CA Regional Water Quality Control Board
San Diego Region

PUBLIC WORKSHOP:

TENTATIVE CLEANUP AND ABATEMENT ORDER (CAO) NO. R9-2005-0126

June 29, 2005

HUMAN HEALTH BENEFICIAL USES IMPAIRMENT

(Tentative CAO Findings 26 – 29)

Finding 26

- **Human Health Impairment**

  “Human health beneficial uses designated for San Diego Bay are impaired due to the elevated levels of pollutants present in the marine sediment at the Shipyard Sediment Site.”

Finding 27

- **Tier I**
  - Screening level risk assessment
  - Based on tissue data derived from laboratory bioaccumulation test
- **Tier II**
  - Comprehensive risk assessment
  - Based on tissue data from site fish and shellfish

Key Differences

- **Tier I**
  - SY Technical Report: Not reported
  - Regional Board: Conducted evaluation
- **Tier II**
  - Chemical concentrations in fish and shellfish
  - Fraction ingested from site
  - Cumulative risk consideration
  - Results

Tier I
Screening Level Risk Assessment

(Tentative CAO Finding 28)

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- **Tier I Results**

Recreational Anglers

- 8 of 9 site stations pose a "possible" cancer risk;
COPCs = inorganic arsenic, BAP, PCBs

- 6 of 9 site stations pose a "possible" non-cancer risk;
COPCs = PCBs

Subsistence Anglers

- 8 of 9 site stations pose a "possible" cancer risk;
COPCs = inorganic arsenic, BAP, PCBs, TBT

- 8 of 9 site stations pose a "possible" non-cancer risk;
COPCs = inorganic arsenic, PCBs

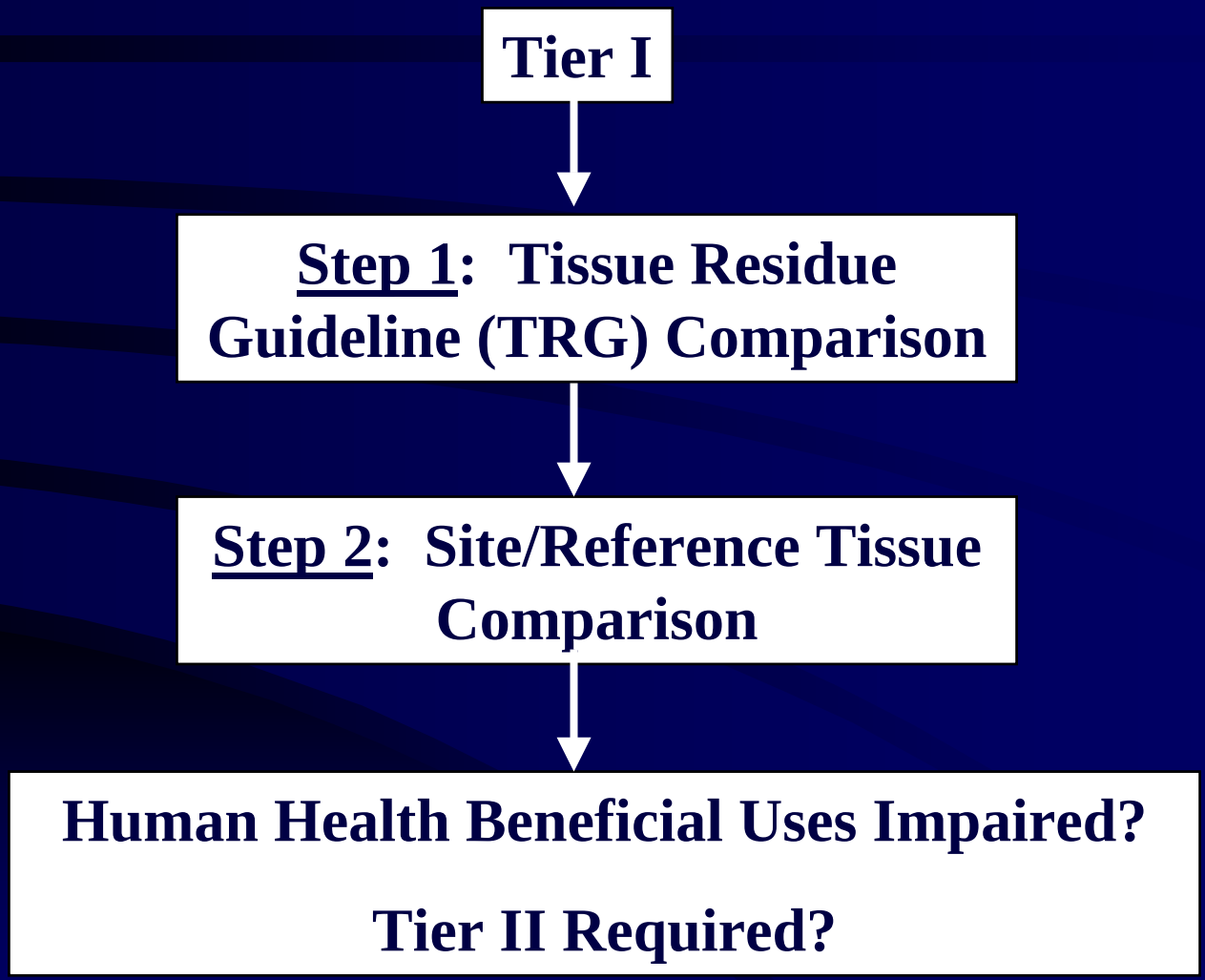
Regional Board's Process

- **Key Elements from EPA Guidance**
  - Selection of Receptors of Concern
  - Risk Characterization
    - Exposure assessment
    - Effects assessment
  - Risk Management

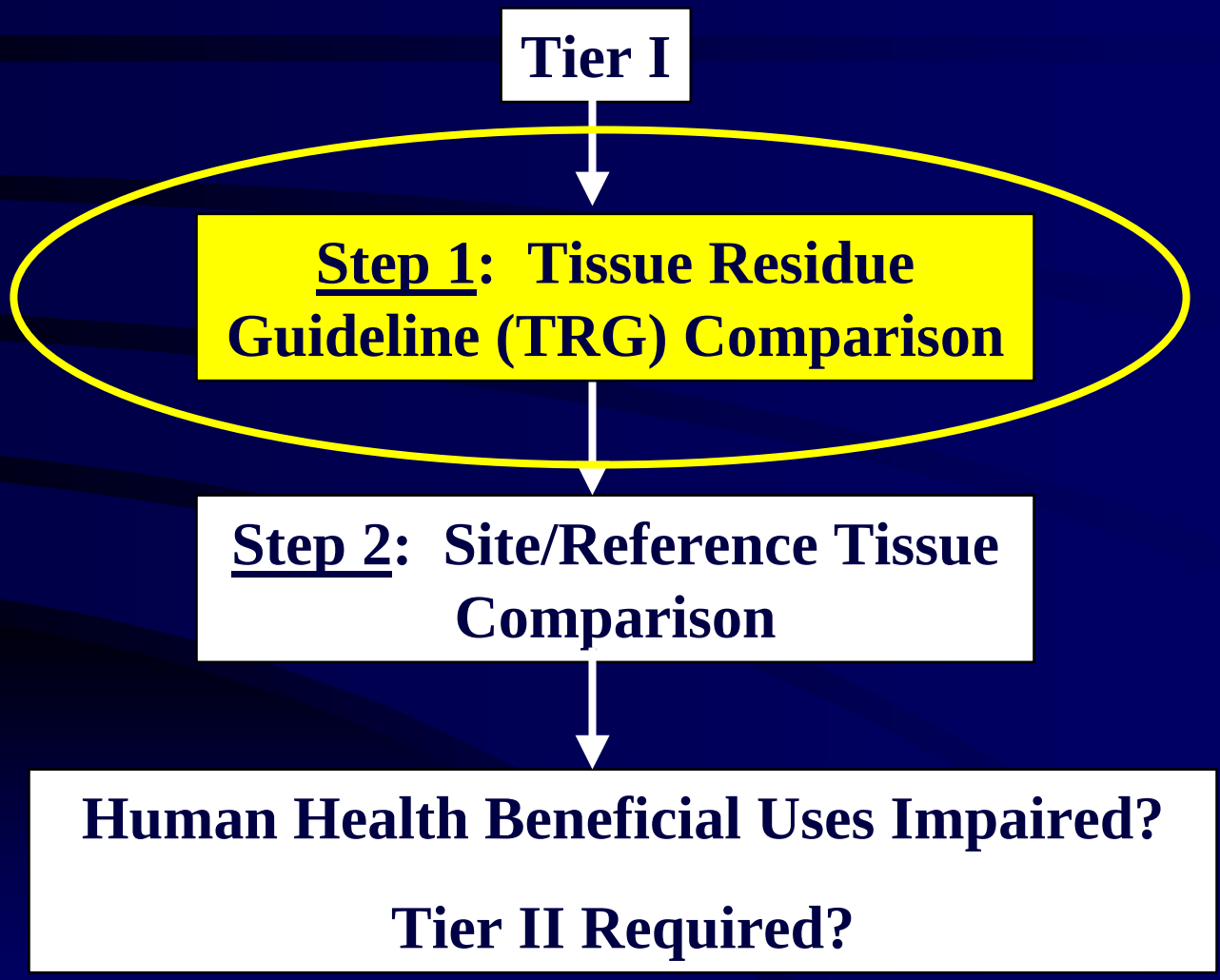
Selection of Receptors of Concern

- **Recreational Anglers**
  - Eat the fish and/or shellfish they catch recreationally
- **Subsistence Anglers**
  - Fish for food, for economic and/or cultural reasons
  - Fish and/or shellfish is major source of protein intake

Risk Characterization



Risk Characterization



Step 1: TRG Comparison

- **Tissue Residue Guidelines (TRG)**
  - Specific TRGs derived by OEHHA
  - Chemicals without TRGs
- **Site Tissue**
  - 28-day laboratory bioaccumulation test (ASTM)
  - *Macoma nasuta* tissue concentrations
  - Sediment from 4 stations at NASSCO, 5 stations at SWM
  - Maximum tissue concentration used

TRG Equations

$$TRG_{carcinogenic} = (TRL \times BW) / (CSF \times CR \times FI \times ABS)$$

$$TRG_{non\text{-}carcinogenic} = (RfD \times BW) / (CR \times FI)$$

TRG	=	tissue screening level for fish/shellfish tissue (ug/kg)
TRL	=	target risk level (unitless)
CSF	=	cancer slope factor $(mg/kg\text{-}day)^{-1}$
RfD	=	reference dose (mg/kg-day)
BW	=	body weight of adult (kg)
CR	=	fish and shellfish consumption rate (g/day)
ABS	=	fraction absorbed (unitless)
FI	=	fractional intake of seafood consumed that originates from site (unitless)

TRG Factors Used by Regional Board

	Units	Recreational Angler	Subsistence Angler
Noncarcinogenic Chemicals			
Body Weight of Adult	kg	70	70
Consumption Rate	g/day	21	161
Fractional Intake	kg/day dry wt	1	1
RfD	mg/kg-day	See Effects Characterization	See Effects Characterization
Carcinogenic Chemicals			
Target Risk Level	unitless	1 x 10-5	1 x 10-5
Body Weight of Adult	kg	70	70
Consumption Rate	g/day	21	161
Fractional Intake	unitless	1	1
Fraction Absorbed	unitless	1	1
CSF	(mg/kg-day)-1	See Effects Characterization	See Effects Characterization

TRG Factors Used by Regional Board

	Chemical	CSF (mg/kg-day)	RfD (mg/kg-day)	Source
Metals				
	Arsenic, inorganic	1.5	0.0003	U.S. EPA (2003)
	Cadmium	NA	0.0005	U.S. EPA (2003)
	Chromium	NA	0.003	U.S. EPA (2003)
	Copper	NA	0.037	U.S. EPA (2003)
	Mercury, total	NA	0.0001	U.S. EPA (2003)
	Nickel	NA	0.02	U.S. EPA (2003)
	Selenium	NA	0.005	U.S. EPA (2003)
	Silver	NA	0.005	U.S. EPA (2003)
	Zinc	NA	0.3	U.S. EPA (2003)

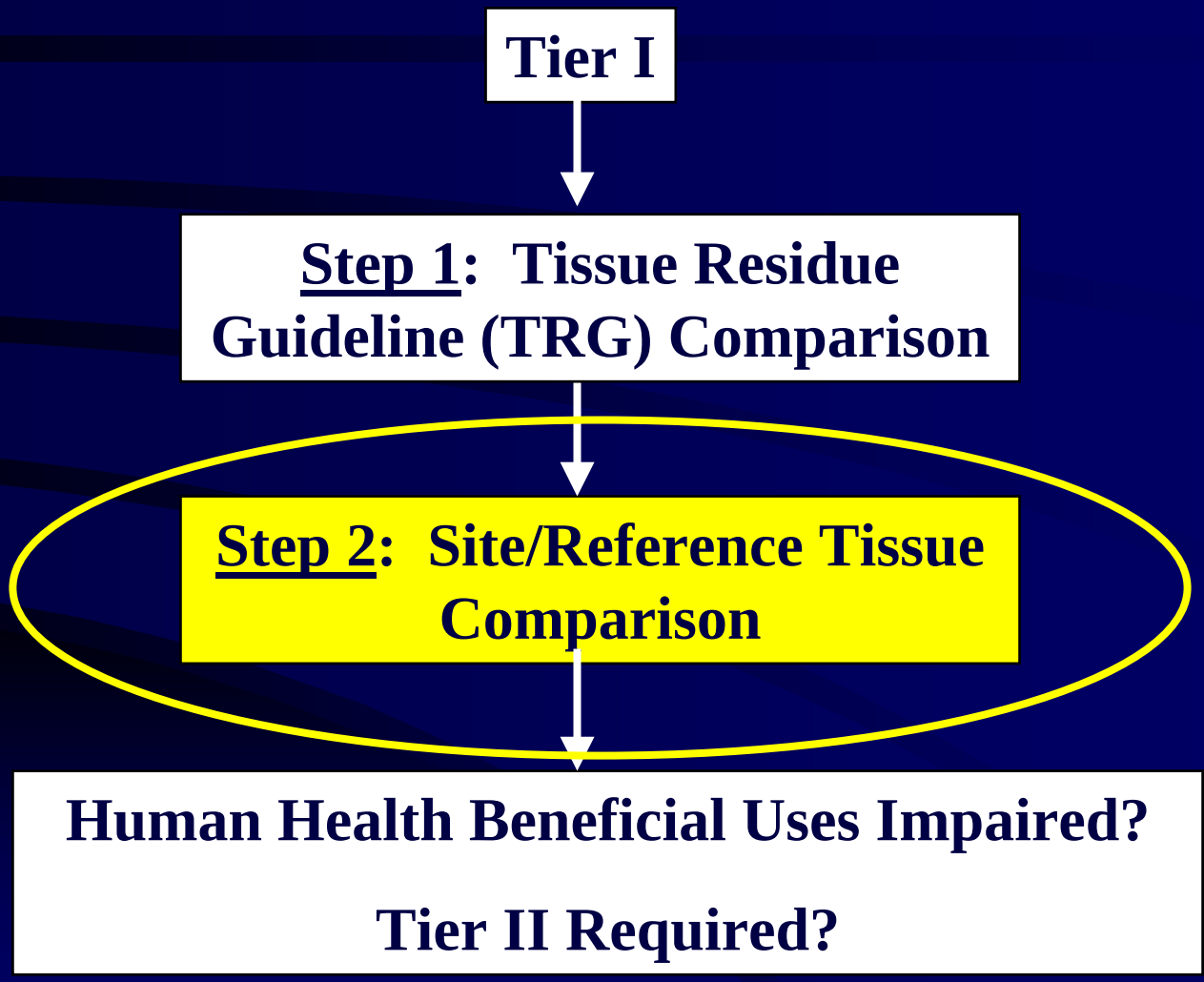
TRG Factors Used by Regional Board

	Chemical	CSF (mg/kg-day)	RfD (mg/kg-day)	Source
Organometallic Compounds				
	Tributyltin	NA	0.0003	U.S. EPA (2003)
Polychlorinated Biphenyls				
	Total PCBs	2	NA	U.S. EPA (2003)
	Total PCBs (as Aroclor 1254)	NA	0.00002	U.S. EPA (2003)
Polycyclic Aromatic Hydrocarbons				
	Naphthalene	NA	0.02	U.S. EPA (2003)
	Acenaphthene	NA	0.06	U.S. EPA (2003)
	Fluorene	NA	0.04	U.S. EPA (2003)
	Anthracene	NA	0.3	U.S. EPA (2003)

TRG Factors Used by Regional Board

	Chemical	CSF (mg/kg-day)	RfD (mg/kg-day)	Source
Polycyclic Aromatic Hydrocarbons (con't)				
	Fluoranthene	NA	0.04	U.S. EPA (2003)
	Pyrene	NA	0.02	U.S. EPA (2003)
	Benz[a]anthracene	1.2	NA	OEHHA (2001)
	Chrysene	0.12	NA	OEHHA (2001)
	Benzo[b]fluoranthene	1.2	NA	OEHHA (2001)
	Benzo[k]fluoranthene	1.2	NA	OEHHA (2001)
	Benzo[a]pyrene	12	NA	OEHHA (2001)
	Indeno[1,2,3-cd]pyrene	1.2	NA	OEHHA (2001)
	Dibenz[a,h]anthracene	4.1	NA	OEHHA (2001)

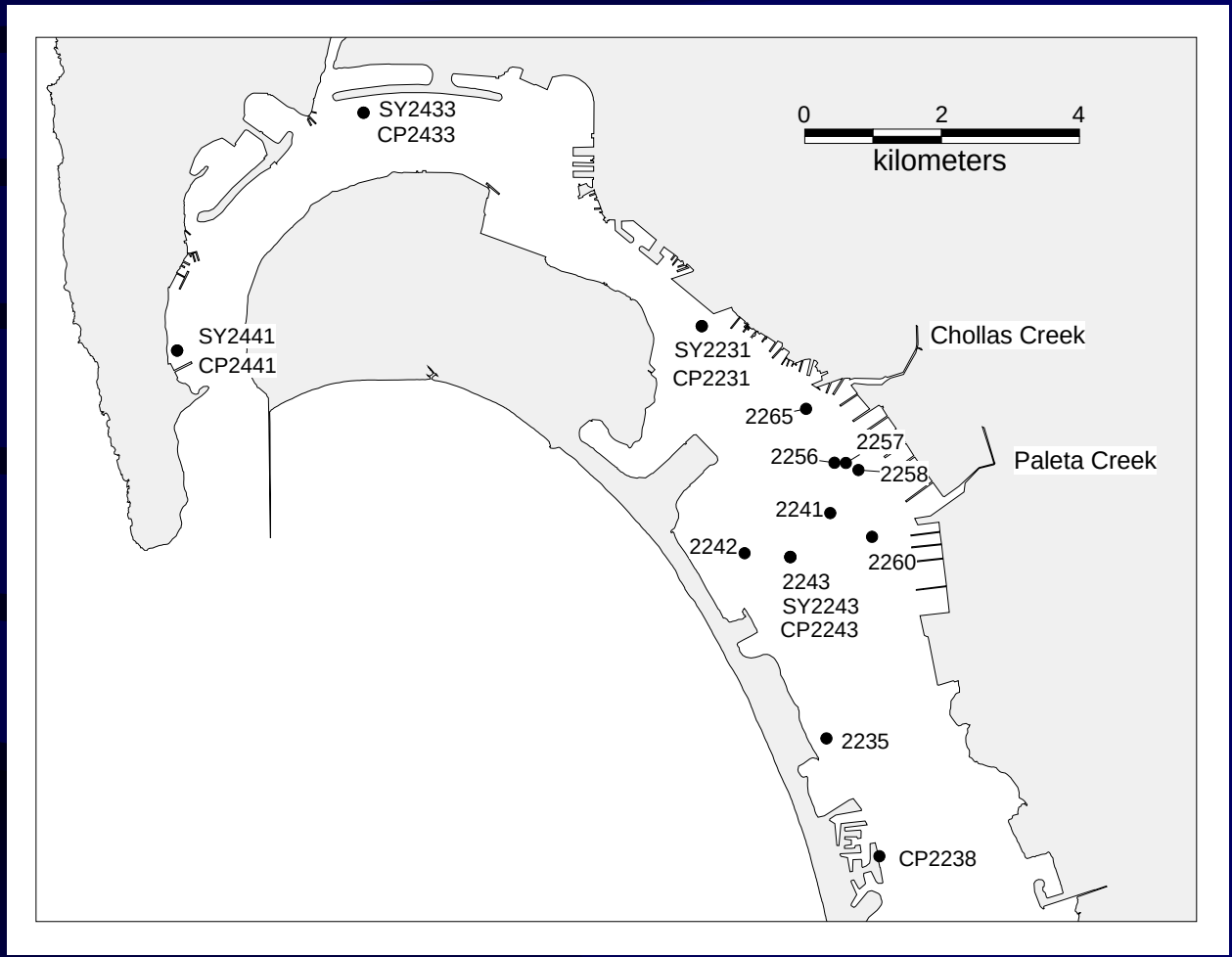
Risk Characterization



Step 2 – Site/Reference Comparison

- **Baseline Pool**
  - **28-day laboratory bioaccumulation test (ASTM)**
  - ***Macoma nasuta* tissue concentrations**
  - **95% upper prediction limit (UPL)**

Baseline Pool Stations



Location of reference stations included in the Baseline Pool. The station identifiers indicate whether the station was sampled during the Chollas/Paleta TMDL study (CP prefix), the Shipyard study (SY), or the Bight'98 survey (no prefix).

95% Upper Prediction Limits

Macoma Tissue Chemicals		95% Upper Prediction Limits
Metals		
	Arsenic	22.8 mg/kg
	Cadmium	0.39 mg/kg
	Chromium	3.9 mg/kg
	Copper	19.2 mg/kg
	Lead	3.3 mg/kg
	Mercury	0.15 mg/kg
	Nickel	4.4 mg/kg
	Selenium	4.9 mg/kg
	Silver	0.57 mg/kg
	Zinc	85.7 mg/kg

95% Upper Prediction Limits

Macoma Tissue Chemicals	95% Upper Prediction Limits
Organometallic Compounds	
Tributyltin	12 ug/kg
Organics	
Benzo[a]pyrene	132 ug/kg
Total Polychlorinated Biphenyls (PCB), as congeners	186 ug/kg
Total Polychlorinated Terphenyls (PCT)	All Baseline Pool stations undetected

Risk Management

	STEP 1 Site Tissue > Recreational TRG	STEP 1 Site Tissue > Subsistence TRG	STEP 2 Site Tissue > Baseline 95% UPL Tissue	Human Health Beneficial Use Impaired		Risk Management	
				Unlikely	Possible	No Further Action	Tier II Required
1	No	No	No	X		X	
2	No	No	Yes	X		X	
3	Yes	No	No	X		X	
4	No	Yes	No	X		X	
5	Yes	Yes	No	X		X	
6	Yes	No	Yes		X		X
7	No	Yes	Yes		X		X
8	Yes	Yes	Yes		X		X

Tier II
Comprehensive Risk Assessment

(Tentative CAO Finding 29)

Key Differences

- **Tier II**
  - Chemical concentrations in fish and shellfish
  - Fraction ingested from site
  - Cumulative risk consideration
  - Results

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- **Tier II Results**

Cancer Risk

- Cancer risk to recreational and subsistence anglers
- Primary contaminant drivers = inorganic arsenic, BAP PCBs

Noncancer Risk

- Noncancer risk to recreational and subsistence anglers
- Primary contaminant drivers = copper, mercury, PCBs

***Key Difference**

- Shipyard technical report concluded no risk to human health

Regional Board's Tier II Process

- **Key Elements from EPA Guidance**
  - Selection of Receptors of Concern
  - Risk Characterization
    - Exposure assessment
    - Effects assessment
  - Risk Management

Selection of Receptors of Concern

- **Recreational Anglers**

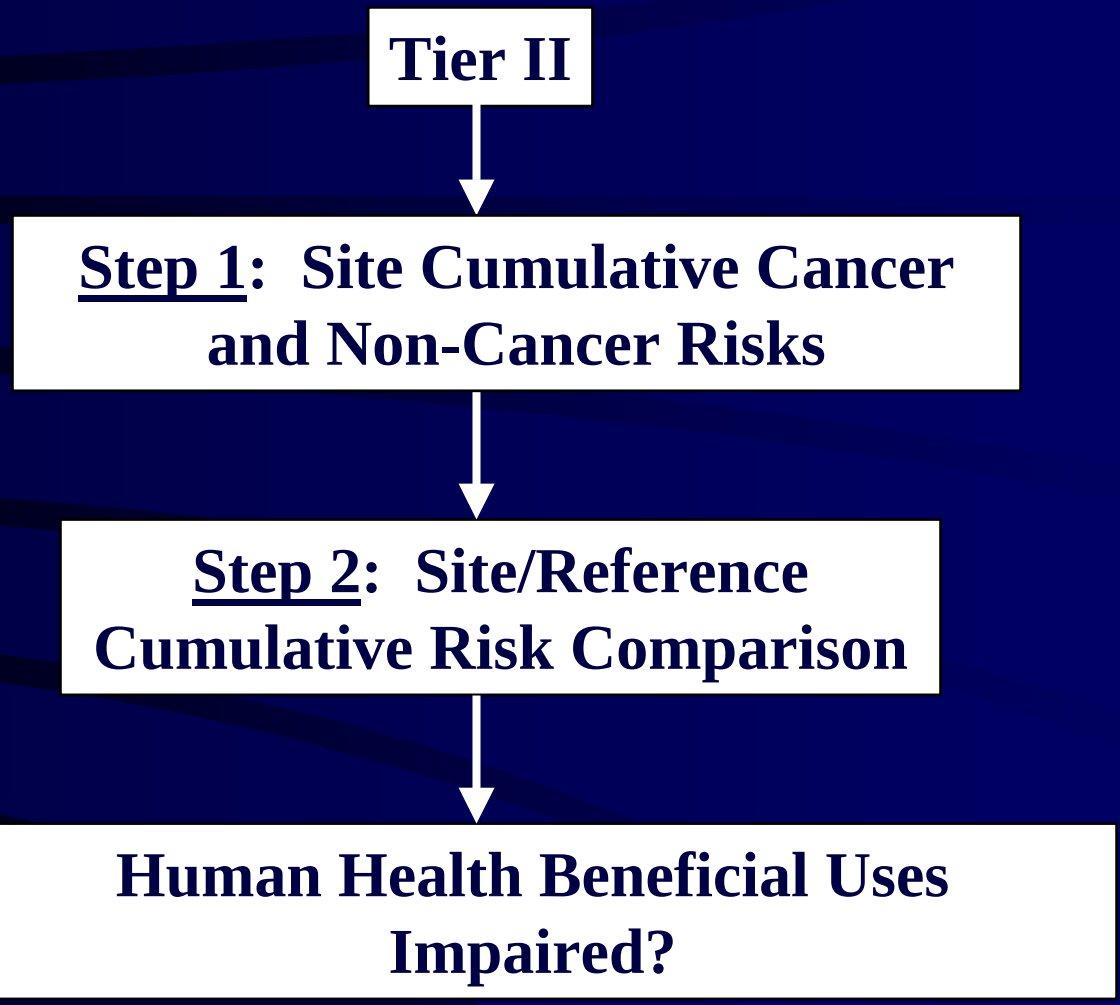
  - Eat the fish and/or shellfish they catch recreationally

- **Subsistence Anglers**

  - Fish for food, for economic and/or cultural reasons

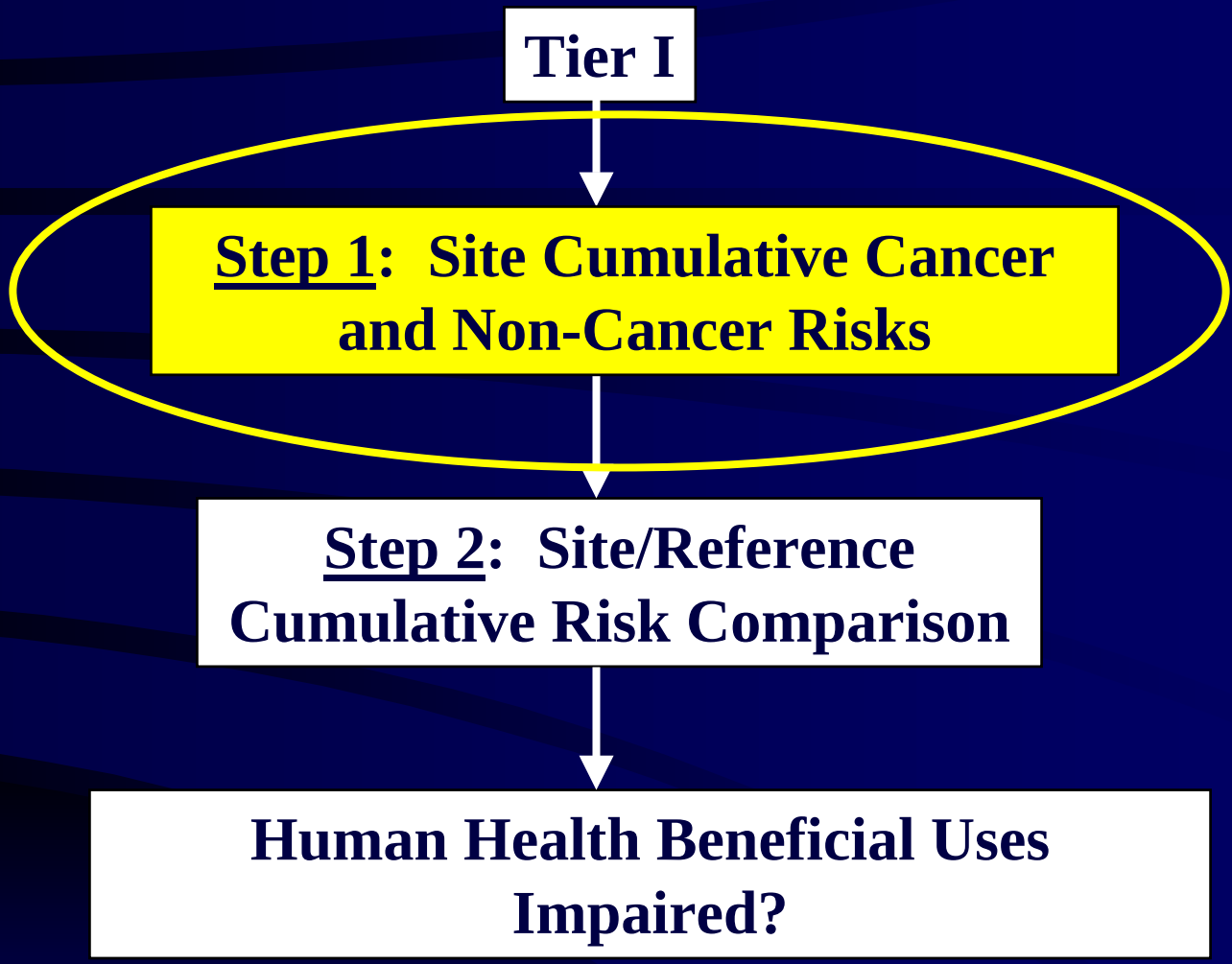
  - Fish and/or shellfish is major source of protein intake

Risk Characterization



*Key Difference: SY technical report did not consider cumulative risks

Risk Characterization



*Key Difference: SY technical report did not consider cumulative risks

Risk Equations

$$Risk_{cancer} = Intake \times CSF$$

$$Hazard\ Index_{non\text{-}cancer} = Intake / RfD$$

Intake = **Human exposure to chemical concentrations in fish and shellfish tissue.**

CSF = **Cancer slope factor**

RfD = **Reference dose**

Risk Equations

$$Risk_{cancer} = Intake \times CSF$$

$$Hazard\ Index_{non\text{-}cancer} = Intake / RfD$$

Intake = **Human exposure to chemical concentrations in fish and shellfish tissue.**

CSF = **Cancer slope factor**

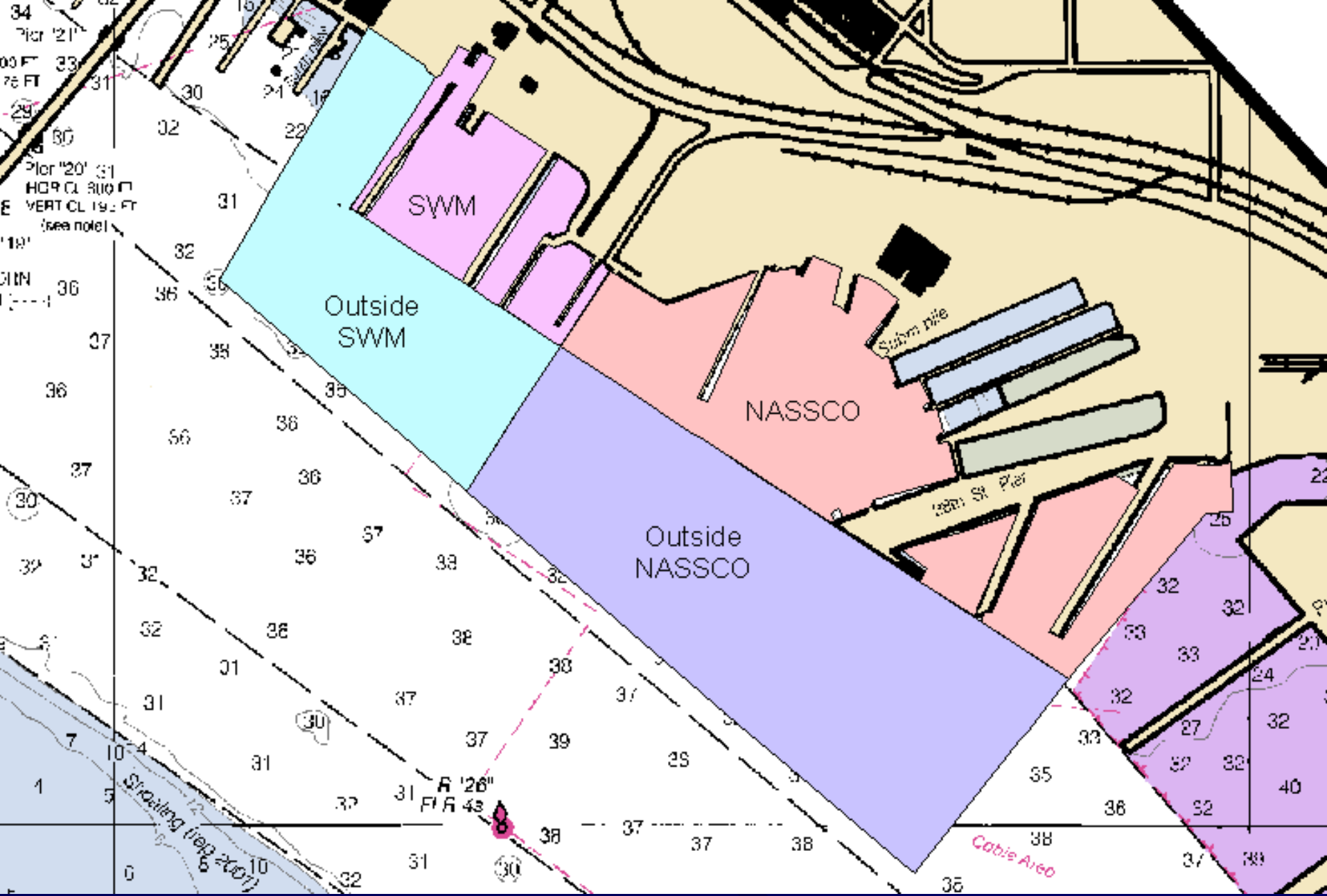
RfD = **Reference dose**

Intake (mg/kg-day) = (C x CR x FI x ED x EF) / (BW x AT x CF)

- **C = Tissue chemical concentration in spotted sand bass and spiny lobster (ug/kg-wet weight)**
- **CR = Fish consumption rate (kg/day)**
- **FI = Fraction ingested from the site (unitless)**
- **ED = Exposure duration (years)**
- **EF = Exposure frequency (days/year)**
- **BW = Body weight (kg)**
- **AT = Averaging time (days)**
  - **noncarcinogens: exposure duration x 365 days**
  - **carcinogens: 70-year lifetime x 365 days**
- **CF = Conversion factor (1,000 ug/mg)**

Exposure Factors Used by Regional Board

- **Recreational Angler**
  - Spotted sand bass (fillet)
  - Spiny lobster (edible tissue)
- **Subsistence Angler**
  - Spotted sand bass (whole body)
  - Spiny lobster (whole body)



Sub-sections of study area.

Exposure Factors Used by Regional Board

Parameter		Units	Recreational Angler	Subsistence Angler
Tissue Chemical Concentration	C	ug/kg-wet wt	Maximum	Maximum
Fish or Shellfish Consumption Rate	CR	kg/day	0.021	0.161
Body Weight	BW	kg	70	70
Exposure Duration	ED	years	30	30
Exposure Frequency	EF	days/year	365	365
Fraction Ingested from Site	FI	unitless	1	1
Averaging Time for Carcinogens	AT_c	days	25,550	25,550
Averaging Time for Noncarcinogens	AT_n	days	10,950	10,950
Conversion Factor	CF	ug/mg	1,000	1,000

Exposure Factors in SY Technical Report

Parameter		Units	Recreational Angler	Subsistence Angler
Tissue Chemical Concentration	C	ug/kg-wet wt	Max or 95% UCL	Max or 95% UCL
Fish or Shellfish Consumption Rate	CR	kg/day	0.021	0.161
Body Weight	BW	kg	70	70
Exposure Duration	ED	years	30	30
Exposure Frequency	EF	days/year	365	365
Fraction Ingested from Site	FI	unitless	0.034, 0.005, 0.023, 0.002	0.034, 0.005, 0.023, 0.002
Averaging Time for Carcinogens	AT_c	days	25,550	25,550
Averaging Time for Noncarcinogens	AT_n	days	10,950	10,950
Conversion Factor	CF	ug/mg	1,000	1,000

Risk Equations

$$Risk_{cancer} = Intake \times CSF$$

$$Hazard\ Index_{non\text{-}cancer} = Intake / RfD$$

Intake = **Human exposure to chemical concentrations in fish and shellfish tissue.**

CSF = **Cancer slope factor**

RfD = **Reference dose**

Effect Factors Used by Regional Board

	Chemical	CSF (mg/kg-day)	RfD (mg/kg-day)	Source
Metals				
	Arsenic, inorganic	1.5	0.0003	U.S. EPA (2003)
	Cadmium	NA	0.0005	U.S. EPA (2003)
	Chromium	NA	0.003	U.S. EPA (2003)
	Copper	NA	0.037	U.S. EPA (2003)
	Mercury, total	NA	0.0001	U.S. EPA (2003)
	Nickel	NA	0.02	U.S. EPA (2003)
	Selenium	NA	0.005	U.S. EPA (2003)
	Silver	NA	0.005	U.S. EPA (2003)
	Zinc	NA	0.3	U.S. EPA (2003)

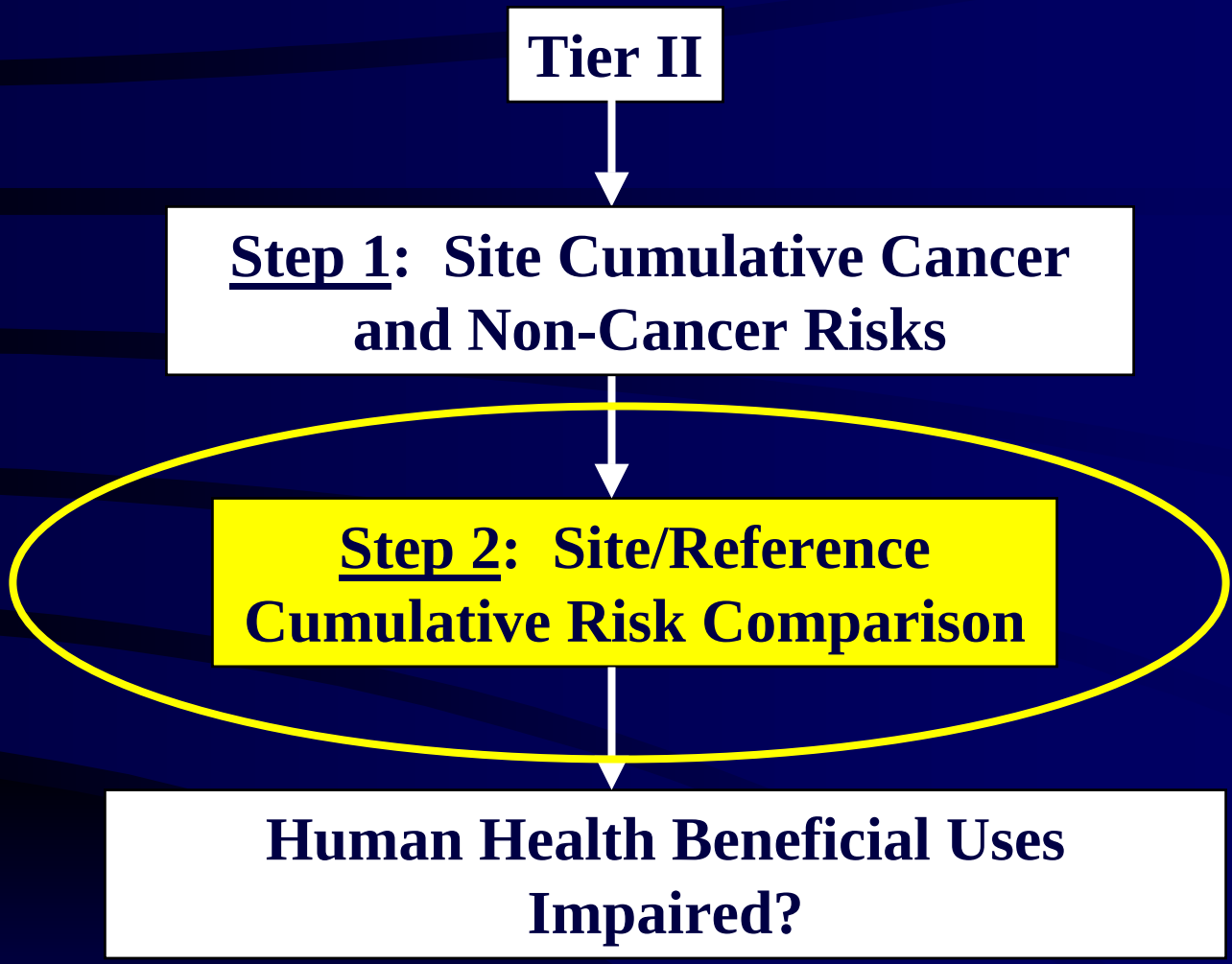
Effect Factors Used by Regional Board

Chemical	CSF (mg/kg-day)	RfD (mg/kg-day)	Source
Organometallic Compounds			
Tributyltin	NA	0.0003	U.S. EPA (2003)
Polychlorinated Biphenyls			
Total PCBs	2	NA	U.S. EPA (2003)
Total PCBs (as Aroclor 1254)	NA	0.00002	U.S. EPA (2003)
Polycyclic Aromatic Hydrocarbons			
Naphthalene	NA	0.02	U.S. EPA (2003)
Acenaphthene	NA	0.06	U.S. EPA (2003)
Fluorene	NA	0.04	U.S. EPA (2003)
Anthracene	NA	0.3	U.S. EPA (2003)

Effect Factors Used by Regional Board

	Chemical	CSF (mg/kg-day)	RfD (mg/kg-day)	Source
Polycyclic Aromatic Hydrocarbons (con't)				
	Fluoranthene	NA	0.04	U.S. EPA (2003)
	Pyrene	NA	0.02	U.S. EPA (2003)
	Benz[a]anthracene	1.2	NA	OEHHA (2001)
	Chrysene	0.12	NA	OEHHA (2001)
	Benzo[b]fluoranthene	1.2	NA	OEHHA (2001)
	Benzo[k]fluoranthene	1.2	NA	OEHHA (2001)
	Benzo[a]pyrene	12	NA	OEHHA (2001)
	Indeno[1,2,3-cd]pyrene	1.2	NA	OEHHA (2001)
	Dibenz[a,h]anthracene	4.1	NA	OEHHA (2001)

Risk Characterization



*Key Difference: SY technical report did not consider cumulative risks

Step 2 – Site/Reference Comparison

- **Reference Area(s)**
  - Located on the west side of San Diego Bay
  - Vicinity of Reference Stations 2230 and 2240
  - Same reference area used in fish histopathology, fish bile, and aquatic-dependent wildlife assessments (2240)
  - Same exposure and effects assumptions
- **Simple Comparison**
  - Cumulative site risk > Cumulative reference risk?

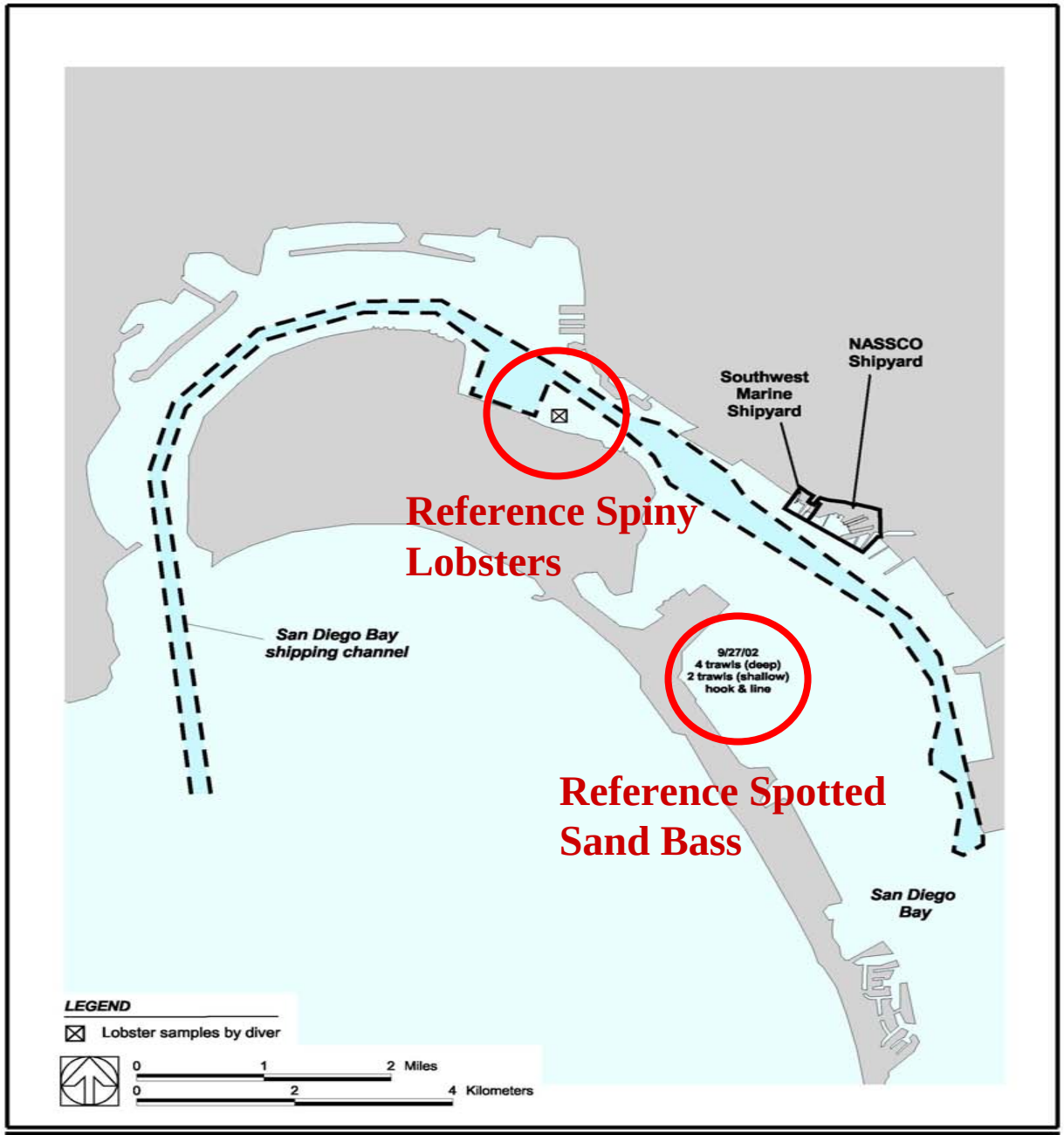


Figure 2-2. Biota sampling reference locations

Exponent®

8601718/8601731.002 1201 | Sep 03, 2003 | biota ref samples view | Fig 2-2 biota ref samples layout | g:\swm_nassco\projects\shipyards_rpt.apr

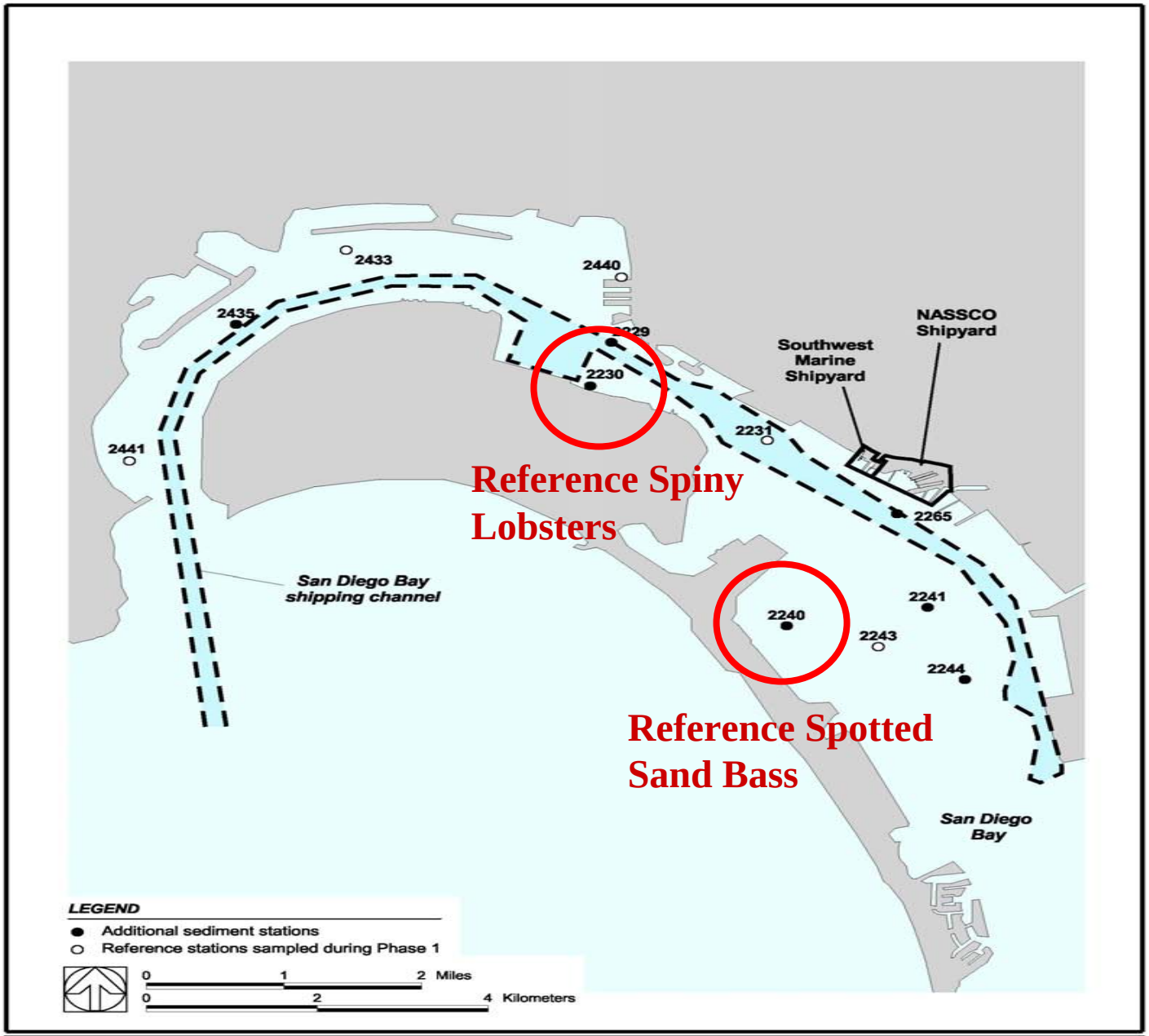


Figure 2-3. Additional sediment sampling locations in San Diego Bay

Exponent®

8601718/8601731.002 1201 | Sep 03, 2003 | add SDB sample view | Fig 2-3 additional samples layout | g:\swm_nassco\projects\shipyards_rpt.apr

Risk Management (Cancer)

	Recreational Angler		Subsistence Angler		Human Health Beneficial Uses Impaired	Risk Management Decision	
	Step 1 > $1x10^{-6}$	Step 2 Cumulative Site Risk > Cumulative Reference Risk	Step 1 > $1x10^{-6}$	Step 2 Cumulative Site Risk > Cumulative Reference Risk		No Further Action	Remedial Action
1	No	No	No	No	No	X	
2	Yes	No	No	No	No	X	
3	No	Yes	No	No	No	X	
4	No	No	Yes	No	No	X	
5	No	No	No	Yes	No	X	
6	Yes	No	Yes	No	No	X	
7	Yes	No	No	Yes	No	X	
8	No	Yes	Yes	No	No	X	
9	No	Yes	No	Yes	No	X	

Risk Management (Cancer)

	Recreational Angler		Subsistence Angler		Human Health Beneficial Uses Impaired	Risk Management Decision	
	Step 1 > $1x10^{-6}$	Step 2 Cumulative Site Risk > Cumulative Reference Risk	Step 1 > $1x10^{-6}$	Step 2 Cumulative Site Risk > Cumulative Reference Risk		No Further Action	Remedial Action
1	No	No	No	No	No	X	
2	Yes	~~No~~ Yes	No	No	~~No~~ Yes	~~X~~	X
3	No	Yes	No	No	No	X	
4	No	No	Yes	No	No	X	
5	No	No	No	Yes	No	X	
6	Yes	No	Yes	No	No	X	
7	Yes	No	No	Yes	No	X	
8	No	Yes	Yes	No	No	X	
9	No	Yes	~~No~~ Yes	Yes	~~No~~ Yes	~~X~~	X

Risk Management (Cancer)

	Recreational Angler		Subsistence Angler		Human Health Beneficial Uses Impaired	Risk Management Decision	
	Step 1 > $1x10^{-6}$	Step 2 Cumulative Site Risk > Cumulative Reference Risk	Step 1 > $1x10^{-6}$	Step 2 Cumulative Site Risk > Cumulative Reference Risk		No Further Action	Remedial Action
10	Yes	Yes	No	No	Yes		X
11	Yes	Yes	Yes	No	Yes		X
12	Yes	Yes	No	Yes	Yes		X
13	No	No	Yes	Yes	Yes		X
14	Yes	No	Yes	Yes	Yes		X
15	No	Yes	Yes	Yes	Yes		X
16	Yes	Yes	Yes	Yes	Yes		X

Risk Management (Non-Cancer)

	Recreational Angler		Subsistence Angler			Risk Management Decision	
	Step 1 > 1	Step 2 Cumulative Site Risk > Cumulative Reference Risk	Step 1 > 1	Step 2 Cumulative Site Risk > Cumulative Reference Risk	Human Health Beneficial Uses Impaired	No Further Action	Remedial Action
1	No	No	No	No	No	X	
2	Yes	No	No	No	No	X	
3	No	Yes	No	No	No	X	
4	No	No	Yes	No	No	X	
5	No	No	No	Yes	No	X	
6	Yes	No	Yes	No	No	X	
7	Yes	No	No	Yes	No	X	
8	No	Yes	Yes	No	No	X	
9	No	Yes	No	Yes	No	X	

Risk Management (Non-Cancer)

	Recreational Angler		Subsistence Angler		Human Health Beneficial Uses Impaired	Risk Management Decision	
	Step 1 > 1	Step 2 Cumulative Site Risk > Cumulative Reference Risk	Step 1 > 1	Step 2 Cumulative Site Risk > Cumulative Reference Risk		No Further Action	Remedial Action
10	Yes	Yes	No	No	Yes		X
11	Yes	Yes	Yes	No	Yes		X
12	Yes	Yes	No	Yes	Yes		X
13	No	No	Yes	Yes	Yes		X
14	Yes	No	Yes	Yes	Yes		X
15	No	Yes	Yes	Yes	Yes		X
16	Yes	Yes	Yes	Yes	Yes		X

Risk Management Results

ASSESSEMNT UNIT	CANCER RISK	NON-CANCER RISK
Inside NASSCO	Combination 16	Combination 16
Outside NASSCO	Combination 16	Combination 14
Inside Southwest Marine	Combination 16	Combination 16
Outside Southwest Marine	Combination 16	Combination 16

Inside NASSCO Leasehold (Cancer)

		Step 1 > 1x10-6	Step 2 Cumulative Site Risk > Cumulative Reference Risk
Recreational Angler	Fillet Sand Bass	Yes	Yes
	Edible Tissue Lobster	Yes	Yes
Subsistence Angler	Whole Body Sand Bass	Yes	Yes
	Whole Body Lobster	Yes	No

Risk Management Result: ???

Inside NASSCO Leasehold (Cancer)

		Step 1 > 1x10-6	Step 2 Cumulative Site Risk > Cumulative Reference Risk
Recreational Angler	Fillet Sand Bass	Yes	Yes
	Edible Tissue Lobster	Yes	Yes
Subsistence Angler	Whole Body Sand Bass	Yes	Yes
	Whole Body Lobster	Yes	No

Risk Management Result: Combination 16

Outside NASSCO Leasehold (Cancer)

		Step 1 > 1x10-6	Step 2 Cumulative Site Risk > Cumulative Reference Risk
Recreational Angler	Fillet Sand Bass	Yes	Yes
Subsistence Angler	Whole Body Sand Bass	Yes	Yes

Risk Management Result: Combination 16

Inside SWM Leasehold (Cancer)

		Step 1 > 1x10-6	Step 2 Cumulative Site Risk > Cumulative Reference Risk
Recreational Angler	Fillet Sand Bass	Yes	Yes
	Edible Tissue Lobster	Yes	Yes
Subsistence Angler	Whole Body Sand Bass	Yes	Yes
	Whole Body Lobster	Yes	No

Risk Management Result: Combination 16

Outside SWM Leasehold (Cancer)

		Step 1 > 1x10-6	Step 2 Cumulative Site Risk > Cumulative Reference Risk
Recreational Angler	Fillet Sand Bass	Yes	Yes
Subsistence Angler	Whole Body Sand Bass	Yes	Yes

Risk Management Result: Combination 16

Inside NASSCO Leasehold (Non-cancer)

		Step 1 > 1	Step 2 Cumulative Site Risk > Cumulative Reference Risk
Recreational Angler	Fillet Sand Bass	Yes	No
	Edible Tissue Lobster	Yes	Yes
Subsistence Angler	Whole Body Sand Bass	Yes	Yes
	Whole Body Lobster	Yes	Yes

Risk Management Result: Combination 16

Outside NASSCO Leasehold (Non-Cancer)

		Step 1 > 1	Step 2 Cumulative Site Risk > Cumulative Reference Risk
Recreational Angler	Fillet Sand Bass	Yes	No
Subsistence Angler	Whole Body Sand Bass	Yes	Yes

Risk Management Result: Combination 14

Inside SWM Leasehold (Non-cancer)

		Step 1 > 1	Step 2 Cumulative Site Risk > Cumulative Reference Risk
Recreational Angler	Fillet Sand Bass	Yes	Yes
	Edible Tissue Lobster	Yes	Yes
Subsistence Angler	Whole Body Sand Bass	Yes	Yes
	Whole Body Lobster	Yes	Yes

Risk Management Result: Combination 16

Outside SWM Leasehold (Non-Cancer)

		Step 1 > 1	Step 2 Cumulative Site Risk > Cumulative Reference Risk
Recreational Angler	Fillet Sand Bass	Yes	Yes
Subsistence Angler	Whole Body Sand Bass	Yes	Yes

Risk Management Result: Combination 16

Risk Management

- **Primary Contaminant Drivers**

  - % contribution to cumulative risk

Chemical-Specific Risk
Cumulative Risk

- Cancer risk drivers: inorganic arsenic, BAP, and PCBs.

- Non-cancer risk drivers: copper, mercury, and PCBs.