



**Proposed Basin Plan  
Amendment  
Big Bear Lake Nutrient TMDLs**

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California Regional Water Quality Control  
Board

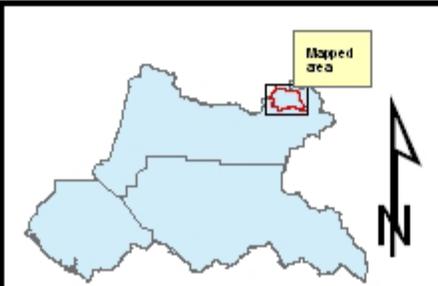
Santa Ana Region

# Presentation Outline

- Watershed setting
- Water Quality Standards
- TMDL components
- Proposed Implementation Plan/Monitoring Program
- Economic Considerations
- CEQA Analysis
- Public Participation




  
 Sources:
   
 - Modified by RWOCB, 2004
   
 - San Bernardino County, 2004
   
 - Hydnet, Inc., 2003
   
 - ReMetrix, Inc., 2000
   
 - RWOCB, 2004



**Map Features**

-  Clean Water Act Section 303(d) listed bodies of water
-  Major roads
-  Big Bear Lake Tributaries
-  City of Big Bear Lake boundary
-  Big Bear Lake watershed boundary
-  Streets

Big Bear Lake Bathymetry  
**DEPTH**

-  69 - 51 feet
-  50 - 36 feet
-  35 - 21 feet
-  20 - 9 feet
-  8 - 1 feet

Figure 1-1. Big Bear Lake Water



# Beneficial Uses

- MUN – Municipal and domestic supply
- AGR – Agricultural supply
- GWR – Groundwater recharge
- REC1 – Water contact recreation
- REC2 – Non-contact water recreation
- WARM – Warm freshwater habitat
- COLD – Cold freshwater habitat
- WILD – Wildlife habitat
- RARE – Rare, threatened or endangered species



# Big Bear Lake Nutrient TMDL – Problem Statement

- Big Bear Lake's beneficial uses are impaired due to nutrient enrichment
  - Depressed oxygen levels –release of SRP, ammonia
  - Algal blooms
  - Noxious and nuisance aquatic plants
    - Eurasian watermilfoil and coontail

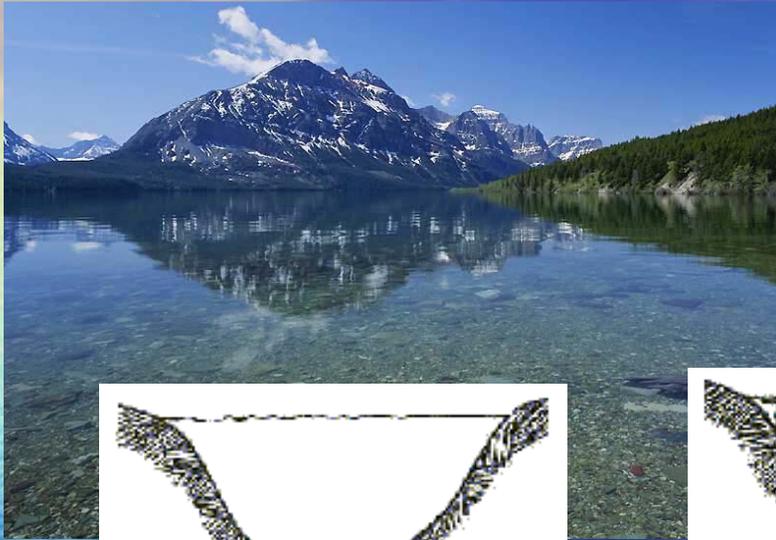




# Nutrient Related Water Quality Objectives

- Algae
  - Waste discharges shall not contribute to excessive algal growth in inland surface receiving waters
- Acute (1-hour) and chronic (4-day) un-ionized ammonia (varies with pH and temperature)
- Nitrate: 10 mg/L as N (for MUN waters)
- Dissolved oxygen: 5 mg/L
- Total phosphorus: 150  $\mu\text{g/L}$
- Total inorganic nitrogen (TIN): 150  $\mu\text{g/L}$

# Trophic State



## Oligotrophic

- Clear water, low productivity
- Very desirable fishery of large fish

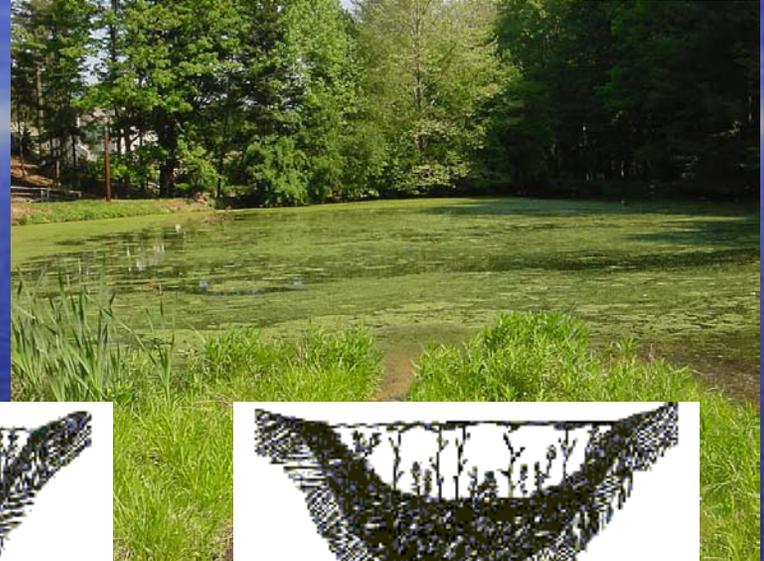
TP =  $<10 \mu\text{g/L}$   
Chla =  $<4 \mu\text{g/L}$



## Mesotrophic

- Increased production
- Accumulated organic matter
- Occasional algal bloom
- Good fishery

TP =  $10\text{-}20 \mu\text{g/L}$   
Chla =  $4\text{-}10 \mu\text{g/L}$



## Eutrophic

- Very productive
- May experience oxygen depletion
- Rough fish common

TP =  $>20 \mu\text{g/L}$   
Chla =  $>10 \mu\text{g/L}$

Proposed final numeric targets:

TP =  $20 \mu\text{g/L}$     Chla =  $5 \mu\text{g/L}$

# TMDL Components

- Problem statement
- Numeric targets
- Source assessment
- Linkage analysis and load capacity (TMDLs)
- TMDL allocations
- Seasonal variation
- Critical conditions
- Margin of safety (MOS)

# Determining nutrient numeric targets for Big Bear Lake



Indicator	Target Value
Total P concentration (interim)	Annual average no greater than 35 µg/L; to be attained no later than 2010
Total P concentration (final)	Annual average no greater than 20 µg/L; to be attained no later than 2015
Total N concentration (final)	Annual average no greater than 1000 µg/L; to be attained no later than 2015
Chlorophyll <i>a</i> concentration (interim)	Growing season average no greater than 10 µg/L; to be attained no later than 2010
Chlorophyll <i>a</i> concentration (final)	Growing season average no greater than 5.0 µg/L; to be attained no later than 2015
Macrophyte Coverage	30-60% on a total area basis by 2015
Percentage of Nuisance Aquatic Vascular Plant Species (final)	95% eradication on a total area basis of Eurasian Watermilfoil and any other invasive aquatic plant species; to be attained no later than 2015

# Proposed Numeric Targets

## Total P, Total N, Chlorophyll *a*

### Interim targets: 2010

- TP, chla – based on water quality observed in Big Bear Lake prior to herbicide or alum treatment

### ● Final targets: 2015

- TP, chla –based on research of literature of values representative of a mesotrophic to eutrophic status
- TN –based on water quality observed in Big Bear Lake prior to herbicide or alum treatment

# Numeric Targets

- Chlorophyll *a*, macrophyte coverage and percentage of nuisance aquatic vascular plant species are indicators of the health of the lake

# TMDL Components

- Problem statement
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- **Source assessment**
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# Nutrient sources

- External sources:
  - Forest, Resort, Urban
    - Simulated with HSPF (Hydmet)
    - Water quality sampling: 2001-2003 (dry hydrological conditions)
  - Atmospheric deposition
    - Literature research
- Internal sources:
  - Macrophyte
    - Collection and species identification (Aquatechnex)
    - Nutrient tissue analyses (USCOE -LAERF Analytical Lab)
  - Sediment
    - Core flux studies (Dr. Anderson)

# Nitrogen Sources

- Dry hydrological conditions
  - Internal loads dominate (91%)
  - External loads (9%)
- Wet hydrological conditions
  - External loads dominate (64%)
  - Internal loads (36%)

# Phosphorus sources

- Dry hydrological conditions
  - Internal loads dominate (96%)
  - External loads (4%)
- Wet hydrological conditions
  - External loads dominate (72%)
  - Internal loads (28%)
  - Total P load an order of magnitude greater than average/dry hydrological conditions

# TMDL Components

- Problem statement
- Numeric targets
- Source assessment
- **Linkage analysis and load capacity (TMDLs)**
- TMDL allocations
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# Linkage Analysis and Load Capacity (TMDL)

How was the TMDL determined?

– WASP lake model (Tetra Tech)

- Simulated lake water quality conditions under different loading scenarios
- WASP model was set up for the time period of 1999-2003 due to limited long-term lake water quality data
- Data collected were representative of dry conditions only
- Predictions can be applied to DRY CONDITIONS ONLY

# WASP Model Results –Dry conditions only

- Nitrogen target not met in any model scenario
- External load reductions showed no difference in lake water quality
- To meet interim TP and chl<sub>a</sub> numeric targets:
  - 60% reduction in internal sediment loads; 25% reduction in internal macrophyte loads
- To meet final TP and chl<sub>a</sub> numeric targets:
  - 80% reduction in internal sediment loads; 25% reduction in internal macrophyte loads

# Proposed Interim Big Bear Lake TP TMDL for dry hydrological conditions

- **Total P interim target (35  $\mu\text{g/L}$ )**
- **Dry hydrological conditions**
- **Compliance date: 2010**

	TP load (lbs/yr)	Existing TP load (lbs/yr)	% Reduction
Internal loading	24,255*	39,331	38
External loading	1757	1757	0
TMDL	26,012	41,088	37

\*Assumes a 60% reduction in internal phosphorus sediment loading and a 12.5% reduction in macrophyte TP loads

# Proposed Final Big Bear Lake TP and TN TMDLs for dry hydrological conditions

- TP final target (20  $\mu\text{g/L}$ )
- TN final target (1000  $\mu\text{g/L}$ )
- Dry hydrological conditions
- Compliance date: 2015

	TP load (lbs/yr)	Existing TP load (lbs/yr)	TN load (lbs/yr)	Existing TN load (lbs/yr)
Internal loading	19,978*	39,331	254,710 <sup>+</sup>	269,328
External loading	1757	1757	26,190	26,190
TMDL	21,735	41,088	280,900	295,518

\*Assumes an 80% reduction in internal phosphorus sediment loading and a 12.5% reduction in macrophyte TP loads

+ Assumes a 12.5% reduction in macrophyte TN loads

# TMDL Components

- Problem statement
- Numeric targets
- Source assessment
- Linkage analysis and load capacity (TMDLs)
- **TMDL allocations**
- Seasonal variation
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# Allocations

- $TMDL = WLA + LA + MOS$
- WLA = wasteload allocations (point sources)– regulated under NPDES permits
  - urban
- LA = load allocations (non-point sources)
  - Forest, resort, atm deposition, macrophytes and sediment
- MOS = margin of safety
  - Implicit

**Proposed interim TMDL, wasteload and load allocations for Big Bear Lake during dry conditions (to be achieved as soon as possible, but no later than 2010)\***

	TP load allocation (lbs/yr)	Existing TP load (lbs/yr)	Reduction (%)
<b>TMDL</b>	<b>26012</b>	<b>41088</b>	<b>37</b>
<b>WLA</b>	<b>475</b>	<b>475</b>	<b>0</b>
Urban	475	475	0
<b>LA</b>	<b>25537</b>	<b>40613</b>	<b>37</b>
Internal sediment source	8555	21388	60
Internal macrophyte source	15700	17943	12.5
Atmospheric deposition	1074	1074	0
Forest	175	175	0
Resort	33	33	0
<b>MOS</b>	<b>0</b>		

\*Specified as an annual average based on a calendar year (January 1-December 31) for dry hydrological conditions only.

# Proposed final TMDLs, wasteload and load allocations for Big Bear Lake during dry conditions (to be achieved as soon as possible, but no later than 2015)\*

	TP load allocation (lbs/yr)	Existing TP load (lbs/yr)	Reduction (%)
<b>TMDL</b>	<b>21735</b>	<b>41088</b>	<b>47</b>
<b>WLA</b>	<b>475</b>	<b>475</b>	<b>0</b>
Urban	475	475	0
<b>LA</b>	<b>21260</b>	<b>40613</b>	<b>48</b>
Internal sediment source	4278	21388	80
Internal macrophyte source	15700	17943	12.5
Atmospheric deposition	1074	1074	0
Forest	175	175	0
Resort	33	33	0
<b>MOS</b>	<b>0</b>		

\*Specified as an annual average based on a calendar year (January 1-December 31) for dry hydrological conditions only.

**Proposed final TMDLs, wasteload and load allocations for Big Bear Lake during dry conditions (to be achieved as soon as possible, but no later than 2015)\***

	TN load allocation (lbs/yr)	Existing TN load (lbs/yr)	Reduction (%)
<b>TMDL</b>	<b>280900</b>	<b>295518</b>	<b>5%</b>
<b>WLA</b>	<b>3445</b>	<b>3445</b>	<b>0</b>
Urban	3445	3445	0
<b>LA</b>	<b>277455</b>	<b>292073</b>	<b>5%</b>
Internal sediment source	152386	152386	0
Internal macrophyte source	102324	116942	12.5%
Atmospheric deposition	21474	21474	0
Forest	460	460	0
Resort	811	811	0
<b>MOS</b>	<b>0</b>		

\*Specified as an annual average based on a calendar year (January 1-December 31) for dry hydrological conditions only.

# TMDL Components

- Problem statement
- Numeric targets
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- **Seasonal variation**
- **Critical conditions**
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# Seasonal variation and critical conditions

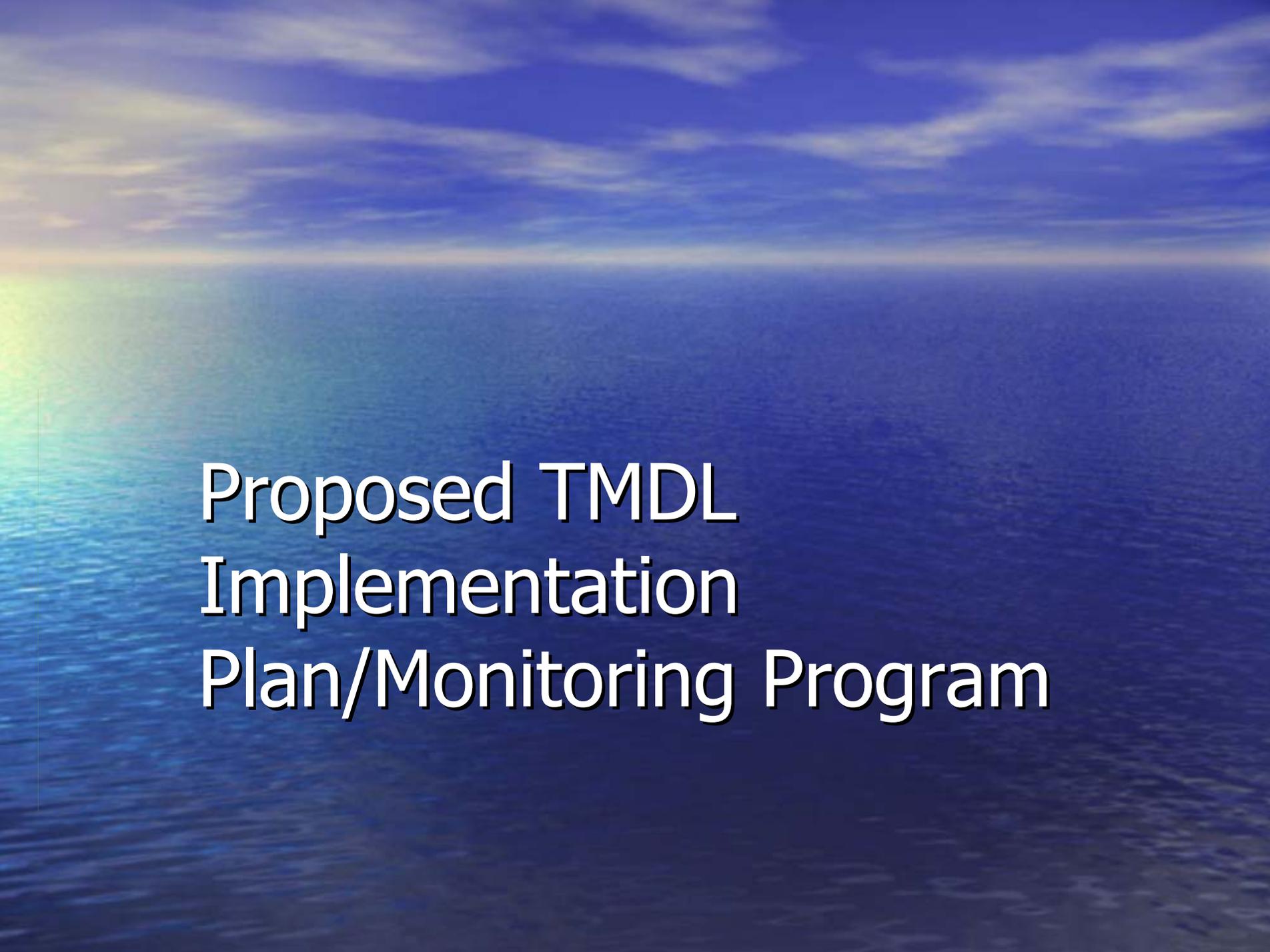
- Seasonal variation
  - Lake and watershed models calibrated with data collected over different seasons from 2001-2003 – model simulations take this variation into account
  - Recommended numeric targets expressed as annual averages (except chla)
- Critical conditions
  - Summer and dry years: lake levels decrease impacting aquatic life and recreational beneficial uses

# TMDL Components

- Problem statement
- Numeric targets
- Source assessment
- Linkage analysis and load capacity (TMDLs)
- TMDL allocations
- Seasonal variation
- Critical conditions
- **Margin of safety (MOS)**

# Margin of Safety

- Implicit MOS considered
  - Conservative selection of numeric targets
  - Conservative assumption in lake model (macrophyte density)



**Proposed TMDL  
Implementation  
Plan/Monitoring Program**

# TMDL Implementation Tasks

1	Establish New Waste Discharge Requirements for Nutrient Sources	<i>(*6 months after BPA approval*)</i>
2	Establish New Waste Discharge Requirements for Lake Restoration Activities	<i>(*18 months after BPA approval*)</i>
3	Revise Existing Waste Discharge Requirements	<i>(*6 months after BPA approval*)</i>

# TMDL Implementation Tasks

4	Nutrient Water Quality Monitoring Program 4.1 Watershed-wide Nutrient Monitoring Plan(s) 4.2 Big Bear Lake Nutrient Monitoring Plan(s)	Plan/schedule due ( <i>*3 months after BPA approval*</i> )  Annual reports due February 15
5	Atmospheric Deposition Determination	Plan/schedule due ( <i>*1 year after BPA approval*</i> )
6	Big Bear Lake and Watershed Model Updates	<i>Plan/schedule due (*6 months after BPA approval*)</i>

# TMDL Implementation Tasks

7	Big Bear Lake In-Lake Sediment Nutrient Reduction Plan	Plan/schedule due ( <i>*1 year after BPA approval*</i> )
8	Big Bear Lake Aquatic Plant Management Plan	<i>Plan/schedule due (*1 year after BPA approval)</i> <i>*5 year report due (*5 years after Regional Board approval of plan/schedule); thereafter, annual reports due February 15</i>
9	Big Bear Lake Multimetric Index Development Plan	<i>Plan/schedule due (*1 year after BPA approval*)</i>

# TMDL Implementation Tasks

10	Review and Revise Nutrient Water Quality Objectives	December 31, 2010
11	Review Big Bear Lake Tributary Data	December 31, 2008
12	Develop TMDLs, WLAs and LAs for wet and/or average hydrological conditions	<i>December 31, 2012</i>
13	Review of TMDLs/WLAs/LAs	<i>Once every 3 years</i>

# Early TMDL implementation

- Two herbicide treatments: 2002 and 2003
  - Eurasian watermilfoil and coontail significantly decreased (Big Bear MWD and ReMetrix, 2004)
- Trial alum project – Papoose Bay 2003
- Full scale alum project – approximately 1500 acres treated in 2004

# Load reductions from alum treatment

- Phosphorus

- >80% reduction in SRP flux rate at stations that received alum treatment
- 45% reduction at east end (limited alum application)

- Nitrogen

- 22-77% reduction in ammonia flux rates



# Economic Considerations

- Costs to reduce internal sediment and macrophyte nutrient loading
- Costs to participate in monitoring and other efforts designed to assess compliance with and refine the TMDLs, and to develop TMDLs for wet and average hydrologic conditions
- Some monitoring and implementation tasks are covered in the Prop. 13 grants
- Since 2000, >4 million dollars have been spent in this watershed

# CEQA Analysis

- Environmental review required:
  - CEQA scoping meeting (January 29, 2004)
  - Staff Report describes proposed amendment and alternatives, identifies mitigation measures for environmental impacts
  - Responds to comments received
  - Environmental Checklist (attached to staff report)

# Public Participation

- TMDL workgroup convened beginning June 2000
  - Active members include: BBMWD, City of Big Bear Lake, San Bernardino County Flood Control District, Caltrans, BBARWA, Big Bear Mountain Resorts, USFS
  - TMDL task force funding: BBMWD, City of BBL, SBCFCD and BBARWA
  - BBMWD instrumental in conducting monitoring, coordinating studies for the TMDLs, early implementation of TMDLs, obtaining grant funds for conducting studies

# Next Steps

- Prepare written responses to all comments
  - Comments requested by September 2, 2005
- Revise implementation plan to incorporate some of the tasks from the sediment TMDLs
- Complete peer review
- Revise the Basin Plan Amendment based on comments received
- Schedule hearing (to consider adoption of amendment)