

Basin Plan Amendment Technical Memo  
Updating the Basin Plan Turbidity Water Quality Objective  
Units of Measurement

## 1. Introduction

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This paper presents supporting information and historical references for updating the turbidity water quality objectives in the Water Quality Control Plan for the Central Coastal Basin (Basin Plan). The existing turbidity water quality objectives in the Basin Plan have outdated units of turbidity measurement, Jackson Turbidity Units (JTU), which are no longer in use. JTU were used historically but were rendered obsolete about the time that the first Basin Plan was developed in the early 1970s. Turbidity analytical methods evolved at this same time with the development of nephelometric meters and the reporting of turbidity in Nephelometric Turbidity Units (NTU). Measuring turbidity as NTU became standard units in regulatory permits, orders, and other Regional Board basin plans. JTU are not currently used in any of the other basin plans in the state.

## 2. Existing Water Quality Objectives for Turbidity

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The existing water quality objectives for turbidity in the Basin Plan are described below and the outdated units of measurement that need to be replaced are underlined.

*Turbidity*

*Waters shall be free of changes in turbidity that cause nuisance or adversely affect beneficial uses. Increase in turbidity attributable to controllable water quality factors shall not exceed the following limits:*

1. *Where natural turbidity is between 0 and 50 Jackson Turbidity Units (JTU), increases shall not exceed 20 percent.*
2. *Where natural turbidity is between 50 and 100 JTU, increases shall not exceed 10 JTU.*
3. *Where natural turbidity is greater than 100 JTU, increases shall not exceed 10 percent.*

*Allowable zones of dilution within which higher concentrations will be tolerated will be defined for each discharge in discharge permits.*

## 3. Proposed Update to the Turbidity Water Quality Objective

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Staff proposes updating the Basin Plan turbidity water quality objective units of measurement from JTU to NTU as noted below.

*Waters shall be free of changes in turbidity that cause nuisance or adversely affect beneficial uses. Increase in turbidity attributable to controllable water quality factors shall not exceed the following limits:*

1. *Where natural turbidity is between 0 and 50 ~~Jackson Turbidity Units (JTU)~~ Nephelometric Turbidity Units (NTU), increases shall not exceed 20 percent.*
2. *Where natural turbidity is between 50 and 100 ~~JTU~~ NTU, increases shall not exceed 10 ~~JTU~~ NTU.*

3. *Where natural turbidity is greater than 100 JTUNTU, increases shall not exceed 10 percent.*

*Allowable zones of dilution within which higher concentrations will be tolerated will be defined for each discharge in discharge permits.*

#### **4. Historic Central Coast Basin Plan Objectives for Turbidity and associated USEPA Criteria**

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The current edition of the Basin Plan was approved in 2016. There are six previous editions (1971(interim), 1975, 1989, 1994, and 2011). Staff reviewed the prior editions and found that the 1971 (interim) Basin Plan had a very similar turbidity objective to the current one but without reference to specific units. The turbidity objective in the 1971 (interim) Basin Plan is as follows:

*Turbidity: Waters shall be maintained at turbidity levels below that which may create unfavorable aesthetic conditions. Where natural turbidity is between 0-50 units, increase shall not exceed 20 percent. No increase shall be greater than 10 units above natural background levels when natural turbidity is between 50 and 100 units or greater than 10 percent when above 100 units. (Basin Plan, 1971)*

The first official Basin Plan was published in 1975. The origin of the turbidity water quality objective in the 1975 Basin Plan is the 1973 State Board Management Memos for Development of 1975 Basin Plans. The Management Memos contained the following turbidity water quality objective. The 1975 Basin Plan and current Basin Plan contain identical allowable turbidity levels.

*Turbidity (JTU)*

*Where natural turbidity is between 0-50 units, increase shall not exceed 20 percent. No increase shall be greater than 10 units above natural background when natural turbidity is between 50 and 100 units or greater than 10 percent when above 100 units.*

The historic Basin Plans and the 1973 State Board Management Memos do not have specific reference sources for the turbidity water quality objectives. Many of the Basin Plan's water quality objectives were based on specific federal criteria found in published federal criteria reports. The federal criteria reports have criteria for turbidity and settleable solids, and color and transparency that are similar to the Basin Plan turbidity objectives. The following excerpts from the 1968 federal water quality report (U.S. Department of Interior, 1968) appear to be the basis of the 1971 (interim) Basin Plan turbidity objective.

***Turbidity***

*(1) Turbidity in the receiving waters due to the discharge of wastes should not exceed 50 Jackson units in warm-water streams or 10 Jackson units in cold-water streams.*

*(2) There should be no discharge to warmwater lakes which would cause turbidities exceeding 25 Jackson units. The turbidity of cold-water or oligotrophic lakes should not exceed 10 units.*

***Settleable Materials***

*Since it is known that even minor deposits of settleable materials inhibit the growth of normal stream and lake flora, no such materials should be added to these waters in quantities that adversely affect the natural biota.*

***Color and Transparency***

*For effective photosynthetic production of oxygen, it is required that 10 percent of the incident light reach the bottom of any desired photosynthetic zone in which adequate dissolved oxygen concentrations are to be maintained.*

Following the 1968 federal water quality report, the federal Clean Water Act (CWA) was passed in 1972. Section 304(a)(1) of the CWA requires USEPA to publish water quality criteria (USEPA, 2017). USEPA published three water quality criteria books: Water Quality Criteria 1972 (referred to as the “Blue Book”), Quality Criteria for Water 1976 (referred to as the “Red Book”), and Quality Criteria for Water 1986 (referred to as the “Gold Book”). The Blue Book was prepared by the National Academy of Sciences-National Academy of Engineering Committee on Water Quality Criteria and supersedes the 1968 federal water quality report noted above. The Blue Book contains an in depth analysis of the effects of suspended and settleable solids on freshwater aquatic life and wildlife. A key impact described in the Blue Book that is related to the turbidity objective, is the impact of suspended particles on light penetration in water and the effects limited light have on plant photosynthesis. This formed the basis of the committee recommendation which is as follows:

*The combined effect of color and turbidity should not change the compensation point more than 10 percent from its seasonally established norm, nor should such a change place more than 10 percent of the biomass of photosynthetic organisms below the compensation point.*

The committee recommendation in the Blue Book was applied to the USEPA criteria in the subsequent Red and Gold Books. The most recent criteria for solids (suspended, settleable) and turbidity in the Gold Book states the following:

*Freshwater fish and other aquatic life:  
Settleable and suspended solids should not reduce the depth of the compensation point for photosynthetic activity by more than 10 percent from the seasonally established norm for aquatic life.*

The criteria’s allowable 10 percent increase is consistent with the allowable increases in the existing Basin Plan turbidity water quality objective for turbidities greater than 100 JTU. The Basin Plan states that:

*Where natural turbidity is greater than 100 JTU, increases shall not exceed 10 percent.*

**Note: This scientific basis for the existing Basin Plan turbidity water quality objective is based on a relative 10 percent increase in water clarity and is independent of the specific units of measurement.**

## **5. Turbidity Objectives from the 9 Regional Boards**

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The turbidity water quality objectives from the nine Regional Boards in the state were reviewed by staff and are summarized in this section. The following Regional Boards have turbidity water quality objectives nearly identical to the Central Coast Regional Water Quality Control Board's (Central Coast Water Board) water quality objective for turbidity but with units as NTU:

- San Francisco Regional Water Quality Control Board
- Los Angeles Regional Water Quality Control Board
- Central Valley Regional Water Quality Control Board
- Santa Ana Regional Water Quality Control Board
- San Diego Regional Water Quality Control Board

The Colorado River Regional Water Quality Control Board (Colorado River Water Board) is an exception having only a narrative turbidity objective without reference to turbidity units or allowable percent change from natural conditions. However, the Colorado River Water Board narrative objective is identical to the main portion of the Central Coast Water Board's objective, which states that *Waters shall be free of changes in turbidity that cause nuisance or adversely affect beneficial uses.* The Lahontan Regional Water Quality Control Board has this same narrative but includes limits for turbidity not to increase natural levels by more than 10 percent. The North Coast Regional Water Quality Control Board turbidity water quality objective limits increases to not be more than 20 percent of naturally occurring background levels. As noted and described below, JTU are only used in the Central Coast Water Board Basin Plan and are not used in any of the other basin plans in the state.

North Coast Regional Water Quality Control Board

*Objectives for Inland Surface Waters, Enclosed Bays, and Estuaries*

Turbidity:

*Turbidity shall not be increased more than 20 percent above naturally occurring background levels. Allowable zones of dilution within which higher percentages can be tolerated may be defined for specific discharges upon the issuance of discharge permits or waiver thereof.*

Source: Water Quality Control Plan for the North Coast Region, May 2011

San Francisco Bay Regional Water Quality Control Board

*Objectives for Surface Waters*

Turbidity:

*Waters shall be free of changes in turbidity that cause nuisance or adversely affect beneficial uses. Increases from normal background light penetration or turbidity relatable to waste discharge shall not be greater than 10 percent in areas where natural turbidity is greater than 50 NTU.*

Source: Water Quality Control Plan for the San Francisco Region, March 2015

Central Coast Regional Water Quality Control Board

*Objectives for All Inland Surface Waters, Enclosed Bays, and Estuaries*

*Turbidity:*

*Waters shall be free of changes in turbidity that cause nuisance or adversely affect beneficial uses. Increase in turbidity attributable to controllable water quality factors shall not exceed the following limits:*

- 1. Where natural turbidity is between 0 and 50 Jackson Turbidity Units (JTU), increases shall not exceed 20 percent.*
- 2. Where natural turbidity is between 50 and 100 JTU, increases shall not exceed 10 JTU.*
- 3. Where natural turbidity is greater than 100 JTU, increases shall not exceed 10 percent.*

*Allowable zones of dilution within which higher concentrations will be tolerated will be defined for each discharge in discharge permits.*

Source: Water Quality Control Plan for the Central Coastal Basin, 2016

Los Angeles Regional Water Quality Control Board

*Regional Objectives for Inland Surface Waters*

*Turbidity:*

*Turbidity is an expression of the optical property that causes light to be scattered in water due to particulate matter such as clay, silt, organic matter, and microscopic organisms. Turbidity can result in a variety of water quality impairments. The secondary drinking water standard for turbidity is 5 NTU (nephelometric turbidity units).*

*Waters shall be free of changes in turbidity that cause nuisance or adversely affect beneficial uses. Increases in natural turbidity attributable to controllable water quality factors shall not exceed the following limits:*

*Where natural turbidity is between 0 and 50 NTU, increases shall not exceed 20%.*

*Where natural turbidity is greater than 50 NTU, increases shall not exceed 10%.*

*Allowable zones of dilution within which higher concentrations may be tolerated may be defined for each discharge in specific Waste Discharge Requirements.*

Source: Water Quality Control Plan: Los Angeles Region, September 11, 2014

Central Valley Regional Water Quality Control Board

## **Sacramento and San Joaquin River Basin Plan**

### *Water Quality Objectives for Inland Surface Waters*

#### *Turbidity*

*Waters shall be free of changes in turbidity that cause nuisance or adversely affect beneficial uses. Increases in turbidity attributable to controllable water quality factors shall not exceed the following limits:*

- *Where natural turbidity is less than 1 Nephelometric Turbidity Unit (NTU), controllable factors shall not cause downstream turbidity to exceed 2*
- *Where natural turbidity is between 1 and 5 NTUs, increases shall not exceed 1 NTU.*
- *Where natural turbidity is between 5 and 50 NTUs, increases shall not exceed 20 percent.*
- *Where natural turbidity is between 50 and 100 NTUs, increases shall not exceed 10 NTUs.*
- *Where natural turbidity is greater than 100 NTUs, increases shall not exceed 10 percent.*

*In determining compliance with the above limits, appropriate averaging periods may be applied provided that beneficial uses will be fully protected.*

Note: The objective also includes designated levels for specific waterbodies that are not shown.

Source: The Water Quality Control Plan for the California Regional Water Quality Control Board Central Valley Region, the Sacramento River Basin and the San Joaquin River Basin, July 2016

## **Tulare Basin Plan**

### *Water Quality Objectives for Inland Surface Waters*

#### *Turbidity:*

*Waters shall be free of changes in turbidity that cause nuisance or adversely affect beneficial uses. Increases in turbidity attributable to controllable water quality factors shall not exceed the following limits:*

- *Where natural turbidity is between 0 and 5 Nephelometric Turbidity Units (NTUs), increases shall not exceed 1 NTU.*
- *Where natural turbidity is between 5 and 50 NTUs, increases shall not exceed 20 percent.*
- *Where natural turbidity is equal to or between 50 and 100 NTUs, increases shall not exceed 10 NTUs.*
- *Where natural turbidity is greater than 100 NTUs, increases shall not exceed 10 percent.*

*In determining compliance with the above limits, the Regional Water Board may prescribe appropriate averaging periods provided that beneficial uses will be fully protected.*

Note: The objective also includes designated levels for specific waterbodies that are not shown.

Source: The Water Quality Control Plan for the Tulare Lake Basin, July 2016

Lahontan Regional Water Quality Control Board

*Water Quality Objectives Which Apply to All Surface Waters*

*Turbidity*

*Waters shall be free of changes in turbidity that cause nuisance or adversely affect the water for beneficial uses. Increases in turbidity shall not exceed natural levels by more than 10 percent.*

Note: The objective also includes designated levels for specific waterbodies that are not shown.

Source: Water Quality Control Plan for the Lahontan Region, 2015

Colorado River Basin Regional Water Quality Control Board

*General Surface Water Objectives*

*Suspended Solids and Settleable Solids*

*Discharges of wastes or wastewater shall not contain suspended or settleable solids in concentrations which increase the turbidity of receiving waters, unless it can be demonstrated to the satisfaction of the Regional Board that such alteration in turbidity does not adversely affect beneficial uses.*

*Turbidity*

*Waters shall be free of changes in turbidity that cause nuisance or adversely affect beneficial uses.*

Source: Water Quality Control Plan Colorado River Basin, March 2014

Santa Ana Regional Water Quality Control Board

*Enclosed Bays and Estuaries*

*Turbidity:*

*Turbidity is a measure of light scattered due to particulates in water.*

*Increases in turbidity which result from controllable water quality factors shall comply with the following:*

<u>Natural Turbidity</u>	<u>Maximum Increase</u>
0-50 NTU	20%
50-100 NTU	10 NTU
Greater than 100 NTU	10%

*All enclosed bay and estuaries of the region shall be free of changes in turbidity which adversely affect beneficial uses.*

*Inland Surface Waters*

Turbidity:

*Turbidity is a measure of light scattered due to particulates in water.*

*Increases in turbidity which result from controllable water quality factors shall comply with the following:*

<u>Natural Turbidity</u>	<u>Maximum Increase</u>
0-50 NTU	20%
50-100 NTU	10 NTU
Greater than 100 NTU	10%

*All inland surface waters of the region shall be free of changes in turbidity which adversely affect beneficial uses.*

Source: Water Quality Control Plan, Santa Ana River Basin 1995, Updated 2008

San Diego Regional Water Quality Control Board

*Inland Surface Waters, Enclosed Bays and Estuaries, Coastal Lagoons and Ground Waters Turbidity*

Water Quality Objectives for Turbidity: *Waters shall be free of changes in turbidity that cause nuisance or adversely affect beneficial uses.*

*Inland surface waters shall not contain turbidity in excess of the numerical objectives described in Table 3-2.*

*Ground waters shall not contain turbidity in excess of the numerical objectives described in Table 3-3.*

*The transparency of waters in lagoons and estuaries shall not be less than 50% of the depth at locations where measurement is made by means of a standard Secchi disk, except where lesser transparency is caused by rainfall runoff from undisturbed natural areas and dredging projects conducted in conformance with waste discharge requirements of the Regional Board. With these two exceptions, increases in turbidity attributable to controllable water quality factors shall not exceed the following limits:*



<b>Natural Turbidity</b>	<b>Maximum Increase</b>
<i>0-50 NTU</i>	<i>20% over natural turbidity level</i>
<i>50-100 NTU</i>	<i>10 NTU</i>
<i>Greater than 100 NTU</i>	<i>10% over natural turbidity level</i>

*In addition, within San Diego Bay, the transparency of bay waters, insofar as it may be influenced by any controllable factor, either directly or through induced conditions, shall not be less than 8 feet in more than 20 percent of the readings in any zone, as measured by a standard Secchi disk. Wherever the water is less than 10 feet deep, the Secchi disk reading shall not be less than 80 percent of the depth in more than 20 percent of the readings in any zone.*

Source: The Water Quality Control Plan for the San Diego Basin 1994 , Updated2016)

## **6. Turbidity Units of Measurement**

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Methods for measuring turbidity were developed in 1900 by Jackson who calibrated an existing visual turbidity meter with standardized solutions. This method involved the visual comparison between a tube with a standardized solution to another with the monitoring sample solution. With this method, the monitoring sample is gradually added to the test cylinder until the transmitted light is seen (by eye) as equal to light transmitted through a cylinder with a standardized solution (refer to Figure 1). The depth of the test solution is then measured and reported as JTU. This test method is considered cumbersome and usefulness is limited with 25 JTU being the lowest measureable value.

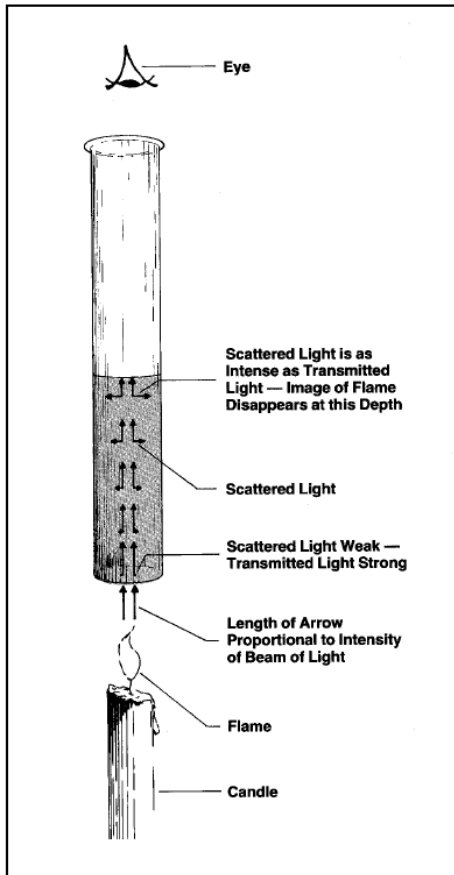


Figure 1. Jackson candle turbidity meter (Sadar, 1996).

In the early 1970s the nephelometric turbidity meter was developed, which along with improved standardized solutions greatly advanced the sensitivity and precision of turbidity monitoring (USEPA, 1999). A nephelometer measures light scattered at a 90-degree angle from an incident light beam to a photo electric light detector (refer to Figure 2). The turbidity relationship is reported as NTU. Nephelometric turbidity meters were adopted by USEPA as a standardized method in 1971.

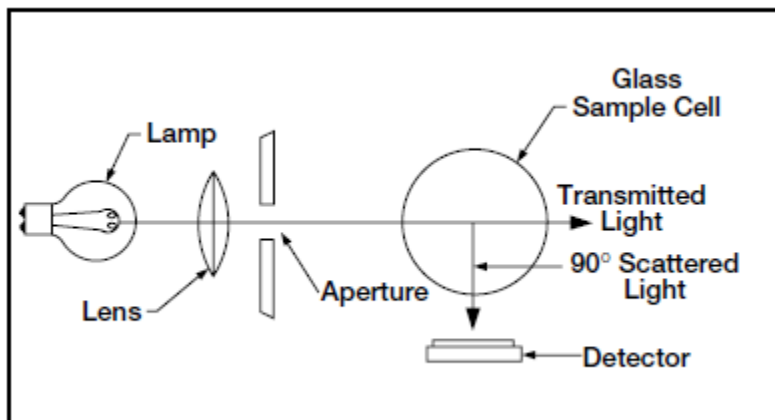


Figure 2. The light transmission processes of a nephelometric meter (Sadar, 1996).

According to the code of federal regulations (CFR) and as required under the CWA, National Pollutant Discharge Elimination System (NPDES) permittees shall quantify turbidity samples with USEPA methods of determination. According to 40 CFR §136.3 the approved procedure is USEPA Method 180.1: Determination of Turbidity by Nephelometry dated August 1993 (refer to Table 1), which is found in the USEPA methods publication (USEPA, 1993).

Table 1. Excerpt of the approved USEPA turbidity methodology from 40 CFR §136.3.

Parameter	Methodology	EPA <sup>52</sup>
73. Turbidity, NTU53	Nephelometric	180.1, Rev. 2.0 (1993)

<sup>52</sup> USEPA. August 1993. Methods for the Determination of Inorganic Substances in Environmental Samples, EPA/600/R-93/100.

Staff also reviewed two prior versions of published USEPA methods of turbidity analysis, one dated 1971 (USEPA, 1971) and another dated 1983 (USEPA, 1983). Both of the prior published methods were nearly identical to the August 1993 method and specify nephelometric meters to measure turbidity. Even though the 1971 method is based on nephelometry, all turbidity units are reported as JTU. The analysis methods are identical between the 1971 and 1983 publications; the primary units in the 1983 publication are in NTU. In addition, the 1983 publication states that NTU are comparable to the previously used JTU. USEPA updated the analytical methods again in 1993 to current standards based on nephelometry and reported as NTU (USEPA, 1993).

**Note: The statement by USEPA in the 1983 publication that JTU and NTU are comparable units of turbidity measurement is central to the staff finding that the recommended Basin Plan amendment is a non-substantive change. Since they are considered comparable, either method can be used to assess the turbidity water quality objective.**

## 7. NPDES Permits and Non-point Source Programs

To discharge to surface waters, waste water treatment plant facilities (WWTP) must have NPDES permits. Staff reviewed several permits and found that the permits required effluent limits and monitoring reported as NTU. The permits reviewed by staff are summarized in Table 2.

Table 2. NPDES permitted facilities, effluent and monitoring and reporting program turbidity units.

NPDES Permitted Facility (Permit No.)	Effluent Turbidity Units	Monitoring and Reporting Program Turbidity Units
Avila Beach Community Service District WWTP (CA0047830)	NTU	NTU
City of Lompoc Regional WWTP (CA0048127)	NTU	NTU
Monterey Regional Water Pollution Control Agency WWTP (CA0048551)	NTU	NTU
City of Pismo Beach WWTP (CA0048151)	NTU	NTU
City of San Juan Bautista WWTP (CA0047902)	JTU/NTU	NTU
City of San Luis Obispo WWTP	NTU	NTU

(CA0049224)		
South San Luis Obispo County Sanitation District WWTP (CA0048003)	NTU	NTU

Stormwater programs also have NPDES permits and require turbidity monitoring of discharge to surface waters. The stormwater permits require reporting of turbidity monitoring data in NTU (CCRWQCB, 2016).

The Central Coast Water Board requires monitoring by non-point source programs such as the Irrigated Lands Regulatory Program. The Irrigated Lands Regulatory Program requires growers, under Agricultural Order R3-2012-0011-01, to report on the turbidity levels of surface waters as NTU.

## 8. Historic Timeline

Table 3 contains a historic timeline up to the development of the current turbidity water quality objectives.

Table 3. Historic timeline of turbidity units

Year	Description	Importance
1900	Development of JTU	Jackson develops standardized solutions for calibrating visual turbidity meters.
1968	Federal Water Quality Report from the National Technical Advisory Committee on Water Quality Criteria	Sets the early water quality criteria that appear to be the basis of initial Basin Plan turbidity water quality objectives. The criteria are reported in JTU and turbidity should not exceed 10 JTU for cold water and 25 JTU for warm water. Natural light should not change more than 10%.
Early 1970s	Development of nephelometer	Availability of accurate and scientific methods for measuring turbidity.
1971	USEPA publishes methods of turbidity analysis	Methods based on nephelometry but reported as JTU.
1971	Basin Plan (interim)	Initial turbidity water quality objectives based on an unspecified turbidity unit and % change. Similar to current object but without specific units.
1972	Federal Clean Water Act became law	The basic structure for regulating and monitoring discharge was established.
1972	Water Quality Criteria 1972 "Blue Book"	In depth analysis by a science panel on the impacts of turbidity and suspended sediment on aquatic life. Panel sets criteria limits at 10% of natural conditions.

Year	Description	Importance
1973	State Board Management Memo for Development of 1975 Basin Plan	The turbidity units are set as JTU and allowable increases set to percent levels of change for turbidity in the Basin Plan.
1975	Basin Plan	The existing turbidity water quality objectives were established in this Basin Plan.
1983	USEPA publishes methods of turbidity analysis	Methods identical to 1971 method but units report as NTU. USEPA considers JTU and NTU as comparable units.
1993	USEPA publishes methods of turbidity analysis	The most recent method based on nephelometry and reported as NTU.
1989, 1994, 2011, 2016	Basin Plan updates	Turbidity water quality objective maintained as JTU.

## 9. Recommendation

Staff recommends that the Basin Plan water quality objective for turbidity be updated as follows:

*Waters shall be free of changes in turbidity that cause nuisance or adversely affect beneficial uses. Increase in turbidity attributable to controllable water quality factors shall not exceed the following limits:*

1. *Where natural turbidity is between 0 and 50 ~~Jackson Turbidity Units (JTU)~~ Nephelometric Turbidity Units (NTU), increases shall not exceed 20 percent.*
2. *Where natural turbidity is between 50 and 100 ~~JTUNTU~~, increases shall not exceed 10 ~~JTUNTU~~.*
3. *Where natural turbidity is greater than 100 ~~JTUNTU~~, increases shall not exceed 10 percent.*

*Allowable zones of dilution within which higher concentrations will be tolerated will be defined for each discharge in discharge permits.*

This recommendation makes our Basin Plan consistent with the majority of the basin plans in the state and consistent with standard USEPA monitoring methods. Measuring turbidity today with a JTU meter is impractical, inefficient, and inaccurate. At the time the Basin Plan was developed, USEPA considered JTU and NTU as comparable units of measurement. The update merely changes the units and does not affect existing regulations and monitoring programs that already monitor and report turbidity as NTU. Therefore, staff finds this update to be a non-substantive or “without regulatory effect” Basin Plan amendment. Without regulatory effect, this Basin Plan amendment is not subject to the Water Board’s California Environmental Quality Act Regulations for a Certified Regulatory Program.

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