

*Water Boards Training Academy
Course WQG101*

Water Quality Goals

Jon B. Marshack, D.Env.
Environmental Program Manager
(Non-Supervisory)
Office of Information
Management and Analysis

(916) 341-5514
jon.marshack@waterboards.ca.gov



Main Concepts

- **How do we select numeric thresholds to assess our water resources?**
 - ◆ Porter-Cologne Water Quality Control Act
 - ◆ Federal Clean Water Act
 - ◆ Water quality standards
 - ◆ State & Regional Water Board plans & policies
- **How do antidegradation principles affect numeric threshold selection?**



5

What Will We Cover Today?

- **Statutes, regulations plans & policies relating to water quality standards**
- **Implementing narrative water quality objectives**
 - ◆ Using numeric thresholds from other organizations and the peer reviewed literature
- **Water Quality Goals**
 - ◆ Report
 - ◆ Database and on-line resources
- **Algorithms to help you select defensible water quality assessment thresholds**

6



**In California
water is a
limited and
valuable
resource**

7

Porter-Cologne Water Quality Control Act

Enacted by state legislature in 1969

**found in Division 7 of
the California Water Code**

- **Legislative declarations**



The Legislature Finds and Declares...

(Water Code §13000)

- **that the people of the state have a primary interest in the conservation, control, and utilization of the water resources of the state, and**
- **that the quality of all the waters of the state shall be protected for use and enjoyment by the people of the state**



The Legislature Finds and Declares...

(Water Code §13000) continued



- that activities and factors which may affect the quality of the waters of the state shall be regulated to attain the **highest water quality which is reasonable**, considering all demands being made and to be made on those waters and the total values involved, beneficial and detrimental, economic and social, tangible and intangible.

10

The Legislature Finds and Declares...

(Water Code §13000) continued



- that the state must be prepared to exercise its full power and jurisdiction to **protect the quality of waters in the state from degradation** originating inside or outside the boundaries of the state...

11

Water Quality Control

Water Code, Section 13050(i)

- **The regulation of any activity or factor which may affect the quality of the waters of the state and includes the prevention and correction of water **pollution** and **nuisance****

12

Pollution

Water Code, Section 13050(l)

- **An alteration of the quality of the waters of the state by waste to a degree which unreasonably affects either of the following**
 - ◆ **The waters for beneficial uses**
 - ◆ **Facilities which serve these beneficial uses**
- **Pollution may include “contamination”**

13

Nuisance

Water Code, Section 13050(m)

Anything which meets **all** of the following

- Is injurious to health, or is indecent or offensive to the senses, or an obstruction to the free use of property,
 - ◆ So as to interfere with the comfortable enjoyment of life or property
- Affects at the same time an entire community or neighborhood, or any considerable number of persons
 - ◆ Although the extent of the annoyance or damage inflicted upon individuals may be unequal
- Occurs during, or as a result of, **the treatment or disposal of wastes**

14

Water Quality Standards

Federal Clean Water Act—



- Provisions of state or federal law
- **Designated use** or uses for waters of the United States and
- **Water quality criteria** for such waters based upon such uses

[40 CFR 130.2(c) and 131.3(i)]

Water Quality Standards In California




- Found in the **Water Quality Control Plans (Basin Plans)**
- Adopted by the **State and Regional Water Boards**



16

Water Quality Standards In California



Water Quality Standards include

- **Beneficial Use designations** for each water body or portion thereof
- **Water Quality Objectives (criteria)** to protect the uses
- **Implementation Programs** to achieve the objectives

17

Water Quality Standards In California



- **“Waters of the state” include both surface waters and groundwaters**
 - ◆ Effectively, both have water quality standards
- **Water Quality Standards apply throughout the water body**
 - ◆ To protect existing and probable future uses

18

Beneficial Uses of Waters of the State

California Water Code § 13050(f)

Beneficial uses of the waters of the state that may be protected against water quality degradation include, but are not necessarily limited to

- ◆ Domestic, municipal, agricultural and industrial supply
- ◆ Power generation
- ◆ Recreation
- ◆ Esthetic enjoyment
- ◆ Navigation
- ◆ Preservation and enhancement of fish, wildlife, and other aquatic resources or preserves

19

Present and Potential Beneficial Uses of Waters of the State

from the Water Quality Control Plans

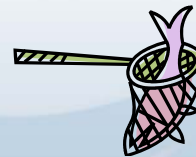
- Municipal and domestic supply
- Agricultural supply
- Industrial supply
 - ◆ Service supply
 - ◆ Process supply
- Groundwater recharge
- Freshwater replenishment
- Navigation



20

Present and Potential Beneficial Uses of Waters of the State

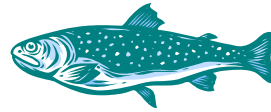
- Hydropower generation
- Recreation
 - ◆ Contact
 - ◆ Non-contact
- Commercial & sport fishing
- Shellfish harvesting
- Subsistence fishing
- Aquaculture



21

Present and Potential Beneficial Uses of Waters of the State

- **Freshwater habitat**
 - ◆ Warm
 - ◆ Cold
- **Estuarine habitat**
- **Inland saline water habitat**
- **Marine habitat**
- **Wetland habitat**
- **Wildlife habitat**



22

Present and Potential Beneficial Uses of Waters of the State

- **Preservation of areas of special biological significance**
- **Preservation of rare, threatened, or endangered species**
- **Migration of aquatic organisms**
- **Spawning, reproduction, and/or early development**



23

Present and Potential Beneficial Uses of Waters of the State

- Water quality enhancement
- Flood peak attenuation/
flood water storage
- Native American culture
- California Indian tribal
traditional and cultural
- California Indian tribal
subsistence fishing
- Subsistence fishing



24

State Water Resources Control Board
Resolution No. 88-63




Adoption of a Policy Entitled “Sources of Drinking Water”

“All surface and groundwaters
of the State are considered to
be suitable, or potentially
suitable, for municipal or
domestic water supply...”




Sources of Drinking Water Policy Exceptions

- Waters with total dissolved solids (TDS) > 3,000 mg/L 
- Waters with contamination, unrelated to a specific pollution incident, that cannot reasonably be treated for domestic use using best management practices or best economically achievable treatment practices

26

Sources of Drinking Water Policy Exceptions

- Source cannot provide an average sustained yield of 200 gallons per day
- Certain municipal, industrial, and agricultural wastewater conveyances and holding facilities
- Regulated geothermal groundwaters 

27

Water Quality Objectives

Water Code §13050(h)

“Water quality objectives” means

- **Limits or levels of water quality constituents or characteristics established for the**
 - ◆ **Reasonable protection of beneficial uses of water or the**
 - ◆ **Prevention of nuisance within a specific area**

28

Water Quality Objectives

Come in two forms:

- **Numeric**
 - ◆ **Specifies a concentration limit**
- **Narrative**
 - ◆ **Describes a requirement or prohibits a condition harmful to beneficial uses**

29

Numeric Water Quality Objectives

examples from the two Central Valley Region Basin Plans

- Ammonia
- Arsenic
- Bacteria
- Barium
- Boron
- Cadmium
- Copper
- Cyanide
- Diazinon
- Dissolved Oxygen
- Iron
- Manganese
- Methyl-mercury
- Molybdenum
- pH
- Salinity
 - ◆ TDS & EC
- Selenium
- Silver
- Temperature
- Thiobencarb
- Turbidity
- Zinc

30

Narrative Water Quality Objectives

language from the Central Valley Region Basin Plans

- **Chemical Constituents - General**
 - ◆ Waters shall **not** contain chemical constituents in concentrations that **adversely affect beneficial uses**
 - ◆ **Example: Boron and agricultural use**



31

Narrative Water Quality Objectives

language from the Central Valley Region Basin Plans

■ Chemical Constituents - MCLs

- ◆ At a minimum, waters designated for use as domestic or municipal supply shall not contain concentrations of chemical constituents in excess of **California drinking water Maximum Contaminant Levels (MCLs)**
- ◆ To protect all beneficial uses the Regional Water Board may apply **limits more stringent than MCLs**

32

Narrative Water Quality Objectives

language from the Central Valley Region Basin Plans

■ Toxicity

- ◆ All waters shall be maintained **free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life**
- ◆ This objective applies regardless of whether the toxicity is caused by a single substance or the interactive effect of multiple substances

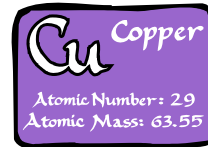


33

Narrative Water Quality Objectives

■ Toxicity

◆ Example: Copper



<u>Beneficial Use by</u>	<u>Toxicity Threshold</u>	<u>ug/L (ppb)</u>
• Humans	MCL	1300
	PHG	300
• Fish	CTR	2.7 to 29
• Plants	Ag limit	200

34

Narrative Water Quality Objectives

language from the Central Valley Region Basin Plans

■ Tastes & Odors

◆ Water shall not contain taste- or odor-producing substances in concentrations that impart undesirable tastes or odors

- To domestic or municipal water supplies
- To fish flesh or other edible products of aquatic origin
- That cause nuisance
- Or otherwise adversely affect beneficial uses



35

Toxicity vs. Taste & Odor



**California
Primary
MCL**

**Taste & Odor
Threshold**

	California Primary MCL	Taste & Odor Threshold
Ethylbenzene	300 ug/L	29 ug/L
Toluene	150 ug/L	42 ug/L
Xylenes	1750 ug/L	17 ug/L
MTBE	13 ug/L	5 ug/L

36

Narrative Water Quality Objectives

language from the Central Valley Region Basin Plans

■ Pesticides

- ◆ No pesticides in water, sediment or aquatic life in concentrations that adversely affect beneficial uses
- ◆ Not exceed MCLs in waters designated MUN
- ◆ No total persistent chlorinated hydrocarbon pesticides in detectable concentrations
- ◆ Not to exceed lowest levels technically and economically achievable



37

Other Narrative WQ Objectives

examples from the Central Valley Region Basin Plans

- **Biostimulatory Substances**
- **Color**
- **Floating Material**
- **Oil and Grease**
- **Radioactivity**
- **Sediment**
- **Settleable Material**
- **Suspended Material**
- **Temperature**
- **Turbidity**

38

Let's Not Be Confused

Beneficial Uses – Water Rights

- **More limited definitions in Water Rights regulations relating to appropriation of water**
 - ◆ **Domestic**
 - ◆ **Irrigation**
 - ◆ **Power**
 - ◆ **Municipal**
 - ◆ **Mining**
 - ◆ **Industrial**
 - ◆ **Fish and Wildlife Preservation and Enhancement**
 - ◆ **Aquaculture**
 - ◆ **Recreational**
 - ◆ **Stockwatering**
 - ◆ **Water Quality**
 - ◆ **Frost Protection**
 - ◆ **Heat Control**

[see Title 23, Division 3, Chapter 2, Article 2, Subarticle 2]

39

Special Water Quality Objectives

Differ from Basin Plan Objectives

- Under its **Water Rights** authority **State Water Board** can adopt water quality objectives specifying flow or operational requirements related to appropriation of water for **beneficial uses**
 - ◆ e.g., Bay-Delta Water Quality Control Plan
- **State Water Board** can manage water rights to ensure these objectives are met
- **Regional Water Boards** have no authority to implement these objectives
- **USEPA** has no authority to approve these objectives under the Clean Water Act



40

Water Rights & Water Quality (flow control)

- **Condition in every Water Rights permit**
 - ◆ Pursuant to State Water Board adopted regulation
- **State Water Board may modify quantity of water diverted**
 - ◆ If necessary to meet water quality objectives in a Water Quality Control Plan (e.g., Basin Plan)
 - ◆ Required findings to modify water diversion
 - Adequate Waste Discharge Requirements have been prescribed for all waste discharges
 - Water quality objectives cannot be achieved solely through control of waste discharges

41

California Toxics Rule (CTR)

- **Federal Clean Water Act**
 - ◆ All States required to have enforceable numeric water quality criteria for **priority toxic pollutants** in surface waters
- **Statewide Water Quality Control Plans SWRCB**
 - ◆ Inland Surface Waters Plan (1991)
 - ◆ Enclosed Bays & Estuaries Plan (1991)
- **National Toxics Rule (NTR) USEPA**
 - ◆ Promulgated in 1992 (amended in 1995 & 1999)
 - ◆ Criteria filled gaps in Statewide Plans

42

California Toxics Rule (CTR)

- **Statewide Plans rescinded in 1994**
 - ◆ Court order from discharger lawsuit
 - ◆ Adoption did not sufficiently consider economics
- **California out of compliance with CWA**
- **California Toxics Rule USEPA**
 - ◆ Promulgated May 2000 (amended Feb 2001)
 - ◆ NTR criteria still in effect
 - ◆ CTR criteria fill gaps in CWA compliance

43

Enforceable Water Quality Standards



- **Two scenarios in California**
 - Water Quality Objectives**
 - + **Basin Plan Beneficial Use Designations**
 - CTR and NTR Criteria**
 - + **Basin Plan Beneficial Use Designations**

44

California Toxics Rule (CTR)

- ***Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries (SIP)***
 - ◆ **SWRCB adopted March 2000 (amended 2005)**
 - Time Schedules
 - Background Levels
 - Mixing Zones
 - Analytical Methods
 - Effluent Limits
 - Reporting Levels
 - Water Effect Ratios



45

California Toxics Rule (CTR)

- **State-adopted Site-specific Objectives**
 - ◆ **If approved by EPA, supersede NTR & CTR**
 - **Sacramento R. – upstream of Hamilton City**
 - **Copper, Cadmium, & Zinc objectives = acute exposure**
 - **CTR chronic criteria also apply**
 - **San Francisco Bay – specific water bodies**
 - **Arsenic, Cyanide, Metals, Selenium objectives**
 - ◆ **If under EPA review, more stringent applies**

46

Implementation Procedures

“Numeric Translators”

- **Clean Water Act water quality standards regulations and guidance require**
 - ◆ **Implementation procedures to ensure that narrative criteria (objectives) for toxic pollutants are attained**
 - ◆ **Using chemical-specific controls**
 - ◆ **Including numeric criteria and permit limits**



48

Policy for Application of Water Quality Objectives

from the Implementation Chapter of the **Central Valley** Region Basin Plans

■ Where and When Objectives Apply

- ◆ In all waters where beneficial uses have been designated, **not just at current points of use**
 - To protect existing and future beneficial uses
- ◆ **Mixing Zones may be designated for NPDES**
 - In a mixing zone, water quality objectives do not apply
 - Zone may not adversely affect beneficial uses
- ◆ **Compliance Schedules may be allowed for new objectives in NPDES permits**
 - If infeasible to achieve immediate compliance

49

Policy for Application of Water Quality Objectives

from the Implementation Chapter of the **Central Valley** Region Basin Plans

- **Numeric receiving water limitations will be established in Board orders for constituents and parameters which will, at a minimum, meet all applicable water quality objectives**
- **The Board will impose more stringent numeric limitations or prohibitions to maintain the existing water quality unless some degradation is allowed pursuant to Resolution No. 68-16 (Antidegradation Policy)**

50

Policy for Application of Water Quality Objectives

from the Implementation Chapter of the **Central Valley** Region Basin Plans

■ Narrative Objectives

- ◆ Implement with numeric limits in orders
- ◆ Evaluate compliance by considering
 - Direct evidence of beneficial use impacts
 - All material and relevant information submitted by the discharger and other interested parties
 - Relevant numeric criteria and guidelines from other agencies and organizations
 - see *“A Compilation of Water Quality Goals”*

51

Policy for Application of Water Quality Objectives

from the Implementation Chapter of the **Central Valley** Region Basin Plans

- Water quality objectives do not require improvement over natural background concentrations
 - ◆ If Background > Water Quality Objective controllable water quality factors are not allowed to cause further degradation
 - e.g., discharges of waste

52

Policy for Application of Water Quality Objectives

from the Implementation Chapter of the **Central Valley** Region Basin Plans

- **Interaction of multiple toxic pollutants**
 - ◆ **Assume additivity for carcinogens and substances with similar toxic effects**



53

Application of Water Quality Objectives

from the Implementation Chapter of the **San Francisco Bay** Region Basin Plan

- **To evaluate compliance with water quality objectives, Board will consider**
 - ◆ **All relevant and scientifically valid evidence**
 - ◆ **Including numeric criteria and guidelines developed and/or published by other agencies and organizations**
 - **Summarized in**
“A Compilation of Water Quality Goals”
(North Coast Region Basin Plan also references Water Quality Goals)

54

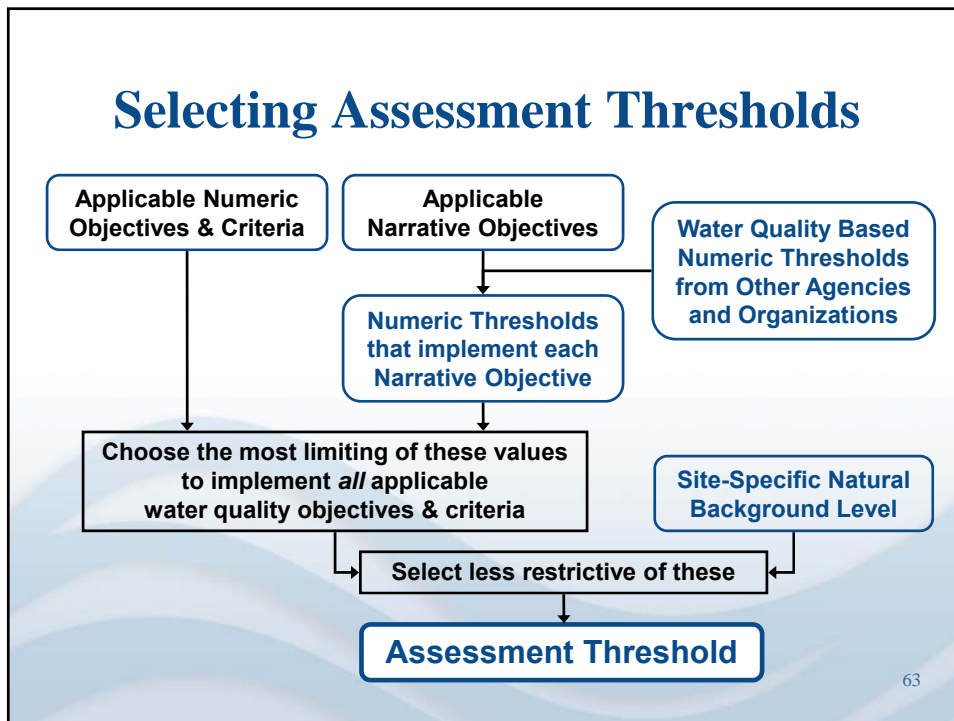
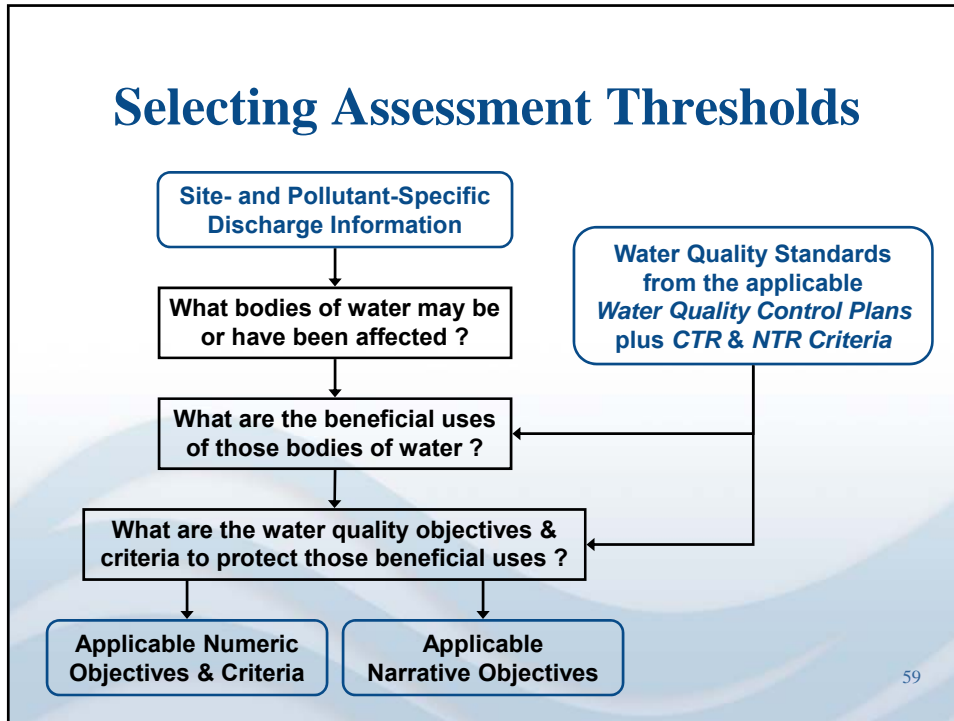
Minimum & Maximum Levels

- **Water Quality Objectives + CTR & NTR Criteria**
define the least stringent limits imposed on ambient water quality
- **Natural Background**
defines the most stringent limits imposed on ambient water quality
 - ◆ Controllable Factors Policies (Basin Plans)
 - ◆ Antidegradation Policy (Res. 68-16)

55

Appropriate Range of Water Quality to Protect Beneficial Uses

56



Sources of Numeric Thresholds

Used to Implement Narrative Objectives

Chemical Constituents objective

- California Drinking Water MCLs **SWRCB-DDW**
 - ◆ Primary MCLs based on human health
 - ◆ Secondary MCLs based on human welfare
 - ◆ Technology & Economics of water use at the tap
- Federal Drinking Water MCLs **USEPA**
 - ◆ Only if < CA MCLs (future use)
- *Water Quality for Agriculture* **FAO-UN**
- *Water Quality Criteria (McKee & Wolf)* **SWRCB**
 - ◆ e.g., industrial use criteria

64

MCLs Are Not Always Sufficient

to Implement the Narrative Toxicity Objective

- Primary MCLs **may not prevent** “detrimental physiological responses...”
- MCLs derived for water distribution systems
- Balancing health vs. technology/economics **may not be relevant** to drinking water **sources** or future beneficial use protection
 - ◆ Total trihalomethane MCL and chloroform
 - Accept some cancer risk to remove pathogens
 - ◆ MCLs for chlorinated solvent carcinogens
 - Outdated analytical quantitation limits
 - ◆ Arsenic MCLs largely ignore cancer risk

65

Sources of Numeric Thresholds

Used to Implement Narrative Objectives

Toxicity objective

no “detrimental physiological responses...”



- California Public Health Goals OEHHA
- Federal MCL Goals USEPA
 - ◆ non-“zero” levels only
- California Notification Levels SWRCB-DDW
- Cancer risk estimates OEHHA, NAS
- Integrated Risk Information System USEPA
 - ◆ Reference doses for non-cancer effects
 - ◆ Cancer risk estimates

66

1-in-a-Million (10^{-6}) Cancer Risk Level

Used to Implement Narrative Toxicity Objective

- SWRCB-DDW Primary MCLs & Notification Levels
 - ◆ *de minimis* cancer risk for involuntary exposure
- OEHHA Public Health Goals for drinking water
 - ◆ level considered negligible or *de minimis*
- California Toxics Rule and National Toxics Rule
 - ◆ human health criteria shall be applied at the State-adopted 10^{-6} risk level
- DTSC Prelim. Endangerment Assessments
 - ◆ $> 10^{-6}$ risk indicates presence of contamination which may pose significant threat to human health
- Example - Region 5 CAO for Mather AFB

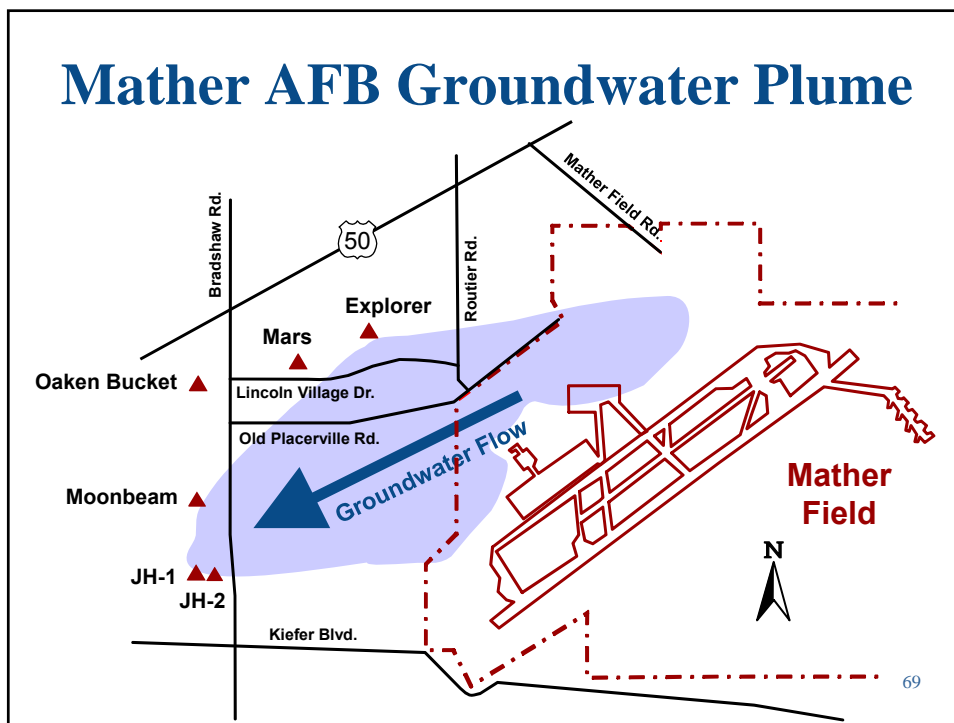
67

Mather AFB, Sacramento

- **Solvents leaked into groundwater**
 - ◆ TCE, PCE, DCE & carbon tetrachloride
 - ◆ Probable human carcinogens
 - ◆ Plume extends off-base to west and north
 - Residential area
- **Several municipal wells impacted and threatened**

68

Mather AFB Groundwater Plume



69

Mather AFB, Sacramento

- **Cleanup and Abatement Order**
 - ◆ Replace impacted water supply
 - ◆ Contain solvent plume
 - ◆ Cleanup groundwater pollution
- **Trigger = 10^{-6} cancer risk levels**
 - ◆ Lower than MCLs



70

Sources of Numeric Thresholds

Used to Implement Narrative Objectives

Toxicity objective

- **Drinking Water Health Advisories** USEPA & NAS
- **Proposition 65 Regulatory Levels** OEHHA
 - ◆ Carcinogens at 1-in-100,000 (10^{-5}) risk level
 - ◆ Reproductive toxins at 1/1000 of NOAEL
 - ◆ Intent of statute
 - Public notice prior to exposure
 - Prohibit discharge to drinking water sources
 - Not establishment of levels considered “safe”



71

Sources of Numeric Thresholds

Used to Implement Narrative Objectives

Toxicity objective



- **National Recommended (Ambient) Water Quality Criteria** **USEPA**
 - ◆ Human Health protective criteria
 - Assume ingestion of aquatic organisms
 - Apply to surface waters only
 - ◆ Aquatic Life protective criteria
- **Pesticide Hazard Assessments** **DFW**
 - ◆ Aquatic Life Protective Thresholds **for DPR**

72

Aquatic Life Protective Thresholds



- **USEPA National Recommended Water Quality Criteria & CTR / NTR Criteria**
 - ◆ Calculated from toxicity data
 - Species representing ≥ 8 families of organisms
 - Both vertebrate and invertebrate species
 - ◆ Chronic (4-day avg.) & acute (1-hour avg.)
 - ◆ Protection of all species for which there are reliable measurements in the data set
 - ◆ Intended to protect species for which those in the data set serve as surrogates ⁷³

73

Aquatic Life Protective Thresholds



- **USEPA National Recommended Water Quality Criteria & CTR / NTR Criteria**
 - ◆ **Freshwater criteria**
 - Where salinity < 1 part per thousand
 - ◆ **Saltwater criteria**
 - Where salinity > 10 parts per thousand
 - ◆ **Use more stringent of freshwater and saltwater criteria**
 - Where salinity between 1 and 10 parts per thousand

74

Sources of Numeric Thresholds

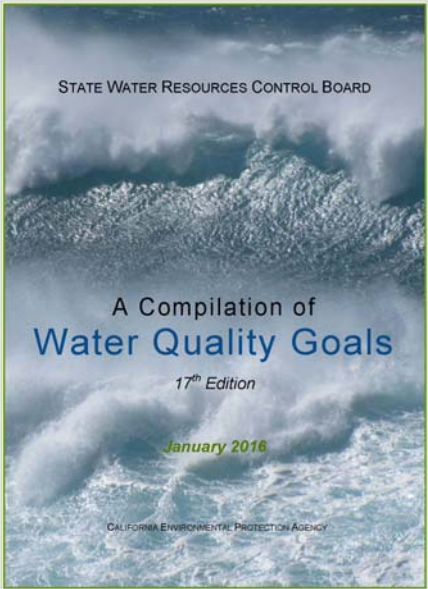
Used to Implement Narrative Objectives



Tastes & Odors objective

- **Secondary MCLs** **SWRCB-DDW & USEPA**
- **National Recommended (Ambient) Water Quality Criteria** **USEPA**
- **Drinking Water Health Advisories** **USEPA & NAS**
- **Taste and Odor Thresholds** **USEPA & others**

75



A Source of Numeric Thresholds

Available on
the Internet at


[www.waterboards.ca.gov/
water_issues/programs/
water_quality_goals/](http://www.waterboards.ca.gov/water_issues/programs/water_quality_goals/)

76

Sources of Numeric Thresholds

from Implementation Chapter of
Sacramento River and San Joaquin River Basin Plan

- **Pesticide discharges from non-point sources**
 - ◆ **Most pesticides lack numeric water quality objectives, recommended criteria, or guidance**
 - ◆ **Board will consider $1/10$ of LC_{50} for most sensitive aquatic life species as upper limit to protect aquatic life**
 - Based on valid toxicity data
 - Lower limits if needed (e.g., LOEC or NOEC) 77



Aquatic Life Toxicity Data

■ Ecotoxicology Database

- ◆ On line at
<https://cfpub.epa.gov/ecotox/>
- ◆ Single chemical toxicity information for aquatic and terrestrial life
 - e.g., LC₅₀, LOEC, NOEC
- ◆ Consult original scientific paper to ensure an understanding of the context of the data



78



Toxicology Basics

Do not be afraid!

Toxicology Basics

■ Paracelsus (1493–1541)

- ◆ All things are poison and nothing is without poison
- ◆ Only the dose permits something not to be poisonous
- ◆ *"The dose makes the poison."*



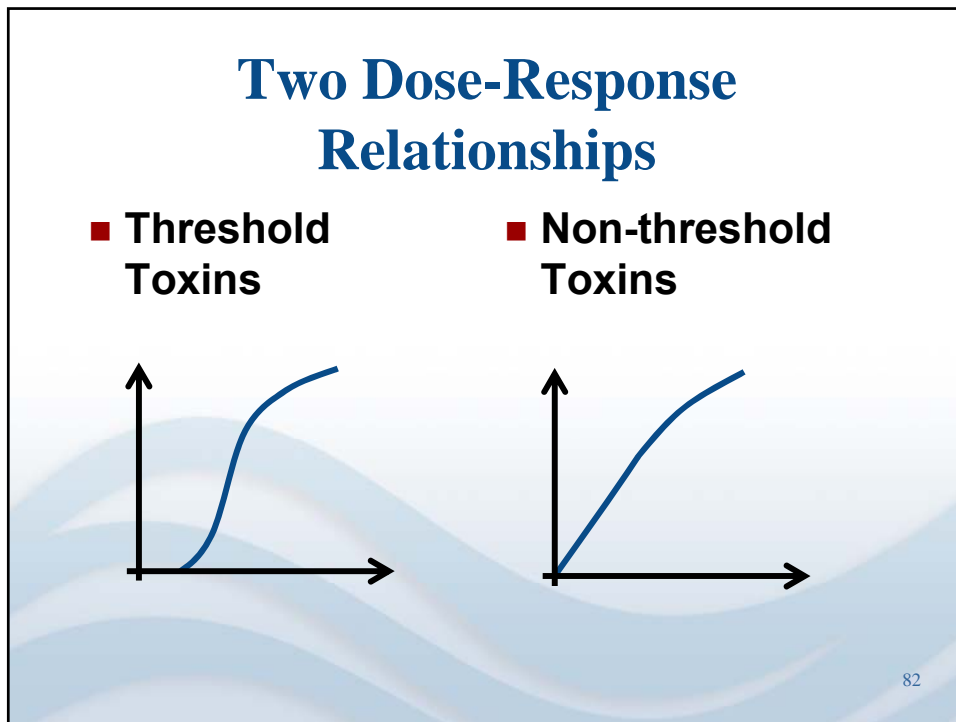
80

Toxicology Basics

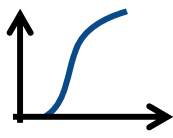
- All chemicals are toxic
- Toxicity dependent on
 - ◆ Potency of chemical
 - ◆ Amount of exposure
 - Concentration x Duration = Dose
 - Units of mg/kg/day
- Degree of effect depends on dose
 - ◆ Dose-Response relationship



81

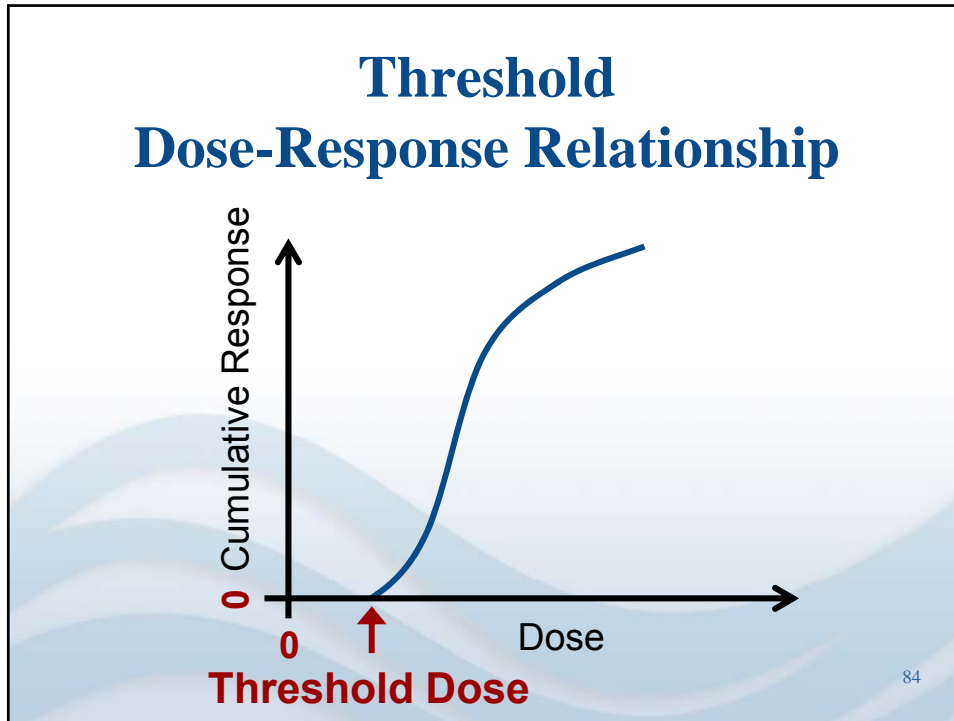


Threshold Toxins



- **Below a particular dose, there is no toxic effect**
- **Examples: cyanide, mercury, malathion**
- **Some toxic chemicals are beneficial at low doses but toxic at higher doses**
 - ◆ e.g., Vitamin A

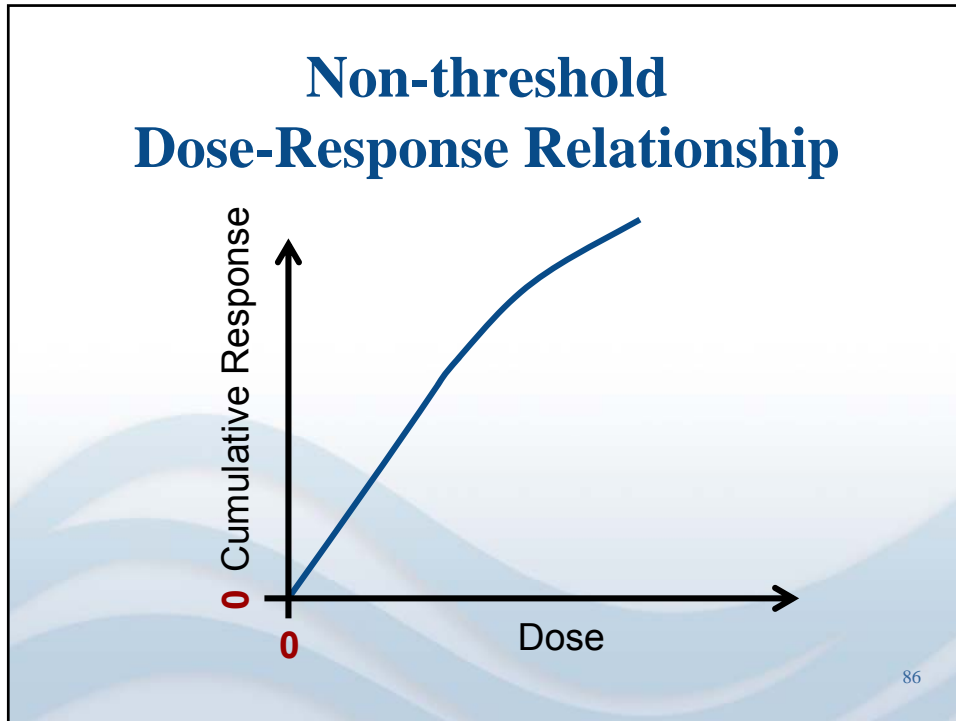
83



Non-threshold Toxins

- Some toxicity or health risk at any dose
- Most carcinogens in this category
- Cancer risk is a probabilistic event
 - ◆ The higher the dose, the higher the probability of experiencing the toxic effect
 - ◆ Risk proportional to dose or concentration
 - If 1-in-a million (10^{-6}) risk at 1 ug/L
 - Then 1-in-100,000 (10^{-5}) risk at 10 ug/L

85




USEPA Weight of Evidence Classes 1986 and 2005 Guidelines

Class A Known human carcinogen

Class H Carcinogenic to humans

- ◆ Sufficient evidence ties human exposure to cancer
- ◆ Can not deliberately experiment on humans
- ◆ Few chemicals in class – arsenic, benzene, vinyl chloride, radioactive elements



87

USEPA Weight of Evidence Classes

1986 and 2005 Guidelines

Class B Probable human carcinogen

Class L Likely to be carcinogenic to humans

- ◆ Limited human evidence
- ◆ Sufficient animal evidence



88

USEPA Weight of Evidence Classes

2005 Guidelines

Class L/N Likely to be carcinogenic above a specified dose but not likely to be carcinogenic below that dose

- ◆ Key event in tumor formation does not occur below that dose
 - e.g., tissue damage



89

USEPA Weight of Evidence Classes

1986 and 2005 Guidelines

Class C Possible human carcinogen

Class S Suggestive evidence of carcinogenic potential

- ◆ No human evidence
- ◆ Limited animal evidence



90

USEPA Weight of Evidence Classes

1986 and 2005 Guidelines

Class D Unknown

Class I Inadequate information to assess carcinogenic potential

- ◆ Insufficient cancer risk data to assign chemical to another category



91

USEPA Weight of Evidence Classes

1986 and 2005 Guidelines

Class E Not a carcinogen

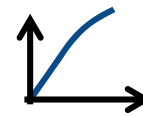
Class N Not likely to be
carcinogenic to humans

- ◆ Sufficient evidence exists to indicate that chemical does not cause cancer



Calculating Health-Based Numeric Thresholds

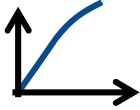
- Non-Threshold Toxins
 - ◆ Risk proportional to dose
 - ◆ Risk and dose related by Cancer Potency (Slope) Factor (q_1^*)
 - Risk per unit dose
 - Units of $(\text{mg/kg/day})^{-1}$



93

Calculating Health-Based Numeric Thresholds

■ **Non-Threshold Toxins**

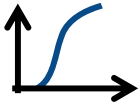


1. Risk Level = Dose x Potency Factor
2. Dose = $\frac{\text{Concentration} \times 2 \text{ liters/day}}{70 \text{ kg}}$
 (mg/kg/day) (mg/L)
3. Concentration = $\frac{\text{Risk Level} \times 70 \text{ kg}}{\text{Potency Factor} \times 2 \text{ liters/day}}$
 (mg/L)

94

Calculating Health-Based Numeric Thresholds

■ **Threshold Toxins**

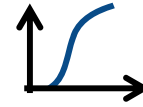


- ◆ Dose Levels from toxicity studies
 - No Observed Adverse Effect Level (NOAEL)
 - Highest dose with no adverse effect
 - Lowest Observed Adverse Effect Level (LOAEL)
 - Lowest dose that caused measurable effect
- ◆ NOAEL or LOAEL used to calculate Reference Dose (RfD)
 - Units of mg/kg/day

95

Calculating Health-Based Numeric Thresholds

■ Threshold Toxins



$$4. \text{ Reference Dose (mg/kg/day)} = \frac{\text{NOAEL (or LOAEL)}}{\text{Uncertainty Factor}}$$

96

RfD Uncertainty Factors


- 3 to 10 for each of these that apply
 - ◆ Extrapolating from animal studies to humans
 - ◆ Using a LOAEL in place of a NOAEL
 - ◆ Using a less appropriate route of exposure
 - ◆ Using a study with subchronic exposure
 - ◆ Potential synergism among chemicals
 - ◆ Any other toxicologic data gaps
- Multiply them together to derive overall uncertainty factor



97

Calculating Health-Based Numeric Thresholds

■ **Threshold Toxins**




4. **Reference Dose** = $\frac{\text{NOAEL (or LOAEL)}}{\text{Uncertainty Factor}}$
 (mg/kg/day)

98

Calculating Health-Based Numeric Thresholds

■ **Threshold Toxins (continued)**



5. **Equivalent Level** = $\frac{\text{Drinking Water RfD x 70 kg}}{\text{DWEL (mg/L) 2 liters/day}}$

6. **Health Advisory** = $\frac{\text{Lifetime DWEL x 20\% RSC}}{\text{Additional Uncertainty Factor*}}$
 (mg/L)

* 10 for Class C or S carcinogens

99

Relative Source Contribution (RSC)

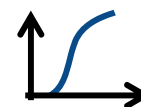
- RSC = Proportion of exposure (dose) assumed to come from drinking water
- (1 – RSC) = proportion of exposure from other sources
 - ◆ Food we eat (other ingestion)
 - ◆ Air we breathe (inhalation)
 - ◆ Things we touch (dermal absorption)
- Default RSC = 20%
- Modify if reliable source-specific exposure data available



100

Calculating Heath-Based Numeric Thresholds

- Threshold Toxins (continued)



$$5. \text{ Equivalent Level} = \frac{\text{Drinking Water RfD} \times 70 \text{ kg}}{\text{DWEL (mg/L)} \times 2 \text{ liters/day}}$$

$$6. \text{ Health Advisory (mg/L)} = \frac{\text{Lifetime DWEL} \times 20\% \text{ RSC}}{\text{Additional Uncertainty Factor}^*}$$

* 10 for Class C or S carcinogens

101

Improving Exposure Assessments

- **OEHHA and EPA also calculate child risk**
 - ◆ 1 liter per day for a 10 kg child
- **OEHHA's recent PHGs even more refined**
 - ◆ Age-specific water ingestion estimates normalized to body weight (L/kg-day)
- **2015 EPA Updated Ambient Water Quality Criteria for the Protection of Human Health**
 - ◆ 70 kg → 80 kg body weight for adults
 - ◆ 2 L/day → 2.4 L/day water consumption rate
 - ◆ 17.5 g/day → 22 g/day fish consumption

102

Routes of Exposure



- **Most Human Health-Based Thresholds**
 - ◆ Assume water ingestion (e.g., 2 liters/day)
 - USEPA IRIS, USEPA Health Advisories, Cal/EPA Cancer Factors, NAS Levels
- **Public Health Goals for VOCs** **OEHHA**
 - ◆ Assume overall human exposure resulting from water use in the home
 - Ingestion of water
 - Inhalation of chemical vapor
 - Dermal exposure from bathing

103

Routes of Exposure



- **USEPA National Recommended Water Quality Criteria & CTR/NTR Criteria**
 - ◆ **Human health protective criteria assume two exposure scenarios based on bioaccumulation & bioconcentration**
 - **Ingestion of water and aquatic organisms**
 - **Applies to all surface waters designated MUN or per SWRCB Resolution 88-63**
 - **Ingestion of aquatic organisms only**
 - **Applies to non-MUN surface waters**

104

Terminology Review

- **Water Quality Standards**
- **Beneficial Uses**
- **Water Quality Criteria**
- **Water Quality Objectives**
- **Drinking Water Standards**
- **Numeric Thresholds**
- **Assessment Threshold**
- **Water Quality Goals**



106


“Water Quality Standards”

- **Federal Clean Water Act**
 - ◆ Navigable waters and their tributaries (surface water)
- **Aspects of State or Federal Law**
- **Two parts**
 - ◆ Designated uses of water to be protected
 - ◆ Water quality criteria to protect those uses
- **Antidegradation Policies**
 - ◆ Often considered part of W.Q. Standards

107

“Beneficial Uses”



- **Porter-Cologne Act** **California term** 
- **Uses of water**
to be protected against degradation
- **Found in Water Quality Control Plans**
- **Groundwater and Surface Water**
- **Discharge of Waste**
 - ◆ Not a beneficial use of water
 - ◆ Cannot occur to the detriment of beneficial uses

108

“Water Quality Criteria”



- **Federal Clean Water Act (surface water)**
- **Limits for constituents or characteristics of water to protect specific uses**
- **Two types**
 - ◆ **Clean Water Act Section 303(c) Criteria**
 - **Enforceable limits under CWA (promulgated)**
 - **California Toxics Rule & National Toxics Rule**
 - ◆ **Clean Water Act Section 304(a) Criteria**
 - **Advisory to states and tribes**
 - **National Recommended Water Quality Criteria**

109

“Water Quality Objectives”



- **Porter-Cologne Act California term**
- **Limits for constituents or characteristics of water to protect beneficial uses**
- **Found in Water Quality Control Plans**
- **Groundwater and Surface Water**
- **Same legal status as CWA Section 303(c) criteria**

110

“Drinking Water Standards”

- **Adopted by SWRCB-DDW or USEPA**
 - ◆ Pursuant to state and federal Safe Drinking Water Acts
- **Enforceable on Water Purveyors**
 - ◆ Applies to water in a drinking water distribution system and at the tap
- **Becomes a Water Quality Objective**
 - ◆ Only when incorporated by reference in a Water Quality Control Plan (Basin Plan)
 - ◆ Does not supersede other water quality objectives



111

“Numeric Thresholds”

- **Not a legal term**
- **As used in *Water Quality Goals*:**
 - ◆ Numeric criteria and guidelines from other agencies and organizations
 - ◆ Intended to protect one or more specific uses of water
 - ◆ Used to implement narrative water quality objectives

112

“Assessment Threshold”

- **Not a legal term**
- **As used in *Water Quality Goals*:**
 - ◆ **Most stringent of the following**
 - Applicable numeric water quality objectives
 - Applicable CTR and NTR criteria
 - Numeric thresholds used to implement narrative water quality objectives
 - ◆ **Selected to comply with *all* applicable**
 - Narrative & numeric water quality objectives
 - Promulgated water quality criteria (CTR/NTR)¹¹³

“Water Quality Goals”

- **Reference tools to help you understand and implement water quality standards**
- **Not a policy or a regulation**
- **Two Parts**
 - ◆ **Training materials**
 - *A Compilation of Water Quality Goals* report
 - This class
 - ◆ **Online searchable database**
 - Additional tools

114

Report “A Compilation of Water Quality Goals”

- **Preface** (*what's new*)
 - **How to Use Water Quality Goals Online**
 - **Selecting Water Quality Goals**
 - ◆ **Water Quality Standards**
 - ◆ **Types of Numeric Thresholds**
 - ◆ **Risk Characterization Methods** (*toxicology*)
 - ◆ **Selecting Assessment Thresholds**
 - ◆ **Assessment Threshold Algorithms**
- } this class

115

Water Quality Goals Online

- **Database of numeric thresholds**
 - ◆ **Search by**
 - **Chemical name or portion of name**
 - **Abbreviation**
 - **Chemical Abstracts Service Registry Number**
 - ◆ **Synonyms**
 - ◆ **Description of each threshold type**
 - ◆ **Footnotes** (*information and limitations*)
 - ◆ **References** (*primary sources with hyperlinks*)
 - ◆ **Adoption dates**

116

Water Quality Goals Online

- **Database updated regularly**
- **Additional tools**
 - ◆ How to use online database
 - ◆ Staff Report
 - ◆ Assessment thresholds table
 - ◆ Download thresholds, footnotes, references
 - Tab text format for use off-line
 - Data Dictionary
 - ◆ Detailed list of updates
 - ◆ Sign up for email updates

117

Water Quality Goals Online

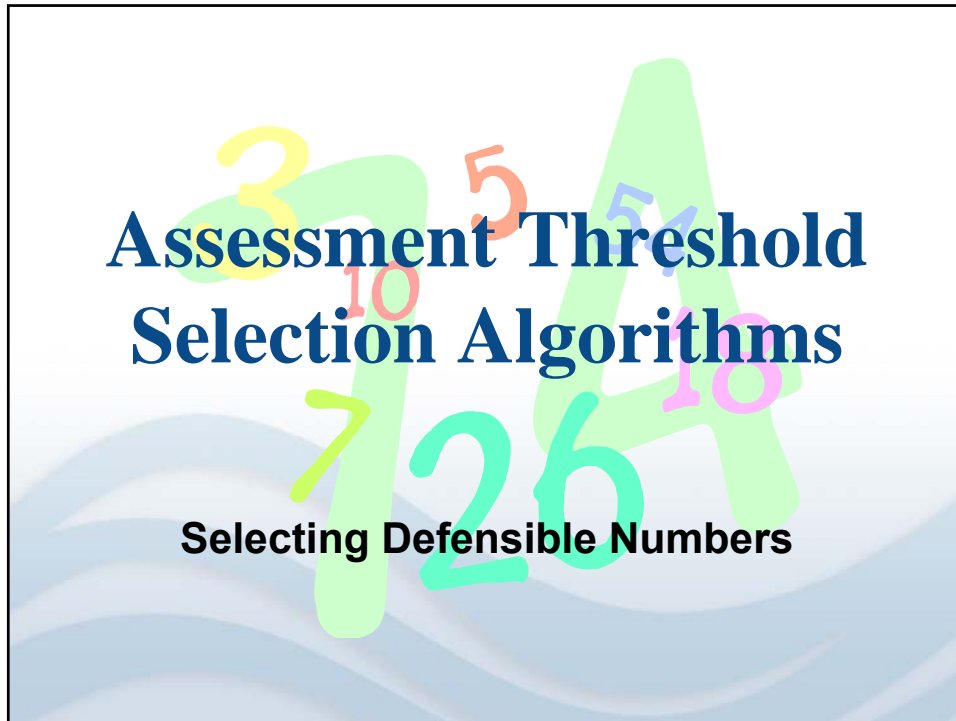
Database Demonstration

[www.waterboards.ca.gov/water_issues/
programs/water_quality_goals/](http://www.waterboards.ca.gov/water_issues/programs/water_quality_goals/)

From the Water Boards home page:

- Select “Water Quality Assessment” then
- Select “A Compilation of Water Quality Goals”

118



Assessment Threshold Selection

- **To be defensible, numeric thresholds should be chosen to implement each applicable water quality objective and promulgated water quality criterion**
- **Assessment threshold is the most limiting of the above**

120

Algorithms – Main Steps

- Step 1.** Select a single **numeric threshold** to satisfy each applicable water quality objective and promulgated criterion or relevant portion thereof
- Step 2.** To satisfy all applicable objectives select the lowest threshold from Step 1 as the **assessment threshold**
- Step 3.** Adjust for natural background levels
 - ◆ Uncontrollable factors

121

Selecting Numeric Thresholds

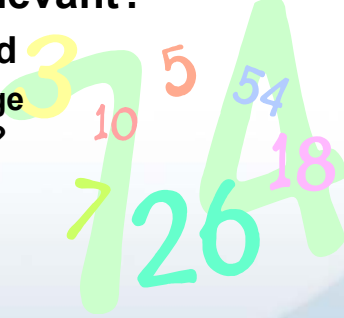
- **Lowest number you can find may not be appropriate**
- **Promulgated thresholds**
- **Defensibility**
 - ◆ Avoid arbitrary selection
 - ◆ Carefully document selection
 - ◆ Cite original references
 - Not “Water Quality Goals”
- **Case-specific information**



122

Algorithms – Guiding Principles for Step 1

- **Is numeric threshold relevant?**
 - ◆ **Check intent of threshold**
 - Does it match the language of the narrative objective?
 - ◆ **Check exposure routes**
 - Is it suitable for the beneficial use being protected?



123

Algorithms – Guiding Principles for Step 1

- **Use risk-based numeric thresholds instead of risk management-based thresholds to implement narrative water quality objectives**
 - ◆ **Toxicity-based thresholds instead of MCLs**
 - ◆ **Risk management-based thresholds may contain irrelevant information or constraints**
 - e.g., outdated analytical quantitation limits or constraints imposed by another agency's regulatory scheme

124

Algorithms – Guiding Principles for Step 1

- **Use California numeric thresholds when available**
 - ◆ **Instead of federal numeric thresholds or thresholds from other sources**
 - ◆ **Consistency within Cal/EPA and with other California agencies**



125

Algorithms – Guiding Principles for Step 1

- **Use numeric thresholds that reflect peer-reviewed science**
 - ◆ **Avoid using draft or provisional thresholds unless nothing else is available**
- **Use numeric thresholds that reflect current science**
 - ◆ **Check dates**

126

Assessment Threshold Algorithms Water Body Types

- **Water Quality Goals, 13th Edition (2003)**
 - ◆ Groundwater
 - ◆ Inland Surface Waters
- **Water Quality Goals, 16th Edition (2011)**
 - Added
 - ◆ Enclosed Bays & Estuaries
 - ◆ Ocean Waters

127


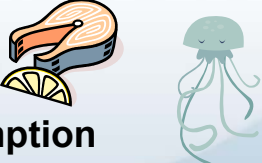
Assessment Threshold Algorithms Limiting Beneficial Uses

- **Groundwater**
 - ◆ Municipal and domestic supply
 - ◆ Agricultural supply
- **Inland Surface Waters**
 - ◆ Municipal and domestic supply
 - ◆ Agricultural supply
 - ◆ Aquatic life protection
 - ◆ Fish and shellfish consumption



128

Assessment Threshold Algorithms Limiting Beneficial Uses

- **Enclosed Bays & Estuaries** 
 - ◆ Aquatic life protection
 - ◆ Fish and shellfish consumption
 - ◆ **No water consumption or agricultural use**
- **Ocean Waters** 
 - ◆ Aquatic life protection
 - ◆ Fish and shellfish consumption
 - ◆ **No water consumption or agricultural use**

129

Assessment Threshold Algorithms Aquatic Life Protection

- **Inland Surface Waters Algorithm**
 - ◆ Where salinity < 10 parts per thousand
- **Enclosed Bays & Estuaries Algorithm**
 - ◆ Non-ocean waters
 - ◆ Where salinity > 1 part per thousand



130

Algorithm for Groundwater

❖ Chemical Constituents Objective

- Numeric W. Q. Objective from Basin Plan
- Drinking Water MCLs – *select lowest of:*
 - California Primary MCL
 - California Secondary MCL
- Threshold indicating beneficial use impairment – *select lowest of:*
 - Agricultural use threshold
 - Federal Primary MCL if < CA Primary MCL

131

Algorithm for Groundwater

❖ Toxicity Objective



- Drinking water health-based – *select first of:*
 - OEHHA Public Health Goal
 - Cal/EPA Cancer Potency Factor – *at 10⁻⁶ risk*
 - SWRCB-DDW Notification Level
 - USEPA IRIS – *lowest of cancer or reference dose*
 - USEPA Health Advisory – *lowest*
 - USEPA MCL Goal – *non-“zero”*
 - Other – *check basis and dates*
 - National Academy of Sciences – *cancer or SNARL*
 - Prop 65 safe harbor levels – *lowest of NSRL or MADL*

132

Algorithm for Groundwater



❖ Tastes and Odors Objective

- Taste- and odor-based thresholds – *select first of:*
 - California Secondary MCL
 - *if not altered by cost or technology*
 - Federal Secondary MCL
 - *if not altered by cost or technology*
 - USEPA National Rec. Water Quality Criterion
 - *if based on taste or odor of water*
 - Other taste and odor thresholds
 - *in peer-reviewed published literature*

133

Algorithm for Groundwater

Step 1. Select a number for each ➤ item

- ◆ Use table in Figure 3 on page 30

Water Quality Objective / Criterion	Relevant Portion of Objective / Criterion	Source	Concentration	Units
Chemical Constituents	Drinking Water MCL (lowest)	SWRCB-DDW		
	Numerical Water Quality Objective Beneficial Use Impairment Numeric Threshold	Basin Plan		
Toxicity	Human Health – Drinking Water			
Tastes & Odors	Taste & Odor Based Numeric Thresholds for Water			

Step 2. Select lowest number from Step 1 as the **assessment threshold**

- ◆ To satisfy all applicable objectives

Step 3. Adjust for natural background

- ◆ uncontrollable factors

134

Algorithm for Inland Surface Waters

- **Different from groundwater algorithm**

- ◆ **Additional beneficial uses**

- Aquatic life protection
 - Fish and shellfish consumption



- ◆ **Promulgated water quality criteria**

- California Toxics Rule & National Toxics Rule
 - Limit application of narrative toxicity objective to protect
 - Human health
 - Aquatic life

135

Algorithm for Inland Surface Waters

- ❖ **California and National Toxics Rules**

- **Criteria for human health protection**

- Water and fish consumption for MUN waters
 - Fish consumption only for non-MUN waters

- **Criteria for aquatic life protection**

- Criteria Continuous Concentration (4-day avg.)
 - Criteria Maximum Concentration (1-hour avg.)

136

Algorithm for Inland Surface Waters

❖ Chemical Constituents Objective

- **Numeric W.Q. Objective from Basin Plan**
 - May supersede CTR and NTR criteria if approved by USEPA
- **Drinking Water MCLs**
 - Same as in groundwater algorithm
- **Threshold indicating beneficial use impairment**
 - Same as in groundwater algorithm

137

Algorithm for Inland Surface Waters

❖ Toxicity Objective



- **Drinking water health-based thresholds**
 - Apply if no CTR or NTR human health criteria**
 - Same as in groundwater algorithm
- **Human health, including fish consumption**
 - **USEPA National Recomm. Water Quality Criteria**
 - Apply if no CTR or NTR human health criteria**
 - Water and fish consumption for MUN
 - Fish consumption only for non-MUN

138

Algorithm for Inland Surface Waters

❖ Toxicity Objective (continued)



➤ Aquatic life protective thresholds –

Apply if no CTR or NTR aquatic life criteria

select first:

- Calif. Department of Fish and Wildlife Criteria
- USEPA National Recom. Water Quality Criteria
 - Criteria Continuous Concentration (4-day avg.)
 - Criteria Maximum Concentration (1-hour avg.)
 - Other averaging periods

139

Algorithm for Inland Surface Waters

❖ Tastes and Odors Objective



➤ Taste- and odor-based thresholds

- Same as in groundwater algorithm **except** USEPA National Recomm. Water Qual. Criterion *based on taste or odor of water or fish flesh*

140

Algorithm for Inland Surface Waters

Step 1. Select a number for each ➤ item

- ◆ Use table in Figure 4 on page 33

Step 2. Select lowest number from Step 1 as the assessment threshold

- ◆ To satisfy all applicable objectives

Step 3. Adjust for natural background

- ◆ uncontrollable factors

141

Algorithm for Inland Surface Waters

■ Use table in Figure 4 on page 33

Water Quality Objective / Criterion	Relevant Portion of Objective / Criterion	Source	Concentration	Units
California Toxics Rule / National Toxics Rule	Human Health Protection	CTR or NTR		
	Aquatic Life Protection – CCC	CTR or NTR		
	Aquatic Life Protection – CMC	CTR or NTR		
Chemical Constituents	Drinking Water MCL (lowest)	SWRCB-DDW		
	Numerical Water Quality Objective	Basin Plan		
	Beneficial Use Impairment Numeric Threshold			
Toxicity	Human Health – Drinking Water			
	Human Health – Fish Consumption	USEPA, NRWQC		
	Aquatic Life Protection – CCC			
Tastes & Odors	Aquatic Life Protection – CMC			
	Taste & Odor Based Numeric Thresholds			

142

Algorithm for Enclosed Bays & Estuaries

- **Similar to inland surface waters algorithm**
 - ◆ CTR and NTR criteria may trump toxicity narratives
- **Different from inland surface waters algorithm**
 - ◆ No MUN use
 - ◆ Human health criteria limited to fish and shellfish consumption
 - ◆ No AGR use
 - ◆ Aquatic life criteria – check salinity



143

Algorithm for Enclosed Bays & Estuaries

- **Use table in Figure 5 on page 35**

Water Quality Objective / Criterion	Relevant Portion of Objective / Criterion	Source	Concentration	Units
California Toxics Rule / National Toxics Rule	Human Health Protection	CTR or NTR		
	Aquatic Life Protection – CCC	CTR or NTR		
	Aquatic Life Protection – CMC	CTR or NTR		
Chemical Constituents	Numerical Water Quality Objective	Basin Plan		
Toxicity	Human Health – Fish Consumption	USEPA, NRWQC		
	Aquatic Life Protection – CCC			
	Aquatic Life Protection – CMC			

144

Algorithm for Ocean Waters

- **Similar to enclosed bays & estuaries algorithm**
 - ◆ Human health criteria limited to fish and shellfish consumption
- **Different from enclosed bays & estuaries algorithm**
 - ◆ CTR and NTR criteria do not apply
 - ◆ California Ocean Plan objectives
 - Trump narrative toxicity objectives
 - ◆ Aquatic life criteria – saltwater



145

Algorithm for Ocean Waters

- **Use table in Figure 6 on page 36**

Water Quality Objective / Criterion	Relevant Portion of Objective / Criterion	Source	Concentration	Units
California Ocean Plan	Human Health Protection	Ocean Plan		
	Marine Aquatic Life Protection – 6-month median	Ocean Plan		
	Marine Aquatic Life Protection – daily maximum	Ocean Plan		
	Marine Aquatic Life Protection – instantaneous maximum	Ocean Plan		
Chemical Constituents	Numerical Water Quality Objective	Basin Plan		
Toxicity	Human Health – Fish Consumption	USEPA, NRWQC		
	Aquatic Life Protection – CCC			
	Aquatic Life Protection – CMC			

146

Assessment Thresholds Table

- On Water Quality Goals web page
- For commonly encountered constituents and parameters
- Algorithm tables filled in for you
- Combined table for all water body types
 - ◆ G = groundwater
 - ◆ IS = inland surface waters
 - ◆ E = enclosed bays and estuaries
 - ◆ O = ocean waters
- To protect limiting beneficial uses

147

Selecting Assessment Thresholds

a groundwater example

Leaking waste oil tank site

Zinc, TCE, Benzene, and Xylenes found in groundwater samples



- Goal: **“Has pollution occurred?”**
- Check the Basin Plan
 - ◆ What are the beneficial uses?
 - ◆ What water quality objectives apply?
- Select numeric threshold for each objective
- Which of these thresholds is most restrictive?
 - ◆ Compare with measured concentrations

150

Selecting Assessment Thresholds

a groundwater example

Chemical Constituents Objective

- Numeric water quality objectives see Basin Plan
- California MCLs
 - Primary

TCE	5 ug/L
Benzene	1 ug/L
Xylenes	1,750 ug/L
 - Secondary

Zinc	5,000 ug/L
------	------------
- Other beneficial use protection
 - Agricultural use

Zinc	2,000 ug/L
------	------------
 - Federal MCLs if lower

Xylenes (draft)	20 ug/L
-----------------	---------

151

Selecting Assessment Thresholds

a groundwater example

Chemical Constituents Objective

- Numeric water quality objectives see Basin Plan
- California MCLs
 - Primary

TCE	5 ug/L
Benzene	1 ug/L
Xylenes	1,750 ug/L
 - Secondary

Zinc	5,000 ug/L
------	------------
- Other beneficial use protection
 - Agricultural use


Zinc	2,000 ug/L
------	------------
 - Federal MCLs if lower

Xylenes (draft)	20 ug/L
-----------------	---------

152

Selecting Assessment Thresholds a groundwater example

Toxicity Objective – Zinc




➤ **Human Health – Drinking Water**

- **USEPA IRIS – Reference Dose** 2,100 ug/L
- **USEPA Health Advisory (draft)** 2,000 ug/L

153

Selecting Assessment Thresholds a groundwater example

Toxicity Objective – Zinc



➤ **Human Health – Drinking Water**

- **USEPA IRIS – Reference Dose** 2,100 ug/L
- **USEPA Health Advisory (draft)** 2,000 ug/L

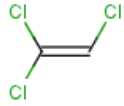
154

Selecting Assessment Thresholds

a groundwater example

Toxicity Objective – TCE

- Human Health – Drinking Water
 - OEHHA Public Health Goal 1.7 ug/L
 - Cal/EPA Cancer Potency Factor 5.9 ug/L
 - USEPA IRIS
 - Reference Dose 3.5 ug/L
 - Cancer risk estimate 0.5 ug/L
 - USEPA Health Advisory – cancer 3 ug/L
 - USEPA MCL Goal zero
 - Other
 - NAS cancer risk level 1.5 ug/L
 - Prop 65 No Significant Risk Level 7 ug/L



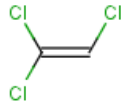
155

Selecting Assessment Thresholds

a groundwater example

Toxicity Objective – TCE

- Human Health – Drinking Water
 - OEHHA Public Health Goal 1.7 ug/L
 - Cal/EPA Cancer Potency Factor 5.9 ug/L
 - USEPA IRIS
 - Reference Dose 3.5 ug/L
 - Cancer risk estimate 0.5 ug/L
 - USEPA Health Advisory – cancer 3 ug/L
 - USEPA MCL Goal zero
 - Other
 - NAS cancer risk level 1.5 ug/L
 - Prop 65 No Significant Risk Level 7 ug/L



156

Toxicity Objective – Benzene

➤ **Human Health – Drinking Water**

- **OEHHA Public Health Goal** **0.15 ug/L**
- **Cal/EPA Cancer Potency Factor** **0.35 ug/L**
- **USEPA IRIS**
 - **Reference Dose** **28 ug/L**
 - **Cancer Risk Estimate (range)** **1 to 10 ug/L**
- **USEPA Health Advisory**
 - **Non-cancer effects** **3 ug/L**
 - **Cancer risk estimate (range)** **1 to 10 ug/L**
- **USEPA MCL Goal** **zero**
- **Other**
 - **Prop 65 – cancer** **3.2 ug/L**
 - **Prop 65 – reproductive toxicity** **12 ug/L** 157

Toxicity Objective – Benzene

➤ **Human Health – Drinking Water**

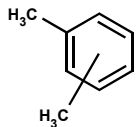
- **OEHHA Public Health Goal** **0.15 ug/L**
- **Cal/EPA Cancer Potency Factor** **0.35 ug/L**
- **USEPA IRIS**
 - **Reference Dose** **28 ug/L**
 - **Cancer Risk Estimate (range)** **1 to 10 ug/L**
- **USEPA Health Advisory**
 - **Non-cancer effects** **3 ug/L**
 - **Cancer risk estimate (range)** **1 to 10 ug/L**
- **USEPA MCL Goal** **zero**
- **Other**
 - **Prop 65 – cancer** **3.2 ug/L**
 - **Prop 65 – reproductive toxicity** **12 ug/L** 158

Selecting Assessment Thresholds

a groundwater example

Toxicity Objective – Xylenes

- Human Health – Drinking Water
 - California Primary MCL (1,750 ug/L)
 - OEHHA Public Health Goal 1,800 ug/L
 - USEPA IRIS – Reference Dose 1,400 ug/L
 - USEPA Health Advisory 1,400 ug/L
 - USEPA MCL Goal 10,000 ug/L



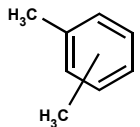
159

Selecting Assessment Thresholds

a groundwater example

Toxicity Objective – Xylenes

- Human Health – Drinking Water
 - California Primary MCL (1,750 ug/L)
 - OEHHA Public Health Goal 1,800 ug/L
 - USEPA IRIS – Reference Dose 1,400 ug/L
 - USEPA Health Advisory 1,400 ug/L
 - USEPA MCL Goal 10,000 ug/L




160

Selecting Assessment Thresholds

a groundwater example

Toxicity Objective – Summary

- **Zinc**
 - ◆ USEPA IRIS Reference Dose **2,100 ug/L**
- **TCE**
 - ◆ California Public Health Goal **1.7 ug/L**
- **Benzene**
 - ◆ California Public Health Goal **0.15 ug/L**
- **Xylenes**
 - ◆ California Public Health Goal **1,800 ug/L**
 - ◆ California Primary MCL **(1,750 ug/L)**




161

Selecting Assessment Thresholds

a groundwater example

Taste and Odor Objective

- Taste & odor based thresholds
 - California 2° MCL **Zinc 5,000 ug/L**
 - Federal 2° MCLs **Zinc 5,000 ug/L**
(draft) **Xylenes 20 ug/L**
 - USEPA NRWQC – T&O **Zinc 5,000 ug/L**
 - Other T&O thresholds
 - 1989 Federal Register & USEPA Fact Sheets **Xylenes 17 ug/L**
 - Peer reviewed journal **Benzene 170 ug/L**
TCE 310 ug/L




162

Selecting Assessment Thresholds a groundwater example

Taste and Odor Objective

- Taste & odor based thresholds
 - California 2° MCL Zinc 5,000 ug/L
 - Federal 2° MCLs (draft)
 - Zinc 5,000 ug/L
 - Xylenes 20 ug/L
 - USEPA NRWQC - T&O
 - Zinc 5,000 ug/L
 - Other T&O thresholds
 - 1989 Federal Register & USEPA Fact Sheets Xylenes 17 ug/L
Benzene 170 ug/L
TCE 310 ug/L
 - Peer reviewed journal



163

Selecting Assessment Thresholds a groundwater example

Numeric Thresholds – Zinc

<i>Water Quality Objective</i>	<i>Threshold</i>
➤ Chemical Constituents (Numeric)	see Basin Plan
➤ Chemical Constituents (MCL)	5,000 ug/L
➤ Chemical Constituents (AGR Use)	2,000 ug/L
➤ Toxicity	2,100 ug/L
➤ Taste & Odor	5,000 ug/L



164

Selecting Assessment Thresholds a groundwater example

Assessment Threshold – Zinc

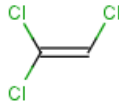


<i>Water Quality Objective</i>	<i>Threshold</i>
➤ Chemical Constituents (Numeric)	see Basin Plan
➤ Chemical Constituents (MCL)	5,000 ug/L
➤ Chemical Constituents (AGR Use)	2,000 ug/L
➤ Toxicity	2,100 ug/L
➤ Taste & Odor	5,000 ug/L

165

Selecting Assessment Thresholds a groundwater example

Numeric Thresholds – TCE




<i>Water Quality Objective</i>	<i>Threshold</i>
➤ Chemical Constituents (Numeric)	see Basin Plan
➤ Chemical Constituents (MCL)	5 ug/L
➤ Chemical Constituents (Ben. Use)	–
➤ Toxicity	1.7 ug/L
➤ Taste & Odor	310 ug/L

166

Selecting Assessment Thresholds a groundwater example

Assessment Threshold – TCE




<i>Water Quality Objective</i>	<i>Threshold</i>
➤ Chemical Constituents (Numeric)	see Basin Plan
➤ Chemical Constituents (MCL)	5 ug/L
➤ Chemical Constituents (Ben. Use)	–
➤ Toxicity	1.7 ug/L
➤ Taste & Odor	310 ug/L

167

Selecting Assessment Thresholds a groundwater example

Numeric Thresholds – Benzene



<i>Water Quality Objective</i>	<i>Threshold</i>
➤ Chemical Constituents (Numeric)	see Basin Plan
➤ Chemical Constituents (MCL)	1 ug/L
➤ Chemical Constituents (Ben. Use)	–
➤ Toxicity	0.15 ug/L
➤ Taste & Odor	170 ug/L

168

Selecting Assessment Thresholds a groundwater example

Assessment Threshold – Benzene

<i>Water Quality Objective</i>	<i>Threshold</i>
➤ Chemical Constituents (Numeric)	see Basin Plan
➤ Chemical Constituents (MCL)	1 ug/L
➤ Chemical Constituents (Ben. Use)	–
➤ Toxicity	0.15 ug/L
➤ Taste & Odor	170 ug/L

169

Selecting Assessment Thresholds a groundwater example

Numeric Thresholds – Xylenes

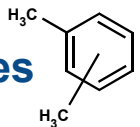
<i>Water Quality Objective</i>	<i>Threshold</i>
➤ Chemical Constituents (Numeric)	see Basin Plan
➤ Chemical Constituents (MCL)	1,750 ug/L
➤ Chemical Constituents (Ben. Use)	–
➤ Toxicity	1,800 ug/L
➤ Taste & Odor	17 ug/L

170

Selecting Assessment Thresholds

a groundwater example

Assessment Threshold – Xylenes



<i>Water Quality Objective</i>	<i>Threshold</i>
➤ Chemical Constituents (Numeric)	see Basin Plan
➤ Chemical Constituents (MCL)	1,750 ug/L
➤ Chemical Constituents (Ben. Use)	
➤ Toxicity	1,800 ug/L
➤ Taste & Odor	17 ug/L

171

Selecting Assessment Thresholds

a groundwater example

Assessment thresholds to implement all applicable water quality objectives

■ Zinc	◆ Agricultural Use Limit	2,000	ug/L
■ TCE	◆ California Public Health Goal	1.7	ug/L
■ Benzene	◆ California Public Health Goal	0.15	ug/L
■ Xylenes	◆ Taste & Odor Threshold	17	ug/L

(Unless numeric water quality objectives are lower)

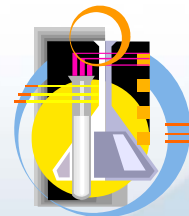
172

How low can you go?

173

Analytical Quantitation Limits

- If assessment < quantitation threshold limit
 - May need different analytical method
 - Available Methods?
 - Cost?
- Check method quantitation limits
 - Should lab be able to do better?
 - ◆ Minimum Levels in SIP
 - ◆ Minimum Levels in Ocean Plan
 - ◆ Detection Limits for Purposes of Reporting (DLRs) from SWRCB-DDW
 - ◆ Analytical method manuals – NEMI



174

Multiple Chemicals Together

175

Σ Additive Toxicity Criterion for Multiple Constituents

From Policy for Application of Water Quality Objectives in the Implementation Chapter of the Central Valley Region Basin Plans

Similar language in Water Board regulations
23 CCR, Chapter 15 § 2550.4 and 27 CCR § 20400(g)



- Multiple toxic pollutants together in water
 - ◆ Potential for toxicologic interactions
- Generally assume additive toxicity for
 - ◆ Pollutants that are carcinogens
 - ◆ Pollutants that manifest their toxic effects on the same organ systems or through similar mechanisms

176

Additive Toxicity Criterion for Multiple Constituents

$$\sum_{i=1}^n \frac{[\text{Concentration of Constituent}]_i}{[\text{Toxicologic Threshold in Water}]_i} < 1.0$$

	Found	10 ⁻⁶ Cancer Risk Estimate
Benzene	0.1 ug/L	0.15 ug/L
TCE	1.5 ug/L	1.7 ug/L
	$\frac{0.1}{0.15} + \frac{1.5}{1.7} =$	1.5 violation

180

To degrade or not to degrade?

181

A Case for Antidegradation

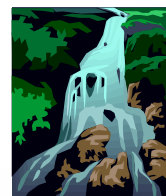
- **The same water is used many times**
 - ◆ Each use causes some degradation
- **Many human activities also cause water quality degradation**
- **If one use or activity is permitted to degrade water quality to just below the water quality objective, no room exists for degradation from other uses or activities that will occur**
 - ◆ Beneficial uses are likely to be impaired by the next use or activity



182

A Case for Antidegradation

- **Our understanding of health and environmental effects of chemicals is constantly evolving**
 - ◆ What we believe to be safe at 10 ppb today may be found to be harmful at 1 ppb tomorrow
 - ◆ Our knowledge of effects of chemical combinations is very limited
- **Desirable to minimize the degree of water quality degradation**



183

State Water Board Resolution No. 68-16 (1968)
**Statement of Policy with Respect to Maintaining
High Quality of Waters in California**

California’s “Antidegradation Policy”

**“Whenever the existing quality of
water is better than the quality
established in policies, . . .
such existing high quality will be maintained
. . .”**




184

State Water Board Resolution No. 68-16 (1968)
**Statement of Policy with Respect to Maintaining
High Quality of Waters in California**

California’s “Antidegradation Policy”

**“. . . until it has been demonstrated
to the State that any change**

- ◆ will be consistent with maximum benefit
to the people of the State,**
- ◆ will not unreasonably affect present and
anticipated beneficial use of such water
and**
- ◆ will not result in water quality less than
that prescribed in the policies.”**




185

State Water Board Resolution No. 68-16 (1968)
**Statement of Policy with Respect to Maintaining
High Quality of Waters in California**

California’s “Antidegradation Policy”

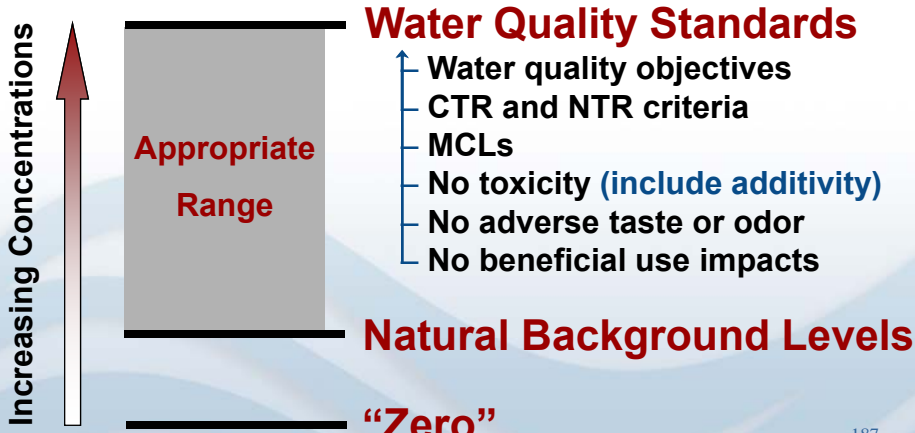
“Any activity which produces or may produce a waste . . . and which discharges or proposes to discharge to existing high quality waters will be required to meet waste discharge requirements which will result in the **best practicable treatment or control** of the discharge necessary to assure that

- ◆ pollution or nuisance will not occur and
- ◆ the highest water quality consistent with maximum benefit to the people of the State will be maintained.”



186

**Appropriate Range of Water Quality
to Protect Beneficial Uses**



187

