

Memo



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To: Joint Fact Finding Committee

From: Adam Lewandowski, AICP, Tiffany Lunday, Sydney Coatsworth, AICP; Ascent Environmental; Brent Wolfe, PE, NHC

Subject: **Summary of Potential Water Quality Impacts of Boating, to Inform the Lake Tahoe Shoreline Plan and EIS**

INTRODUCTION

Among other things, the Shoreline Plan will regulate new and redeveloped boating facilities on Lake Tahoe. These new or redeveloped facilities would likely result in some increase in boat use on Lake Tahoe. The effects of increased boating activity on Lake Tahoe's water quality is an important issue in developing the Shoreline Plan. The degree to which an increase in boating use resulting from the Shoreline Plan could affect water quality will be evaluated in the Shoreline EIS. To support development of the Shoreline Plan and EIS, this memo summarizes the general types of water quality impacts that could occur as a result of increased boating use, and lists the information sources that the Joint Fact Finding Committee has identified relevant to each type of potential water quality impact.

It should be noted that additional effects on water quality could occur from the construction and maintenance of shorelines facilities (e.g., new pier construction, dredging). Increased boat use could also result in negative effects on related resources, such as through the introduction and spread of aquatic invasive species. However, this memo only addresses the possible negative effects on water quality in Lake Tahoe that could result from increased boat use, and motorized boating in particular. The likelihood that these negative effects would occur and the severity of the impacts will be evaluated in the Shoreline Plan EIS.

We are seeking concurrence from the Joint Fact Finding Committee that the categories of water quality impacts described below are comprehensive and appropriate for the environmental review of the boating use under the shoreline plan. We are also seeking input from the Joint Fact Finding Committee on other sources of information that would be useful in evaluating the magnitude and extent of these potential water quality impacts.

WATER QUALITY EFFECTS OF BOATING ACTIVITY

The possible effects of increased boating on water quality can be broadly grouped into three different categories, described below:

1. Sediment resuspension and turbidity
2. Air pollutant deposition
3. Direct contamination from hydrocarbon and other pollutants

Sediment Resuspension and Turbidity

The Lake Tahoe TMDL identified shoreline erosion as contributing 0.5%, 4%, and less than 1% of the total contribution of Nitrogen, Phosphorus, and fine sediment, respectively, that enter Lake Tahoe. While not a major source of the pollutants of primary concern, the physical processes and geomorphology of the near shore environment play a role in the quality of Lake Tahoe's waters. The interplay of littoral, meteorological (especially wind), and anthropogenic forces can affect shoreline erosion and the resuspension of lake bottom sediment, which can influence near shore turbidity.

The hydrodynamic effects of motorized boating can include wake-induced shoreline sediment disruption and propeller wash-induced sediment scour. These forces have the potential to entrain sediment and organic matter along the shoreline and affect turbidity levels in the nearshore environment. The ability for boating activity to generate physical changes at the shoreline, and resulting changes in water quality, depends on a number of factors, including the size and speed of the boat, the characteristics of the shoreline, and the relative size and distribution of sediments in the shore zone. Research on this topic generally indicates motorized boat-induced resuspension of sediment occurs when boats are moving at high speeds in shallow water (i.e., less than 10 – 20 ft. depth).

Research papers and reports relating to these processes within the Lake Tahoe environment were identified by the Joint Fact Finding Committee, and are summarized below. Additional research from areas outside of the Tahoe region is available. A broader literature review is recommended to support the analysis in the EIS.

Table 1 Summary of Available Information on Sediment Resuspension and Turbidity

Study	Author/Year	Synopsis
Sediment Processes and Resuspension		
The Shore-Zone System for Lake Tahoe	TRPA 1971	This report contains a physical characterization of the shore zone system of Lake Tahoe, and the processes therein. It goes on to discuss human influences on the nature of the system (including regulation of lake levels, forestry, and structural manipulation of the shore zone area), and makes recommendations for future anthropogenic activity vis a vis characterization of the physical shore zone system and potential for changes to it.
Sedimentation of the Littoral Zone in Lake Tahoe, California – Nevada	Osborne et. al. 1985	This study contains an investigation and assessment of the character and physical processes of the littoral zone of Lake Tahoe. It identifies sources of beach sand, and the structure of littoral cells, including a proposed model for the littoral system.
Investigation of Near Shore Turbidity at Lake Tahoe	LRWQCB/Nevada Division of State Lands 2002	This study investigated the spatial and temporal variability of turbidity in the near shore environment of Lake Tahoe. It found the highest turbidity values in the nearshore environment adjacent to Tahoe Keys and other areas of South Lake Tahoe, and Tahoe City. A strong correlation between development on-shore and near shore turbidity was identified.
Predicting and Managing Changes in Near-Shore Water Quality	Schladow et. al. 2010	This study investigated three areas pertinent to near shore water quality: in-situ measurement and observation of physical processes (especially resuspension), modeling wind-driven waves and their impact on resuspension, creation of a 3D hydrodynamic model, algal survey, invasive species, and urban storm water runoff into the lake.
Effect of Motorized Watercraft on Summer Nearshore Turbidity at Lake Tahoe, California - Nevada	Alexander and Wigart 2013	This study measures the summer nearshore turbidity at two piers in South Lake Tahoe and found turbidity to be influenced by wind, boating, and lake currents, but not streamflow or urban storm water runoff. It speculates that wave action and turbulence from boating in the nearshore likely suspend sediment and release nutrients.

Table 1 Summary of Available Information on Sediment Resuspension and Turbidity

Study	Author/Year	Synopsis
Wind-driven Nearshore Sediment Resuspension in a Deep Lake during Winter	Reardon et. al. 2014	This study investigated wind-driven nearshore sediment resuspension. Wind waves were found to be the predominant force in sediment resuspension compared with currents and random motion. The authors draw a connection between the results and impacts on lake clarity.
Seasonal Nearshore Sediment Resuspension and Water Clarity at Lake Tahoe	Reardon et al. 2015	As follow-up study to <i>Wind-driven Nearshore Sediment Resuspension in a Deep Lake during Winter</i> , this study investigates seasonal differences in nearshore sediment resuspension, as well as the influence of changing lake levels. The authors draw a connection between the results and impacts on lake clarity.

Source: TRPA 2016

Air Pollutant Deposition

The Lake Tahoe TMDL identified atmospheric deposition of pollutants onto the surface of the lake as contributing 55%, 15%, and 15% of the total contribution of Nitrogen, Phosphorus, and fine sediment, respectively, that enter Lake Tahoe. Oxides of nitrogen (NOx) and Particulate Matter (PM) are present as a byproduct in the exhaust generated from combustion sources, including boats, and can be deposited on the surface of the lake in particulate form. The Lake Tahoe TMDL found that “airborne pollutants are generated mostly from within the Lake Tahoe basin and come from motor vehicles, wood burning, and road dust. Motor vehicles, including cars, buses, trucks, boats, and airplanes are primary sources of atmospheric nitrogen.”¹ Information on emissions from motorized boats is readily available (see air quality studies available at <http://www.trpa.org/programs/shorezone/>), and these emissions will be quantified as part of the Shoreline EIS. The EIS will also quantify the proportion of these emissions that would be deposited into Lake Tahoe, however that analysis has not yet been completed.

Table 2 Summary of Available Information on Air Pollutant Deposition from Boating

Study	Author/Year	Synopsis
Local air pollutants threaten Lake Tahoe's clarity	Gertler et. al. 2006	This article reviewed a series of studies performed by research groups from the U.S. Department of Agriculture's Forest Service, UC Davis and the Desert Research Institute. Overall, the studies found that the air pollutants most closely connected to the decline in Lake Tahoe's water quality originated largely from within the basin.
Lake Tahoe Atmospheric Deposition Study (LTADS), Final Report	California Air Resources Board 2006	This study evaluated the amount and sources of aerial deposition of pollutants into Lake Tahoe. It found that motor vehicles exert a large influence on NOx, NH3, PM_coarse, and PM_large concentrations in the Tahoe Basin while wood burning exerts the dominant influence on PM_fine concentrations. It also noted that the location and timing of emission sources is important in determining their potential for deposition.

Source: TRPA 2016

Direct Hydrocarbon and Other Pollutant Contamination

Direct pollutant discharges of hydrocarbons or other contaminants into lake Tahoe could result from boating. Possible discharges could include petroleum (hydrocarbon) products from spills or engine leaks, or microbial contamination from bilge or wastewater pumping. A number of different hydrocarbon contaminants are present in boat engine fuels. The group of chemicals known as BTEX (benzene, toluene, ethylbenzene, and xylene), and polyaromatic hydrocarbons (PAHs), are toxic constituents that are present in both non-

¹ Nevada Division of Environmental Protection. 2011. Final Lake Tahoe Total Maximum Daily Load, page 7-8

combusted engine fuel and combustion byproducts. An additional concern regarding PAHs is their increase in toxicity to aquatic organisms under high ultraviolet exposure, like that which occurs in the Lake Tahoe environment.

The mechanisms by which hydrocarbons enter the water are fueling spills, other accidental spills, engine leaks, and exhaust emissions. Modern outboard engines exhaust beneath the surface of the water, and consequently, all exhaust must pass through the water column. Most hydrocarbons will pass through the water column to the air, but some will dissolve or condense, and remain in solution, or deposit as a film at the surface of the water.

Research papers and reports relating specifically to these processes within the Lake Tahoe and similar alpine lake environments are available, and summarized below.

Table 3 Summary of Available Information on Direct Contamination from Hydrocarbons and Other Pollutants

Study	Author/Year	Synopsis
Hydrocarbon Contamination and Other Direct Pollutant Discharges		
Motorized Watercraft Environmental Assessment	TRPA 1997	This presents an Environmental Assessment of a proposed series of ordinances that would limit and regulate the use of motorized watercraft on Lake Tahoe including: <ul style="list-style-type: none"> - Phase out carbureted 2 stroke engines - Establish a no wake zone - Ban the use of motorized watercraft in tributaries The assessment covers: water quality, air quality, noise, recreation, boating safety, economics, fisheries, and wildlife.
Lake Tahoe Motorized Watercraft Report – An Integration of Water Quality, Watercraft Use, and Ecotoxicology Issues	TRPA/UC Davis 1998	TRPA organized a study group known as the Motorized Watercraft Technical Advisory Group to “develop, coordinate, and implement a research plan focused on the potential water quality and limnological impacts of motorized watercraft on high alpine lakes.” This report synthesizes the results of studies carried out in effort to achieve that stated goal. Altogether, the studies present the following: <ul style="list-style-type: none"> - Sources of fuel constituents - Magnitude of constituents - Fate and transport analysis - Evaluation of the potential for these constituents to pose a risk to human health and aquatic life
Options for Minimizing Fuel-Related Contaminants in Lakes and Reservoirs	University of California, Davis/CH2M HILL/Contra Costa Water District 2001	This study looks at the relationship between recreational boating on lakes and reservoirs, and the effects on human and biological health, and aesthetics. The focus is on the contaminants MTBE and BTEX, which are emitted from motorized watercraft and contaminate waterbodies. Management options are presented and evaluated through modeling scenarios.
Environmental Assessment of the Impacts of PAH in Lake Tahoe and Donner Lake	University of Nevada, Reno/University of California, Davis/USGS 2003	This study was designed to evaluate problematic and toxic PAH emissions from watercraft in Donner Lake and Lake Tahoe, and the potential effects of phototoxicity on various organisms. It also includes a regulatory assessment designed to evaluate management measures to control non-point pollution associated with boat emissions.
Bioassessment of Tahoe Keys Marina, South Lake Tahoe, CA	CDFG 2004	The Tahoe Keys Property Owners Association contracted CDFW's Aquatic Bioassessment Laboratory to assess the biological condition of the marina as a condition of their NPDES permit. Benthic macroinvertebrate communities and water quality were sampled and analyzed at four locations within the Keys to assess aquatic health. The results are presented in this report.

Table 3 Summary of Available Information on Direct Contamination from Hydrocarbons and Other Pollutants

Study	Author/Year	Synopsis
The Relationship between Boating Activity on Lake Tahoe and Contamination from Polycyclic Aromatic Hydrocarbons (PAHs)	Entrix 2004	This paper is a synthesis of existing literature on the relationship between boating activity in Lake Tahoe and potential water quality impacts from PAHs. It provides information on the linkage between boating and PAH issues, a summary and critique of literature on the subject, and a discussion of control strategies and mitigation measures. The paper was originally intended to assist in scoping the water quality section of the 2008 Shorezone Ordinance Amendments EIS.
VOC Loading from Marine Engines to a Multiple-Use Lake	Heald et. al. 2004	This paper presents the results of the boating survey conducted on Donner Lake during the summer of 2000, and formed the basis for model calibration in the 2001 report <i>Options for Minimizing Fuel-Related Contaminants in Lakes and Reservoirs</i> (see above).
Gasoline-Related Organics in Lake Tahoe Before and After Prohibition of Carbureted Two-Stroke Engines.	Lico 2004	This study evaluated the effect of the ordinance banning two-stroke engines from all waters in the Lake Tahoe Basin. It focuses on the concentration of MTBE, BTEX, and PAHs prior to, and after, implementation of the ordinance.
Lake Tahoe Source Water Protection Risk Assessment	Tahoe Water Suppliers Association/Black and Veatch 2008	This report presents a variety of risk assessment tools for quantifying the impacts of increased lake recreation, particularly increased body-contact recreation. It assesses the vulnerability of public drinking water intakes to microbial contamination from body-contact recreation.
2009 Monitoring Results for the Lake Tahoe Shorezone Water Quality Monitoring Program	Rowe et. al. 2009	This study presents the results of water quality monitoring data that were collected during the summer of 2009. This data was collected as a part of what was to be a long-term water quality monitoring program to understand the effectiveness of the Shorezone Blue Boating Program, and predict and evaluate whether additional shorezone structures, and the associated increase in boating activity, would result in higher levels of watercraft-generated pollution. The 2009 dataset was intended to provide a kind of baseline for a longer-term monitoring program.
Waste Discharge Requirements and National Pollutant Discharge Elimination System Permit for Storm Water Runoff Associated with Marina Operations and Discharges from Maintenance Dredging in the Lake Tahoe Hydrologic Unit (NPDES No. CAG616003)	LRWQCB 2011	This permit establishes permit limits for constituents in discharges to land treatment systems and surface waters in the Lake Tahoe Hydrologic Unit from the operation of marinas and from maintenance dredging. It also establishes limits on constituents in receiving waterbodies.
2013 Watershed Control Program Annual Report	Tahoe Water Suppliers Association 2013	The TWSA annual report addresses, on an annual basis, a full description of water supply sources at the lake, potential sources of pollution, activities and programs that have the ability to affect lake water quality, research projects, and pollution controls, including regulatory efforts.

Source: TRPA 2016