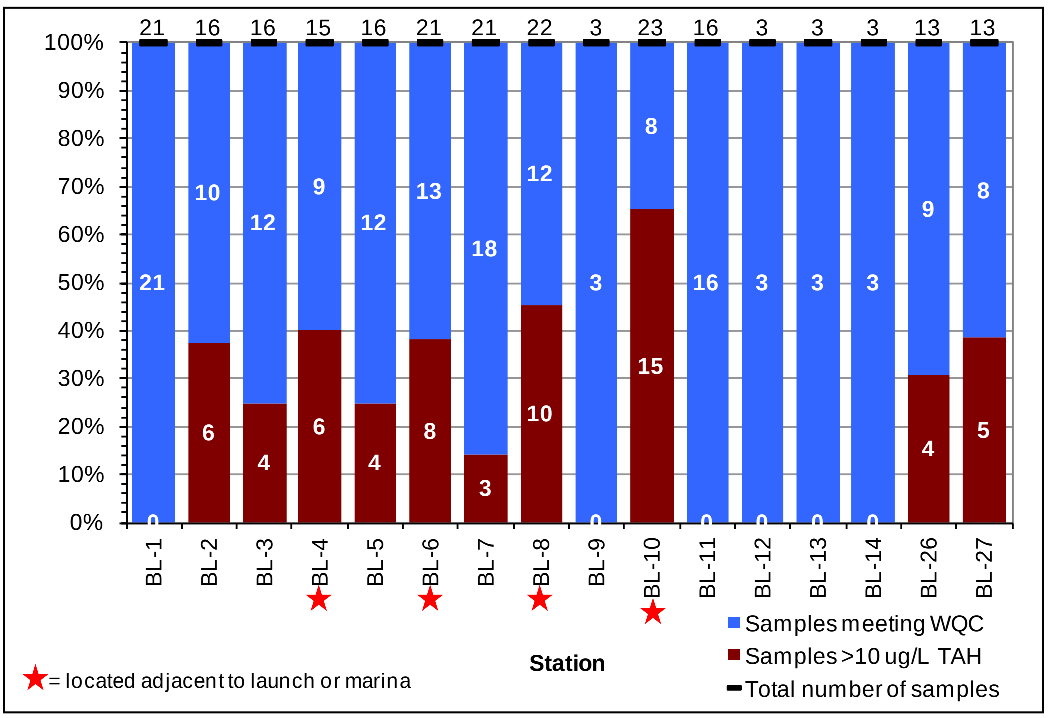
Based on the analysis of data collected during 2004, 2005 and 2009 (as shown in Figure 4-3 through Figure 4-7), the following conclusions were drawn about the levels of petroleum hydrocarbons in Big Lake:

- Surface samples collected at sites near launches and marinas had the highest TAH concentrations and had relatively more samples exceeding the water quality criterion than other sites.
- The highest concentrations of TAH were measured at stations BL-10 and BL-4. As shown in Figure 4-7, BL-10 is located near the North Shore State Recreation Site in an area heavily used for launching boats, swimming, camping, and using personal watercraft. BL-4 is located near the South Shore State Recreation Site in the most heavily used basin of the lake.
- The highest concentrations of TAH were measured on holiday weekends when watercraft density was highest.



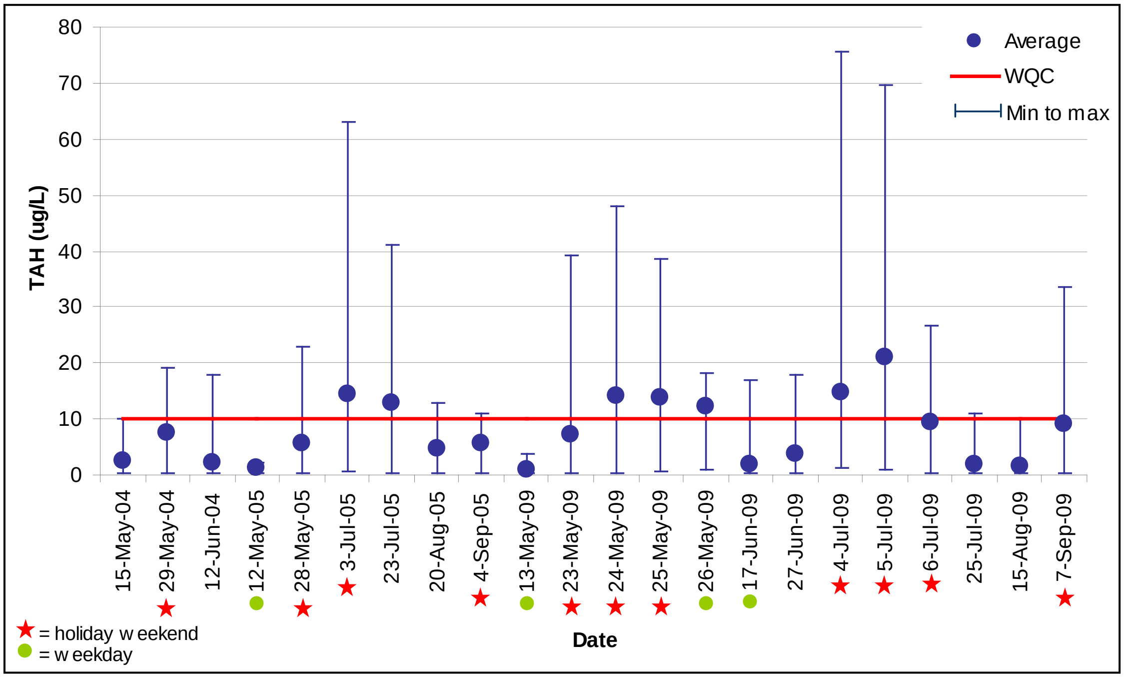
Note: WQC = water quality criterion (10 µg/L for TAH)
Water quality criterion is measured as an instantaneous maximum concentration, not an average. Average concentrations for water quality monitoring are presented along with minimum and maximum concentrations to illustrate the range of observed TAH concentrations at the respective station.

Figure 4-3: Range of TAH Concentrations Measured in Samples Collected at 0.15-meter Depth at Each Big Lake Sampling Site (2004, 2005 and 2009)



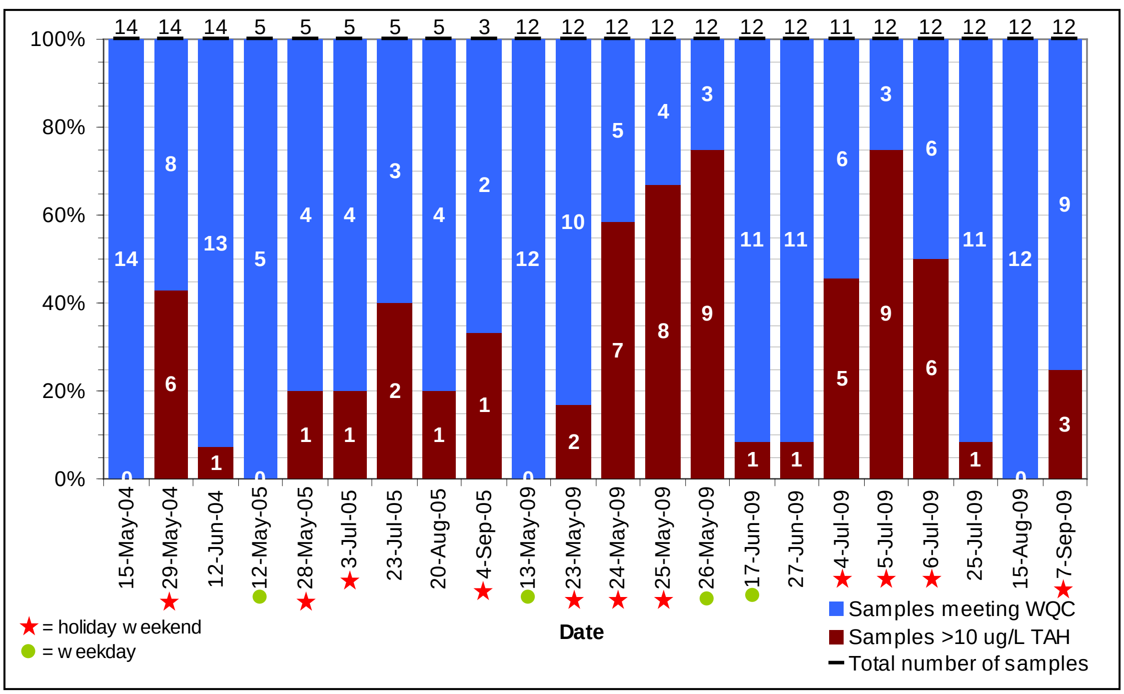
Note: WQC = water quality criterion (10 µg/L for TAH)
Water quality criterion is measured as an instantaneous maximum concentration, not an average. Average concentrations for water quality monitoring are presented along with minimum and maximum concentrations to illustrate the range of observed TAH concentrations at the respective station.

Figure 4-4: Percent of Samples (Collected at 0.15-meter Depth) Exceeding the TAH Water Quality Criterion at Each Big Lake Sampling Site (2004, 2005 and 2009)



Note: WQC = water quality criterion (10 µg/L for TAH)
Water quality criterion is measured as an instantaneous maximum concentration, not an average. Average concentrations for water quality monitoring are presented along with minimum and maximum concentrations to illustrate the range of observed TAH concentrations at the respective station.

Figure 4-5: Range of TAH Concentrations Measured in Samples Collected at 0.15-meter Depth in Big Lake on Each Sampling Date (2004, 2005 and 2009)



Note: WQC = water quality criterion (10 µg/L for TAH)
Water quality criterion is measured as an instantaneous maximum concentration, not an average. Average concentrations for water quality monitoring are presented along with minimum and maximum concentrations to illustrate the range of observed TAH concentrations at the respective station.

Figure 4-6: Percent of Samples (Collected at 0.15 Meter Depth) Exceeding the TAH Water Quality Criterion in Big Lake on Each Sampling Date (2004, 2005 and 2009)

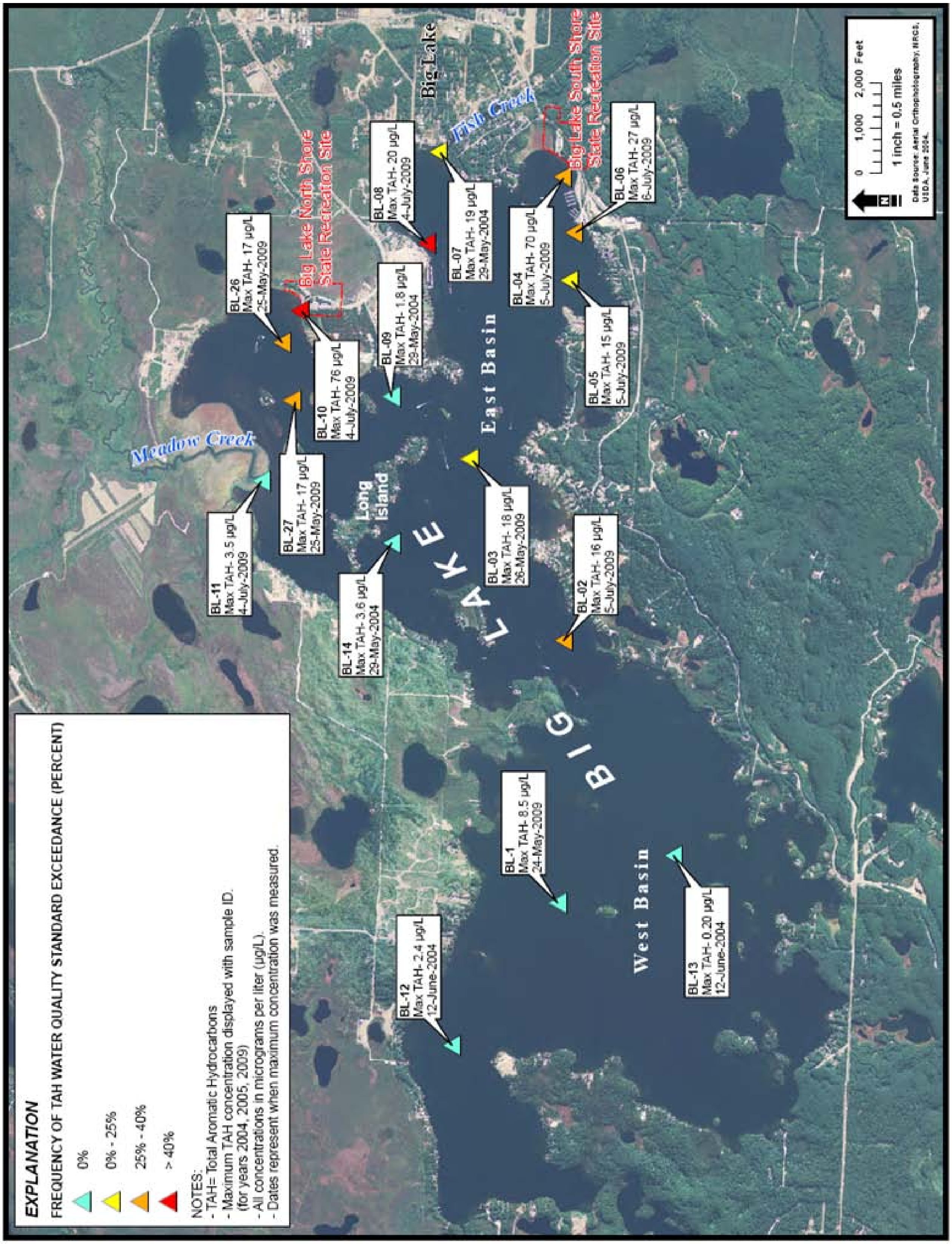


Figure 4-7: Percent of Samples Exceeding TAH Criterion and Maximum TAH Concentration Measured at Each Big Lake Sampling Site (OASIS 2010a)

5. Potential Sources of Pollutants

This section discusses the potential sources of petroleum hydrocarbons to Big Lake, including point, nonpoint and natural sources.

5.1. Point Sources

As authorized by the Clean Water Act, the NPDES permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. Point sources are discrete conveyances such as pipes or man-made ditches that discharge directly to a waterbody. The NPDES permit program in Alaska was previously administered by EPA, but on October 31, 2008, EPA approved the state's NPDES Program application. Federal permitting and compliance and enforcement programs are transferring to ADEC's APDES Program in phases over a three-year period, with full program transfer by October 2011.

The two basic types of APDES permits issued are individual and general permits. An *individual permit* is a permit specifically tailored to an individual facility. Once a facility submits the appropriate application(s), the permitting authority develops a permit for that particular facility based on the information contained in the permit application (e.g., type of activity, nature of discharge, receiving water quality). The authority issues the permit to the facility for a specific time period (not to exceed five years) with a requirement that the facility reapply prior to the expiration date.

A *general permit* covers multiple facilities within a specific regulated category such as stormwater discharges. According to the NPDES regulations at 40 CFR §l22.28, general permits may be written to cover categories of point sources having common elements, such as:

- Storm water point sources;
- Facilities that involve the same or substantially similar types of operations;
- Facilities that discharge the same types of wastes or engage in the same types of sludge use or disposal practices;
- Facilities that require the same effluent limits, operating conditions, or standards for sewage sludge use or disposal; and
- Facilities that require the same or similar monitoring.

General permits, however, may only be issued to dischargers within a specific geographical area such as city, county, or state political boundaries; designated planning areas; sewer districts or sewer authorities; state highway systems; standard metropolitan statistical areas; or urbanized areas.

5.1.1. Individual Permits

No individual APDES permits are issued for the discharge of petroleum into Big Lake.

5.1.2. General Permits

Stormwater discharges covered under general permits represent a potential source of petroleum products in many areas. Stormwater occurs when rainfall or snowmelt runs off of the land and surfaces such as streets, parking lots, and rooftops and is delivered and discharged to local waterbodies. As it flows across the land surface the stormwater can pick up pollutants such as fertilizers, sediment, pesticides, or oil and grease. In some areas or for certain activities, stormwater discharges are regulated through the state's stormwater permitting program. There are three general classes of activities that are covered by stormwater general permits:

- Municipal separate storm sewer systems (MS4s)
- Construction activity that disturbs one or more acres or which is part of a larger project that disturbs one or more acres in total
- Several types of industrial or commercial activity

There are no regulated MS4s that discharge to Big Lake. Regulated stormwater from industrial facilities and construction sites is discussed below.

Industrial Stormwater

Activities that take place at industrial facilities, such as storage of vehicles at junk yards, often result in pollutants coming into contact with rainwater. As runoff from rain or snowmelt comes into contact with these activities, it can pick up pollutants and transport them to a nearby storm sewer system or directly to a river, lake, or coastal water. Industrial facilities that fall under any of the following 11 categories and discharge to waters of the United States are required to obtain permit coverage for their stormwater discharges:

- Category One (i): Facilities subject to federal stormwater effluent discharge standards
- Category Two (ii): Heavy manufacturing (e.g., paper mills, chemical plants, pretroleum refineries, and steel mills and foundries)
- Category Three (iii): Coal and mineral mining and oil and gas exploration and processing
- Category Four (iv): Hazardous waste treatment, storage, or disposal facilities
- Category Five (v): Landfills, land application sites, and open dumps with industrial wastes
- Category Six (vi): Metal scrapyards, salvage yards, automobile junkyards, and battery reclaimers
- Category Seven (vii): Steam electric power generating plants
- Category Eight (viii): Transportation facilities that have vehicle maintenance, equipment cleaning, or airport deicing operations
- Category Nine (ix): Treatment works treating domestic sewage with a design flow of 1 million gallons a day or more
- Category Ten (x): Construction Activity disturbing 5 acres or more
- Category Eleven (xi): Light manufacturing (e.g., food processing, printing and publishing, electronic and other electrical equipment manufacturing, and public warehousing and storage).

EPA has issued a Multi-Sector General Permit (MSGP) (USEPA 2008) that addresses stormwater discharges from 29 sectors of industrial activity within the above categories. Operators of applicable facilities apply to obtain coverage under the MSGP by submitting a Notice of Intent (NOI) to the permitting authority (i.e., EPA or the state). Queries of ADEC's Water Permit Search and EPA's eNOI system did not identify any industrial facilities covered by the MSGP discharging to Big Lake. It is possible that facilities in the area meet the criteria for requiring coverage and have not yet applied. For example, marinas on Big Lake might require coverage for stormwater discharges from their facilities under Sector Q – Water Transportation

While available data indicate that watercraft use is the primary cause of the petroleum-related impairment in Big Lake, stormwater carrying petroleum products could cause localized problems if proper pollution prevention and spill response activities are not being followed.

Construction Stormwater

Construction site operators engaged in clearing, grading, and excavating activities that disturb 1 acre or more must obtain coverage under a stormwater permit before any soil is disturbed at the site and continuing until all building is completed and the ground is completely stabilized with a permanent, perennial, vegetative cover. As with industrial facilities, construction site operators apply for coverage under the Construction General Permit by submitting an NOI to the permitting authority. Queries of ADEC's Water Permit Search and EPA's eNOI system at the time of writing this TMDL did not identify any active construction facilities covered by the MSGP discharging to Big Lake.

Any past or future construction sites are not expected to contribute to the petroleum-related impairment in Big Lake. Construction sites are temporary in nature, both spatially and temporally, while impairment in Big Lake has been shown to occur during multiple years of monitoring and with consistent patterns (e.g., elevated concentrations during times and near areas of high boat activity). In addition, activities at construction sites are not expected to be a likely source of petroleum products. Permitted construction site operators are required to minimize exposure of construction and waste materials to stormwater and the occurrence of spills through the use of storage practices, prevention and response practices, and other controls and to prevent litter, construction debris, and construction chemicals (e.g., diesel fuel, hydraulic fluids, and other petroleum products) that could be exposed to stormwater from becoming a pollutant source in stormwater discharges (ADEC 2010).

5.2. Nonpoint Sources

A nonpoint source is a combination of diffuse pollutants that eventually discharge to a waterbody. Nonpoint source pollution generally begins by rainfall or snowmelt moving through a watershed, gathering natural and anthropogenic pollutants and eventually depositing the pollutants in a receiving waterbody. Nonpoint source pollution generally results from land runoff, precipitation, atmospheric deposition, drainage, seepage or hydrologic modification. The term "nonpoint source" is defined as any source of water pollution that does not meet the legal definition of "point source" in section 502(14) of the Clean Water Act. Therefore, in Alaska it represents any source not regulated under the APDES program.

The regulation of nonpoint source pollution occurs at the state and local level; however, Section 319 of the Clean Water Act provides federal leadership through the EPA to assist state and local governments. Most protection of nonpoint source pollution occurs through BMPs, including structural BMPs such as detention basins and vegetated buffers and non-structural BMPs such as education, training, and good housekeeping to reduce polluted runoff from activities or sites that drain to waterways.

Potential nonpoint sources of elevated petroleum hydrocarbons in surface waters can include surface runoff carrying petroleum products from leaking vehicles, accidental spills and improper storage or disposal as well as direct inputs from motorized watercrafts, atmospheric deposition of combustion byproducts (e.g., from wood-burning stoves), and illegal dumping or accidental spills. However, results from monitoring conducted in Big Lake in 2004, 2005 and 2009 (as shown in Section 4) showed that elevated concentrations of petroleum hydrocarbons occurred at times and locations that correlated with increased motorized watercraft usage on Big Lake. Petroleum hydrocarbons from motorized watercraft can come from gasoline leaks and spills but most of it likely results from the combustion process of gasoline motors, especially conventional 2-stroke engines, which are designed to directly release unburned fuel out of the exhaust into the water during combustion.

While motorized watercraft (Figure 5-1) are expected to be the primary sources of petroleum hydrocarbons to Big Lake, the community has also noted concerns about vehicle use on the lake during winter, when the frozen lake serves as a roadway for vehicles, including snow machines. During the 2009 study, Big Lake was sampled on the day the ice went out (May 13) and concentrations were not detected above the water quality criterion. Five of the 12 surface samples collected were non-detects. Of the seven detected concentrations, the highest TAH result was 3.9 µg/L at station BL-8, two samples measured between 2 and 3 µg/L TAH, and the remaining four samples were less than 0.3 µg/L TAH. Based on these results, together with summer data and knowledge of activities on the lake, it is assumed that hydrocarbon accumulation on the ice during winter activities is not expected to affect lake water quality. The amount of petroleum dripping or spilling onto the ice is anticipated to be a small volume, and hydrocarbons exposed to the air will volatize. Therefore, the amount of hydrocarbons still on the ice when it sinks in the spring is likely small enough that it would be sufficiently diluted by the volume of water in the lake. Although winter activities are not expected to negatively affect water quality in Big Lake, the activities do pose a potential source of petroleum hydrocarbons, and future management of Big Lake should consider activities on the lake during both summer and winter that could impact petroleum hydrocarbon levels.

Figure 5-1: Moored Watercraft at North Shore Recreation Site

5.3. Contaminated Sites

ADEC's Division of Spill Prevention and Response, Contaminated Sites Program is responsible for managing clean-up operations at contaminated sites in the state. This program uses two databases to track contaminated sites: Contaminated Sites and Leaking Underground Storage Tanks (LUST). A review of the Contaminated Sites and LUST databases and interactive mapping tool identified five contaminated sites within the immediate vicinity of Big Lake. Four of those sites are characterized as "clean up complete," and one is characterized as an "open" site. Figure 5-2 shows the locations of contaminated sites in the vicinity of Big Lake, based on ADEC's Contaminated Sites interactive map, and Table 5-1 summarizes the sites. As shown in the table, three of the four closed sites were cleaned up and closed prior to 1993. The remaining closed site was deemed clean and closed in 2001. The only open site near Big Lake is located at a residence along the southern shore of the West Basin. Soil sampling in August 2009 showed concentrations from petroleum-related analyses well below ADEC soil clean up levels, and the most recent groundwater monitoring (July 2010) resulted in one non-detect sample and two samples with detectable concentrations of BTEX (TAH) at 8.46 µg/l and 11.5 µg/l.

Because elevated TAH concentrations have been observed throughout Big Lake and at concentrations significantly higher than those measured in groundwater at the nearby contaminated site, it is assumed that contaminated sites are not contributing to the petroleum-related impairment in Big Lake.

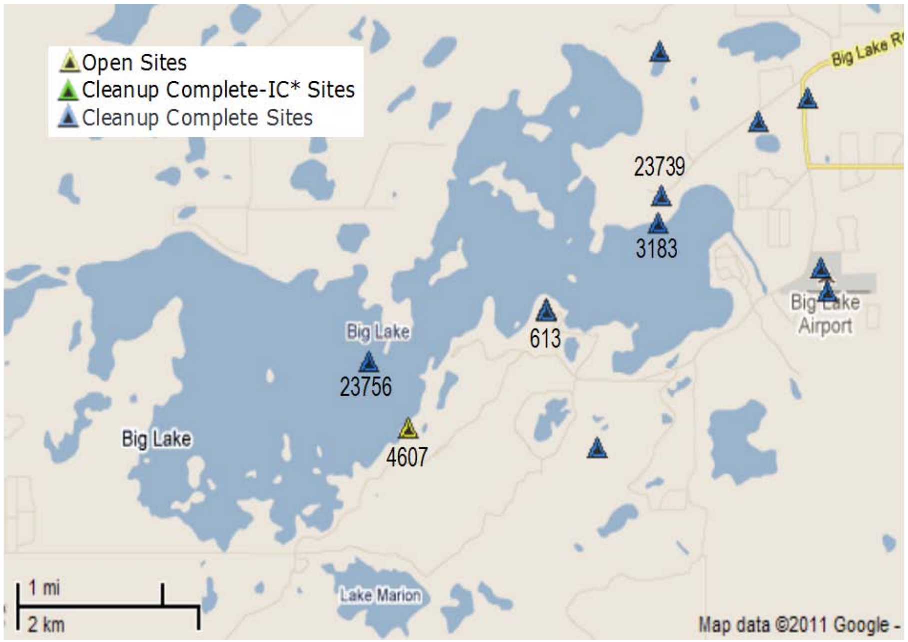


Figure 5-2: Contaminated Sites in the Vicinity of Big Lake

Table 5-1: Petroleum-related Contaminated Sites Located in the Vicinity of Big Lake

Site Name/Location	Hazard ID	Description	Date of Site Closure
Open Sites – Cleanup Ongoing			
Residence - 5100 South Dottie Lou Lane, 7.9 Mile South Big Lake Road , Big Lake, AK 99652	4607	In June 2007 a contractor accidentally bumped the valve from the 300-gallon aboveground heating oil tank. Approximately 30 gallons of diesel fuel were released inside the residence and seeped through the floor boards and onto the ground. Contamination impacted groundwater at ~12 feet below ground surface. On-site drinking water well was sampled on 10/27/07 and was non-detect for volatile organic compounds (VOCs). Approximately 176 cubic yards of hydrocarbon-impacted soil were removed and transported for thermal treatment. Initial soil sampling results indicated diesel range organics (DRO), benzene, and ethylbenzene levels above cleanup levels, and initial ground water sampling results indicated DRO, residual range organics (RRO), and benzene levels above cleanup levels. Additional soil sampling for DRO, GRO and BTEX was conducted in August 2009 during installation of two groundwater wells (MW-1 and MW-2). The soil sample collected from MW-2 and the duplicate of the sample from MW-1 did not detect any target analytes. The lab estimated concentrations of GRO, DRO, and total xylenes at 0.813 mg/kg, 14.1 mg/kg, and 0.0245 mg/kg, respectively, in the original sample from MW-1. These values are considerably below the ADEC soil cleanup levels of 300 mg/kg, 250 mg/kg, and 63 mg/kg, respectively. Three rounds of groundwater sampling have occurred at the site. Most recent groundwater sampling occurred in July 2010 and included collecting groundwater samples from the two onsite monitoring wells, performing a groundwater elevation survey, and inspecting Big Lake near the release site for potential sheening. No sheen was observed on the bank and surface water along the shoreline of Big Lake in the	–

		vicinity of the release. Analytical results for MW-1 were all non-detect. Sampling results at MW-2 (approximately 70 feet from the shore of Big Lake) reported TAH concentrations of 8.46 µg/l and 11.5 µg/l. ADEC has requested further groundwater monitoring be conducted to assess future TAH and TAqH levels and will evaluate the site for closure after reviewing results of the next groundwater sampling.	
Closed Sites – Cleanup Complete			
Burkeshore Marina Shop, 3610 Burkeshore Drive, North Shore Big Lake, Big Lake, AK 99652	3183	Elevated levels of BTEX, DRO, and metals contamination detected in lab analysis of sludge sample from seepage pit servicing the maintenance shop floor drain. Groundwater monitoring well was placed near the seepage pit in the direction of and 75 feet from the Big Lake shoreline. Well sampling analytical results showed detectable contaminants similar to the seepage pit analytes but at concentrations below applicable cleanup levels. Phase I Site Assessment was completed in October 1999. Approval of the site closure was based on information provided in a report summarizing findings from corrective actions performed in May 2001. The report noted that wastewater and sludge from the seepage pit was removed, analyzed, and manifested off site as hazardous waste that exhibited high concentrations of petroleum hydrocarbons (e.g., DRO up to 42,200 mg/kg and RRO up to 71,000 mg/kg, benzene up to 0.226 mg/kg). The concrete seepage pit was removed, cleaned and recycled, and soil was excavated around the seepage pit, stockpiled, and analyzed. The department concluded that soil impacted by the contamination was mostly below cleanup levels. Groundwater monitoring showed that during two sampling events, no contaminants were detected above cleanup levels and there was no evidence that the contamination has migrated to Big Lake. Based on the information presented in the report, ADEC determined that the cleanup actions have removed hazardous substances so there is no longer a risk to human health or the environment.	9/26/2001
Big Lake Marina, Big Lake shore @ Fish Cr.; Tract B of Blank subdiv., Big Lake, AK	23756	LUST site where one of the tanks contained gasoline and two might have held heating fuel. Samples were taken for analysis to confirm the contamination. Soil samples collected from some locations showed TPH concentration from 12 to 4890 ppm and BTEX concentrations from non-detect to 195 ppm. Groundwater monitoring wells installed in February 1990 indicated 0.5 ppb of benzene in water.	3/16/1993
North Shore Business Park, Burkshore Subdivision, Wasilla, AK	23739	LUST site where soil sample results showed 9 to 1890 ppm total petroleum hydrocarbons. Stockpiled contaminated soils were treated or incorporated into concrete.	9/16/1991
Weaver Brothers, 1611 East 1st Avenue, Anchorage, AK	613	Spilled diesel on the lot from a drum was contained. Contaminated soil was stockpiled on site then processed during the spring of 1990.	04/19/1990

5.4. Natural Sources

Geologic conditions near Big Lake should not produce naturally occurring petroleum hydrocarbons. Therefore, there is assumed to be no background presence of naturally occurring petroleum hydrocarbons in Big Lake. This assumption has been confirmed by water quality monitoring at control sites in Big Lake (OASIS 2010a).

6. TMDL Allocation Analysis

A TMDL represents the total amount of a pollutant that can be assimilated by a receiving water while still achieving water quality standards—also called the *loading capacity*. A TMDL is composed of individual waste load allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources and natural background loads. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody.

The analytical approach used to estimate the loading capacity and allocations for Big Lake is based on the best available information to represent the impairment and expected sources.

6.1. Loading Capacity

The loading capacity is equivalent to the TMDL and is the greatest amount of a given pollutant that a waterbody can receive without violating the applicable water quality standards, as represented by the TMDL water quality target. The TMDL for petroleum hydrocarbons in Big Lake is expressed as a concentration, equivalent to Alaska's numeric water quality criterion for TAH of 10 µg/L[3]. A concentration-based TMDL is directly comparable to the applicable water quality criterion and as such, is easily communicated.

A concentration-based TMDL was determined to be appropriate because using a more complicated analysis to estimate petroleum loads from boating activities and other sources and necessary reductions would not provide additional guidance or benefit to the subsequent planning and implementation actions, many of which are already underway. Because the expected primary source of petroleum hydrocarbons to Big Lake is motorized watercraft, pollutant reduction efforts will likely focus on public education regarding boat launch and refueling practices, motor types and their affect on water quality, and proper spill response. The resulting improvements from these types of BMPs are difficult to quantify and link to necessary load reductions.

Conceptually, the loading capacity represents the sum of WLAs, LAs, and MOS. Therefore, when the loading capacity is expressed as a load, it is divided among WLAs for point sources and LAs for nonpoint sources, minus a MOS. In those cases, the allowable load is a finite mass of pollutant that can be divided into individual loads for each source, that when combined represent the total loading capacity. However, when the loading capacity is expressed as a concentration, this additive approach is not applicable. As a concentration, the loading capacity represents an allowable ratio of the pollutant to water. Therefore, if the loading capacity is expressed as a concentration like in Big Lake, all allocations are equivalent to, rather than a portion of, the loading capacity.

Necessary reductions in existing concentration were also calculated for the sampling sites in Big Lake to identify the relative magnitude of impairment and associated reductions needed to meet the loading capacity and corresponding water quality standards. Reductions were calculated based on the maximum observed TAH concentration and the load allocation at each sample site shown to exceed the water quality criterion:

$$\text{Percent Reduction} = \frac{(\text{Maximum Measured Concentration} - \text{Load Allocation})}{(\text{Maximum Measured Concentration})} \times 100$$

[3] TMDLs are typically based on *loads* of pollutants—some allowable mass of a pollutant over a specified time period such as kilograms per day. The loading capacity is then divided among WLAs for point sources and LAs for nonpoint sources, minus a MOS. Conceptually, this definition is denoted by the equation

$$\text{TMDL} = \Sigma\ \text{WLAs} + \Sigma\ \text{LAs} + \text{MOS}$$

6.2. Wasteload Allocation

There are currently no known active permitted discharges of petroleum hydrocarbons to Big Lake. Therefore, the WLA for this TMDL is not applicable. If future activity is proposed that will entail regulated discharge of petroleum hydrocarbons to Big Lake, the TMDL may be revised to include modified WLAs. Possible revision of the WLA in this TMDL will depend on analysis of relevant factors at that time.

6.3. Load Allocation

The LA is the portion of the loading capacity allocated to nonpoint source discharges to the waterbody. As discussed in Section 5.2, motorized watercraft is the primary source and the only nonpoint source documented to impact petroleum levels in Big Lake. The concentration-based LA for motorized watercraft is equal to the loading capacity for TAH. Table 6-1 summarizes the LA for each sample site shown to have exceeded the TAH criterion in past monitoring events along with the necessary percent reductions of TAH concentrations from the maximum observed TAH concentration at each sample site. The reductions in existing concentration are provided to illustrate the relative magnitude of impairment and associated reductions needed to meet the loading capacity and water quality standards, again showing the highest reductions needed at those sites located near marinas or boat launch areas (BL-4, BL-6, BL-8, BL-10). Using the highest observed concentration to calculate reductions reflects the worst case scenario. Therefore, the reductions represent the levels needed to ensure that water quality standards are met during all conditions.

Table 6-1: TMDL Allocation Summary

Sample Site	Total Aromatic Hydrocarbons (µg/L)					Percent Reduction to Meet LA
	Loading Capacity	WLA	LA	Future Growth	Maximum Observed	
BL-2	10	NA	10	10	16	38.0%
BL-3	10	NA	10	10	18	43.6%
BL-4	10	NA	10	10	70	85.6%
BL-5	10	NA	10	10	15	33.9%
BL-6	10	NA	10	10	27	62.5%
BL-7	10	NA	10	10	19	47.4%
BL-8	10	NA	10	10	20	50.7%
BL-10	10	NA	10	10	76	86.8%
BL-26	10	NA	10	10	17	41.1%
BL-27	10	NA	10	10	17	40.0%

6.4. Margin of Safety

A MOS must be included in a TMDL to account for any uncertainty or lack of knowledge regarding the pollutant loads and the response of the receiving water. The MOS can be implicit (incorporated into the TMDL analysis through conservative assumptions) or explicit (expressed in the TMDL as a portion of the loadings) or a combination of both. For the Big Lake TMDL, because the loading capacity and allocations are set equal to the water quality criterion, there is no uncertainty that if the TMDL is met it will result in conditions that support designated uses.

In addition, the state water quality criterion for hydrocarbons has a built in safety factor of 0.01. The numeric criterion of 10 µg/L for TAH was based on the published results of laboratory studies on Alaska species. Given a threshold toxicity, a safety factor was applied to minimize risk of possible sublethal biological effects. Reported lethal toxicity values for Alaskan test species in crude oil or fuel oil, measured as total hydrocarbons or TAH, ranged from roughly 0.3 to 14.0 mg/L depending on the species and life stage of the species tested. EPA recommended using a safety factor of 0.01 of the lowest LD_{50} (lethal dose where 50 percent of the organisms die) of the most sensitive fresh water or marine species of life stage tested in establishing allowable hydrocarbon levels in the aquatic environment. Given an average lethal value of 1.0 mg/L for sensitive Alaskan organisms, ADEC established a criterion of 0.01 mg/L (or 10 µg/L) for TAH.

Although not technically a MOS, the TMDL also includes targeted reductions based on the difference between the maximum observed TAH concentration and the water quality criterion (and loading capacity). Using the maximum concentration rather than an average concentration represents the worst-case scenario for management of TAH and ensures that lake concentrations will meet the TAH criterion under average and extreme conditions.

6.5. Seasonal Variation and Critical Conditions

Seasonal variation and critical conditions associated with pollutant loadings, waterbody response, and impairment conditions can affect the development and expression of a TMDL. Therefore, TMDLs must be developed with consideration of seasonal variation and critical conditions to ensure the waterbody will maintain water quality standards under all expected conditions.

Because the primary source of petroleum hydrocarbons in Big Lake is motorized watercraft, the times of highest loading and worst impairment are expected to be during summer months when lake use is highest. Available water quality data support this assumption, showing exceedances of water quality criteria throughout the summer months, with the highest TAH concentrations during holiday weekends (Memorial Day, Independence Day, and Labor Day) when lake use is the highest. As discussed in Alaska's 2010 Integrated Report and throughout this report, the impairment and critical conditions of Big Lake are seasonal, with impairment occurring from May 15 to September 15. Therefore, the TAH TMDL and associated allocations for Big Lake apply during these months to be protective of the lake and meet water quality standards. However, it is important to note that applicable water quality criteria for petroleum hydrocarbons, including TAH and TAqH, apply year-round, during all conditions and seasons.

6.6. Future Growth

As described in the *Big Lake Community Council Area Comprehensive Plan Update* (Big Lake Planning Team et al. 2009), the rapid growth of the Mat-Su Borough has been well documented, with growth rates among some of the highest in Alaska. For the 1990s the Borough was in the top 40 fastest growing areas in the United States. Between 2000 and 2006, the Borough's population grew by 30 percent, compared to just 9 percent for Anchorage and 7 percent for the state as a whole. Both the Borough and the Big Lake area have undergone rapid growth in the past 20 years with Big Lake's growth outpacing the Borough's at points. More recently both the Borough and the Big Lake community populations have grown less quickly but still at a pace that equals or exceeds the rest of the state. The population of the Big Lake community in 2010 was 3,350, representing an average annual growth of 2.7% during the preceding decade, as compared to an average annual growth rate of nearly 8% between 1990 and 2000 and of 26% between 1980 and 1990. For the area around Big Lake, early growth was driven by its reputation as a recreational playground with more recent population increases reflecting the area's transition into a commuter suburb and retirement community.

Continued growth in the community of Big Lake and nearby areas will lead to continued and likely increased use of the lake for recreation and transportation as well as increased development in the surrounding watershed. Future sources, such as facilities that will apply for coverage under the NPDES MSGP or additional in-lake watercraft, have the potential to deliver petroleum hydrocarbons to the lake. To address this, the TMDL establishes an allocation for future sources equivalent to the water quality criterion (and loading capacity) of 10 µg/L to ensure that any future point and nonpoint sources also meet established water quality targets. For example, if the marinas on Big Lake meet the eligibility requirements for coverage under the MSGP for industrial stormwater, the future allocation of 10 µg/L would apply to stormwater discharges from their properties.

Any future sources are expected to be a small portion of the input of hydrocarbons and as long as they meet the water quality criterion of 10 µg/L they will not contribute to the impairment in Big Lake. The future allocation provides a tool and opportunity for considering and effectively managing future sources without hindering growth in the area or further impairing Big Lake.

6.7. Daily Load

A TMDL is required to be expressed as a daily load; the amount of a pollutant the waterbody can assimilate during a daily time increment and meet water quality standards. The TMDL for petroleum hydrocarbons in Big Lake is presented as a maximum concentration allowed in the water column. The allowable concentration is applicable at all times and can therefore be applied on a daily basis. This is consistent with the requirement to express the TMDL on a daily time increment.

7. Implementation

The primary cause of elevated petroleum hydrocarbons in Big Lake is motorized watercraft. Many activities are already underway in the community to address this source. This section summarizes these activities and potential future activities related to watercraft activity. In addition, this section provides information on implementation activities that could address inputs from other nonpoint sources and future regulated stormwater sources.

7.1. Current Activities Related to Motorized Watercraft

ADEC is currently leading a coordinated effort with the Big Lake community and local, regional, state and federal stakeholders to develop an action plan for addressing the petroleum hydrocarbon impairment in Big Lake. To date the community and their partners have participated in seven work sessions (August, October, November 2010; February, April, October, November 2011) to develop a set of prioritized actions that meet three key criteria: 1) they must address the most critical issues and geographic areas; 2) they must have community support and a high likelihood for community-led implementation; and 3) they contribute to the long-term health of the lake. Participants in the process have included Big Lake community residents and property owners, the state senator and representative for the area and their staff, representatives from the Mat-Su Borough, ADEC, Alaska Department of Fish and Game (ADF&G), and Alaska Department of Natural Resources (ADNR), Division of Parks & Outdoor Recreation (State Parks). Table 7-1 summarizes the actions identified by the Big Lake community to date to address the petroleum impairment in the lake. (Information on the evolving Big Lake Action Plan, including detailed work session notes, is available on ADEC's website at www.dec.state.ak.us/water/wnpspc/protection_restoration/biglakewq/index.htm.)

Table 7-1: Action Items Identified by Big Lake Community to Address Impairment in Big Lake

Action (Estimated Completion Date)	Past Achievements (Starting August 2010)	Current Status (as of February 2012)	Responsible Parties
1. Develop a clean boating campaign that reaches all Big Lake recreators including resident and visitors. Estimated completion date: Summer 2012	• ADEC developed educational insert that has been distributed with the Department of Motor Vehicles boat licensing information. • State Parks also distributed insert with launch pass materials. • Insert can be used as template for other campaign components (e.g., fishing licenses, marinas, boat manufacturers, refueling station). • Ten Big Lake recreators attended the Alaska Water Wise Class to learn about clean boating and boating safety. • The educational brochure went out with marine billings. • Cook Inletkeeper conducted an informal survey to assess boating practices on Big Lake. • Cook Inletkeeper worked with the community to develop a "Communications Plan" for the education campaign. The plan identifies funded and unfunded water quality improvement projects. • The community with the assistance of Mat-Su Conservation Services has made connections to the Mat-Su Resource Conservation + Development and the Mat-Su Health Foundation.	• Cook Inletkeeper will be working with the community to develop a more complete educational program including a pilot launch host program that will provide on-site educational volunteers at the Borough and State recreation sites. • The workgroup is continuing to research funding opportunities for unfunded actions in the "Communications Plan." • The workgroup will continue to work with local businesses regarding the possibility of making the educational insert available for their customers.	• Cook Inletkeeper • Big Lake Water Quality Work Group • Mat-Su Conservation Services • Big Lake Businesses/Chamber of Commerce

2. Educate and work with marina owners and staff to implement appropriate components of the Alaska Clean Harbors (ACH) program Clean Harbor checklist
 	
Estimated completion date:
Summer 2011
	• ADEC met with marina operators and coordinated with them to obtain feedback on feasible changes.
	• *Marinas (Summer of 2011):*
	  • Conducted a self-assessment using Clean Harbor guidelines.
	  • Gave out bilge pillows and got some back; these were incinerated using a Smart Ash Burner.
	  • Held batteries for proper disposal.
	  • Purchased and distributed bilge socks to their customers.
		• Cook Inletkeeper is continuing to coordinate with local marinas on several actions toward meeting Alaska Clean Harbors standards.	• Cook Inletkeeper
			• Burkeshore Marina
			• Shilanski Family Marina

Action (Estimated Completion Date)	Past Achievements (Starting August 2010)	Current Status (as of February 2012)	Responsible Parties
3. Improve state launch ramps Estimated completion date: Summer 2012	• ADNR State Parks has developed an initial design for an improved launch ramp that includes a passive treatment mechanism • Two metal clean boating signs and spill response panels were put up at the North and South recreation sites. • State recreation campground hosts and the concessionaire directed boaters to the marinas for bilge socks.	• The workgroup is continuing to pursue options for launch improvements, including working with ADNR State Parks representatives beginning with an updated letter legislators that includes a quote from a local contractor that shows the approximate cost to do the bioremediation project at the three public launch sites (North Shore, South Shore and Mat-Su Borough site); request to legislators to discuss the request with DNR to expedite the funding process for the design and construction to include funding for environmental controls (e.g. bioremediation project).	• Big Lake Water Quality Workgroup
4. Evaluate funding opportunities to implement action plan Estimated completion date: Ongoing	• Community partnered with Cook Inletkeeper and was successful in their FY12 ACWA grant application. Grant activities include developing action plans with the marinas to meet Clean Harbor checklists; developing and piloting a launch host program; and developing and distributing clean boating kits and other outreach materials. • The community presented project updates to the Big Lake Chamber of Commerce and gained support from the Board of Directors to collaborate on fundraising efforts. • The community established a fiscal sponsor relationship with the Mat-Su Resource Conservation + Development for future fundraising efforts that meet both groups' missions.	• See Action Items 1, 2 and 3 above regarding pursuit of education and launch ramp-related funding pursuits.	• Big Lake Water Quality Workgroup • Mat-Su Conservation Services
5. Resample Big Lake Estimated completion date: Summer 2012	• Sampling was conducted at key sites in 2004, 2005 and 2009.	• ADEC will conduct community check-ins to assess progress on action plan, and if the community feels they have made significant progress, ADEC will retest.	• ADEC • Big Lake Water Quality Workgroup

Action (Estimated Completion Date)	Past Achievements (Starting August 2010)	Current Status (as of February 2012)	Responsible Parties
6. Request a State Parks Director's Order that includes the following actions for Big Lake: • No refueling at launch areas • Require plugs to removed only after the watercraft is required distance away from launch ramp • Create bilge pump out station with a tank to collect/dispose of dirty bilge water • Monitor bilges and check for pads before allowing launch or refueling • Use booms to contain spills but not as a daily solution Estimated completion date: Undetermined	• After coordinating with the DNR State Parks Director on the possibility of implementing a Director's Order, it was determined that this was not a feasible approach.	• The community is working with State Parks to implement other action items as outlined above.	• N/A
7. Draft and submit a policy request letter to legislative representatives to include the following recommended statewide policy changes • Encourage no refueling policy on the water except at the marinas and mandatory haul out for refueling jet skis • Institute a boat inspection program that includes a prevention checklist • Employ launch hosts that can inspect watercraft at launches • Ban use of dish detergent as a dispersal agent Estimated completion date: Undetermined	• The community has decided to table this action until they have implemented the educational and facility improvement actions 1-5 above.	• None to report	• N/A
8. Establish a Lake Association Estimated completion date: Undetermined	• This action item is considered a longer-term solution and will be reconsidered after implementation of all other action items	• None to report	• N/A

7.2. Potential Future Activities Related to Motorized Watercraft

In addition to the actions listed in Table 7-1, further options for addressing the petroleum impairment include limiting the number of motorized watercraft allowed on the lake during busy days and establishing requirements for the types of motors allowed on Big Lake. The types of motorized watercraft operating on a waterbody can have significant impact on the amount of petroleum pollution. For watercraft with 2-stroke engines, 25% to 30% of fuel consumed might exit the cylinder unburned thereby discharging to the waterbody, while the use of a 4-stroke engine reduces fuel lost in the combustion process by 75% to 95% (OASIS 2010a). This means that a 2-stroke engine could be contributing between 4 and 20 times as much petroleum as a comparable 4-stroke engine, making them a potentially significant source of petroleum hydrocarbons to waterbodies. To gauge the number of watercrafts with 2-stroke versus 4-stroke engines field personnel counted watercraft and noted, when possible, the engine type during the 2009 intensive monitoring events (Memorial Day and 4th of July weekends). Watercraft counts were used along with assumptions regarding watercraft use, engine performance, gasoline characteristics, and Big Lake characteristics to estimate the amount of TAH loading coming from motorized watercraft. During the intensive surveys, only approximately 40% of engine types could be identified. Of those identified, 10-15% were identified as 2-stroke engines. However, the preliminary loading analysis estimated these engines as accounting for 50% of the hydrocarbon pollution entering Big Lake.

The Kenai River presents an example of successfully addressing a petroleum impairment by instituting restrictions on the types of watercraft that can use the river (USEPA 2011, Stevens et al. 2009). Restrictions prohibiting the use of on two stroke motors during high use periods resulted in the river no longer being impaired. EPA instituted stricter emissions standards for manufacturers of marine outboard motors, requiring manufacturers to replace carbureted 2-stroke outboards and personal watercraft with cleaner, new technology engines[4]. The goal of the regulations was to reduce emissions and improve air and water quality. The original rule was finalized in October 1996 and was phased in with incremental reductions through 2006. (A 2000 amendment to the 1996 rule allowed flexibility for small manufacturers to implement the rule over a longer timeframe, through 2009.) Therefore, any new watercraft that are purchased and used in Big Lake will have cleaner 4-stroke motors, and older motors will eventually be phased out.

ADEC and local stakeholders can evaluate the feasibility and necessity of pursuing a motor buy-back program to accelerate the phase out of the older more polluting 2 stroke motors given the local conditions, funding opportunities and consideration of relevant regulations. Funding toward a buy back has not yet been found.

7.3. Activities Related to Localized Nonpoint Sources

In addition to clean boating activities, good housekeeping activities at lakeside homes can reduce the potential for localized discharge of petroleum hydrocarbons to Big Lake. Residential activities related to vehicle maintenance and accidental spills can deposit petroleum hydrocarbons on the ground where they can be delivered to the lake in surface runoff. Educating local homeowners can help prevent exposure of petroleum hydrocarbons to surface runoff and therefore the lake. A primary source of petroleum hydrocarbons in residential areas is petroleum substances from vehicles, whether from vehicles that are leaking oil or activities associated with vehicle repair and maintenance (e.g., oil changes). Good housekeeping activities that minimize the potential for spilling or leaking oil onto the ground can include:

- Repair and maintain vehicles as necessary to prevent leaking oil.
- Use drip pans when changing fluids.
- Perform vehicle maintenance indoors.

[4] Control of Air Pollution; Final Rule for New Gasoline Spark Ignition Marine Engines; Exemptions for New Nonroad Compression Ignition Engines at or Above 37 Kilowatts and New Nonroad Spark Ignition Engines at or Below 19 Kilowatts (Federal Register: October 4, 1996, Volume 61, Number 194, Page 52087-52169)

- Store wastes in appropriate and separate containers, if possible in original container with the product name.
- Dispose of used oil and other fluids properly. All Mat-Su Borough landfills and transfer facilities maintain a collection point for recycling of used engine oil.
- Do not pour waste oil or hazardous wastes on the ground, down the drain, in local sewers, or into local waterways.
- Properly dispose of unused equipment.
- Have absorbents and containers available to clean up spills. (It should be noted that it is illegal to use dish soap to address petroleum spills in water based on state regulations for the control of oil and hazardous substances pollution (18 ACC 75). Dish soap does not remove petroleum hydrocarbons but rather disperses them into the water column.)
- Have emergency phone numbers for fire, ambulance, and oil or chemical spill response unit readily available.

7.4. Activities for Future Regulated Stormwater Sources

In addition to the above actions related to watercraft use, if existing or future industrial sources apply to obtain coverage for stormwater permits under the MSGP, they will be subject to a number of requirements related to responsible practices to prevent input of petroleum to Big Lake. For example, if marinas in the area meet the criteria and apply for coverage under MSGP they would be subject to the following Water Transportation sector-specific requirements to prevent pollutant delivery in the facility's stormwater (USEPA 2008):

- **Good Housekeeping Measures:**
    - *Pressure Washing Area.* If pressure washing is used to remove marine growth from vessels, the discharge water must be permitted by a separate NPDES permit. Collect or contain the discharges from the pressures washing area so that they are not co-mingled with stormwater discharges authorized by this permit.
    - *Blasting and Painting Area.* Minimize the potential for spent abrasives, paint chips, and overspray to discharge into receiving waters or the storm sewer systems. Consider containing all blasting and painting activities or use other measures to minimize the discharge of contaminants (e.g., hanging plastic barriers or tarpaulins during blasting or painting operations to contain debris). When necessary, regularly clean stormwater conveyances of deposits of abrasive blasting debris and paint chips.
    - *Material Storage Areas.* Store and plainly label all containerized materials (e.g., fuels, paints, solvents, waste oil, antifreeze, batteries) in a protected, secure location away from drains. Minimize the contamination of precipitation or surface runoff from the storage areas. Specify which materials are stored indoors, and consider containment or enclosure for those stored outdoors. If abrasive blasting is performed, discuss the storage and disposal of spent abrasive materials generated at the facility. Consider implementing an inventory control plan to limit the presence of potentially hazardous materials onsite.
    - *Engine Maintenance and Repair Areas.* Minimize the contamination of precipitation or surface runoff from all areas used for engine maintenance and repair. Consider the following (or their equivalents): performing all maintenance activities indoors, maintaining an organized inventory of materials used in the shop, draining all parts of fluid prior to disposal, prohibiting the practice of hosing down the shop floor, using dry cleanup methods, and treating and/or recycling stormwater runoff collected from the maintenance area.

- *Material Handling Area.* Minimize the contamination of precipitation or surface runoff from material handling operations and areas (e.g., fueling, paint and solvent mixing, disposal of process wastewater streams from vessels). Consider the following (or their equivalents): covering fueling areas, using spill and overflow protection, mixing paints and solvents in a designated area (preferably indoors or under a shed), and minimizing runoff of stormwater to material handling areas.
- *Drydock Activities.* Routinely maintain and clean the drydock to minimize pollutants in stormwater runoff. Address the cleaning of accessible areas of the drydock prior to flooding, and final cleanup following removal of the vessel and raising the dock. Include procedures for cleaning up oil, grease, and fuel spills occurring on the drydock. Consider the following (or their equivalents): sweeping rather than hosing off debris and spent blasting material from accessible areas of the drydock prior to flooding and making absorbent materials and oil containment booms readily available to clean up or contain any spills.

- **Employee Training.** As part of your employee training program, address, at a minimum, the following activities (as applicable): used oil management, spent solvent management, disposal of spent abrasives, disposal of vessel wastewaters, spill prevention and control, fueling procedures, general good housekeeping practices, painting and blasting procedures, and used battery management.
- **Preventive Maintenance.** As part of your preventive maintenance program, perform timely inspection and maintenance of stormwater management devices (e.g., cleaning oil and water separators and sediment traps to ensure that spent abrasives, paint chips, and solids will be intercepted and retained prior to entering the storm drainage system), as well as inspecting and testing facility equipment and systems to uncover conditions that could cause breakdowns or failures resulting in discharges of pollutants to surface waters.

7.5. Follow-up Monitoring

Follow up monitoring in Big Lake will be essential to assessing the progress and benefits of the Action Plan and other implementation actions. Repeat monitoring at the sampling sites and during the observed times of worst impairment (e.g., high use weekends) will be necessary to track water quality improvement. The water quality progress can be used to assess implementation actions and refine or enhance the action plan and related priorities as necessary. Repeat water quality data will also be necessary for identifying when Big Lake meets applicable water quality standards and can be removed from the state's impaired waters list. At least two years of data showing concentrations meeting water quality criteria will be necessary to delist the lake.

8. Public Notice

On March 11, 2012, ADEC provided official public notice of the draft TMDL. Notice was provided on the State's Public Notice Web site, as a link from ADEC's Big Lake project web site, and published in the Anchorage Daily News statewide newspaper. Additionally, notification to known stakeholders was sent directly (via email) to known stakeholders. A public informational meeting was held on April 3, 2012, in Big Lake at the Lion's Club meeting room. Three people from the general public attended. The opportunity to comment on the draft TMDL closed April 24, 2012. No public comments were received.

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