Health Consultation

CALCASIEU ESTUARY
WATER SAMPLING EVALUATION

CALCASIEU PARISH, LOUISIANA

EPA FACILITY ID: LA0002368173

MARCH 9, 2005

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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HEALTH CONSULTATION

CALCASIEU ESTUARY
WATER SAMPLE EVALUATION

CALCASIEU PARISH, LOUISIANA

EPA FACILITY ID: LA0002368173

Prepared by:

Louisiana Department of Health and Hospitals
Office of Public Health
Section of Environmental Epidemiology and Toxicology
Under Cooperative Agreement with the
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

Table of Contents

List of Acronyms

AL	action level
AT	averaging time
ATSDR	Agency for Toxic Substances and Disease Registry
BW	body weight
CF	conversion factor
cm	centimeter
COPC	contaminant of potential concern
CREG	cancer risk evaluation guide
CSF	cancer slope factor
CVs	health-based comparison values
CW	contaminant concentration in water
ED	exposure duration
EF	exposure frequency
EMEG	environmental media evaluation guide
EPA	United States Environmental Protection Agency
ET	exposure time
IR	ingestion rate
kg	kilogram
km	kilometers
km^2	square kilometers
L/day	liters per day
LDEQ	Louisiana Department of Environmental Quality
LDHH	Louisiana Department of Health and Hospitals
LOAEL	lowest-observed-adverse-effects level
LTHA	lifetime health advisory
MCL	maximum contaminant level
mg/kg	milligrams per kilogram
mg/kg/day	milligrams per kilogram per day
MRL	minimal risk level
NPDES	National Pollutant Discharge Elimination System
OPH	Office of Public Health
PC	permeability constant
RfD	reference dose
RBC	risk-based concentration
RI	remedial investigation
RMEG	reference dose media evaluation guide
SA	surface area
SEET	Section of Environmental Epidemiology and Toxicology
µg/L	micrograms per liter
WQC	water quality criteria

Summary and Statement of Issues

In 1999, the U.S. Environmental Protection Agency (EPA) Region VI began a remedial investigation (RI) of the Calcasieu Estuary in Calcasieu Parish, Louisiana. The RI examined the potential human heath and environmental effects resulting from uncontrolled releases of chemical contaminants into the estuary. During this investigation, water samples were analyzed for the presence of more than 200 chemicals. Based on the levels present, 168 of these are considered to be contaminants of potential concern (COPCs), or contaminants that may increase human health risk or ecological risk. Residents of the area requested a health consultation be performed to explain the results of the investigation in terms of human health risk. The Louisiana Department of Health and Hospitals/Office of Public Health/Section of Environmental Epidemiology and Toxicology (LDHH/OPH/SEET) performed that assessment through a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). SEET staff reviewed the contaminant concentrations reported by the EPA to determine whether exposure to contaminated water in these areas poses a threat to human health and to determine what further public health actions, if any, may be needed.

Background

Site Description and History

Located in the southwestern corner of Louisiana, the Calcasieu Estuary covers approximately 50 square kilometers (km^2) of the Calcasieu River Basin (see Appendix A, Figure A-1) [1]. Saltwater migrates north into the estuary from the Gulf of Mexico via the Calcasieu River, and freshwater drains back toward the Gulf from the estuary via numerous inland water bodies. The estuary supports a diverse aquatic ecosystem surrounded by an industrialized city. The industrial development of the Calcasieu Estuary dates back to the late 1800s. Over time, several chemical manufacturing plants and petroleum refineries have been located along the estuary. Facility discharges and accidental releases have contributed to the contamination of water within the estuary, as have dredging, stormwater runoff, and urban and agricultural activities [1].

The three locations sampled for water contamination during the EPA RI were Bayou d'Inde, the Upper Calcasieu Estuary, and the Lower Calcasieu Estuary. These areas contain land used for commercial and industrial purposes, as well as rural and urban residential sites.

Bayou d'Inde, a major tributary of the Calcasieu River, includes 15 km^2 of land located west of Lake Charles in the northern part of the estuary (see Appendix A, Figure A-2) [1]. The bayou is divided into four reaches and adjacent marshes:

- **Reach 1** extends from the Pittsburgh Plate Glass Company (PPG) canal to the ship channel; the adjacent Lockport Marsh lies at the merging point of this reach and the ship channel;
- **Reach 2** extends from state highway LA 108 to the PPG Canal; a number of small marshes lie near this reach;
- **Reach 3** extends from Bayou d'Inde's merging point with Little Bayou d'Inde to LA 108; and

- **Reach 4** extends from the headwaters of the bayou to its merging point with Little Bayou d'Inde.

Reaches 1 through 3 are entirely industrial, while Reach 4 is rural residential and agricultural. Industries that had or have permits through the National Pollutant Discharge Elimination System (NPDES) to dispose materials into Bayou d'Inde include PPG, Citgo, Equistar (formerly OxyChem), Firestone, Westlake Polymers, CertainTeed Products, and Big Three Industries. Contaminants appear to enter the system through industrial releases, primarily between Little Bayou d'Inde and LA 108, and near the LA 108 bridge; through unidentified releases to Maple Fork Bayou in Reach 2; and through industrial releases to the PPG canal [1].

The *Upper Calcasieu* is a 25-km long area extending from the saltwater barrier north of Lake Charles on the Calcasieu River through Lake Charles to Coon Island Loop (see Appendix A, Figure A-3) [1]. Water samples were collected from four sections within this area:

1. *Below Clooney Loop*, which extends from the Coon Island Loop and the shallow lake covering much of Coon Island to the merging point of the Calcasieu River Ship Channel and the Clooney Island Loop. This area also includes Contraband Bayou.
2. *Clooney Loop*, which extends from the Clooney Island Loop to the merging point of the Calcasieu River Ship Channel and Lake Charles.
3. *Lake Charles*, which includes Lake Charles itself.
4. *North of Lake Charles*, which includes the Calcasieu River above the lake and the marsh areas surrounding this portion of the river.

Historic and current industries with NPDES permitted disposal into Upper Calcasieu include Lyondell (formerly ARCO and Olin Chemicals), Conoco, and PPG.

The *Lower Calcasieu* is defined as the portion of the Calcasieu Estuary from the I-210 bridge just south of Coon Island Loop to the outlet of Moss Lake, a total distance of 11 km (see Appendix A, Figure A-4) [1]. This area encompasses Bayou Olsen, Moss Lake, Bayou Guy, Indian Marais Lagoon, an unnamed system of shallow lakes between Bayou Guy and Prien Lake, Prien Lake itself, and the portion of the Calcasieu River Ship Channel that runs parallel to these water bodies. The industries with potential to discharge into this portion of the estuary include Bridgestone Firestone, CitCon, Citgo, Conoco, Entergy, Himont, LA Pigment, Lake Charles Harbor, Lyondell, Montell, OxyChem/Equistar, PPG, and W.R. Grace.

Background water samples were also taken from reference areas in Johnson's Bayou, Willow Bayou, Bayou Bois Connine, Bayou Choupique, and Grand Bayou, which are relatively unaffected by industrial activities (see Appendix A, Figure A-1) [1]. These locations were selected for having similar environmental characteristic as the Calcasieu Estuary study area, but with minimal contamination [1].

Demographics

Calcasieu Parish is considered to be part of the Lake Charles metropolitan area. Census 2000 results recorded a population of 183,577. The largest ethnic group in the parish at that time was

Caucasian (73.6%), followed by African-American (24.0%), Asian (0.6%), and Native American (0.3%).

Ninety-three percent (93.0%) of the population age 25 years or older in 2000 had earned at least a high school diploma. The median household income was $35,372, with 15.4% of persons living below the poverty level. The largest employers were the educational, health, and social services industry; followed by the manufacturing industry; the retail trade industry; the art, entertainment, recreation, accommodation, and food services sector; and the construction industry [1, 2].

Discussion

Data Used

The data used in this evaluation came from two phases of water sampling performed during EPA's RI of the Calcasieu Estuary. Samples were reviewed through a data validation process to ensure data quality and usability. The data evaluation included tests for precision, accuracy, completeness, and a measure of how well the data represented actual conditions within the estuary. Data gathered from the remedial investigation were determined usable through this data evaluation process and in compliance with EPA's environmental investigation quality assurance guidelines [1].

Exposure Pathways

Activities such as bathing, fishing, washing, and swimming involve skin contact with water. Few residents of Calcasieu Parish are likely to use water from the lakes or bayous as their major source of water for home use. For the purpose of this health consultation, estimated skin contact for Calcasieu Estuary water was limited to recreational activities, such as swimming.

Ingestion of contaminated water can occur when individuals drink or cook with the water or when small amounts of water are accidentally swallowed during aquatic recreation. Because few residents of Calcasieu Parish are likely to use water from the estuary as their major source of drinking or cooking water, an estimation of the health risk involved in ingesting this water was again limited to incidental ingestion of water during aquatic recreation.

Water may also be inhaled as an aerosol during household activities, such as showering. Because the Calcasieu Estuary is not used as a primary water source for household plumbing systems, this route of exposure was not considered for this health consultation.

Calcasieu Parish's municipal water source is the Chicot Aquifer, which is located underneath Calcasieu Parish and several other parishes in southwestern Louisiana. Therefore, contact with Calcasieu Estuary water contamination is likely to be through recreational exposure rather than through daily use. SEET estimated the recreational exposure frequency for the period May through October, which the Louisiana Department of Environmental Quality (LDEQ) defines as the period of primary contact recreation. These are the months during which full body immersion in natural waters is most likely to occur in Louisiana [3]. SEET used this period of 184 days to

calculate potential health risks for recreational exposures, estimated at 5 hours per day. A residential exposure frequency of 365 days was also examined for comparison.

Evaluation Process

A total of 9,086 water samples were collected from the Calcasieu Estuary. The process by which the possible health effects of water contaminants in the Calcasieu Estuary were evaluated is summarized here and described in detail in Appendix B. Samples labeled as nondetects were excluded from the evaluation.

Samples were analyzed for metals, polycyclic aromatic hydrocarbons (PAHs), herbicides, pesticides and polychlorinated biphenyls, semivolatile organic compounds, and volatile organic compounds. PAHs were evaluated as mixtures of compounds with similar mechanisms of toxicity using toxicity equivalency factors (TEFs) as outlined in Appendix B [4, 5]. All other contaminants were individually evaluated. Appendix B, Table B-3 lists an example of recreational dose and cancer risk evaluation. An example of the evaluation of residential doses and cancer risk for comparison purposes is listed in Appendix B, Table B-4.

Contaminant concentrations found within each water sample were first compared to health-based comparison values (CVs). These conservative screening values are only used to select environmental contaminants for further evaluation. CVs are not used to predict adverse human heath effects.

Contaminant concentrations that exceeded health-based CVs are listed in Appendix C, Tables C-1 through C-4. They include antimony, arsenic, barium, cadmium, manganese, thallium, lead, Aroclor 1254, beta-benzenehexachloride (beta-BHC), and bis(2-ethylhexyl)phthalate. These contaminants of concern (COCs) were further evaluated by comparing estimated exposure doses to the appropriate health guidelines for each chemical. Concentrations of lead, for which no health guideline is available, were evaluated using EPA's action level for lead (see Appendices B and C). If the exposure dose for a chemical was less than the health guideline or action level for that chemical, adverse health effects were considered to be unlikely. If the exposure dose was greater, then it was compared to known health effect levels identified in the ATSDR's toxicological profiles.

The cancer risk was estimated for all contaminants identified as carcinogens. EPA's range of acceptable cancer risks is from 1 excess cancer per 10,000 people to 1 excess cancer per 1,000,000 people exposed for a lifetime ($1 \times 10^{-4} - 1 \times 10^{-6}$) [5].

Health Effects Evaluation

Skin exposure to water from the Calcasieu Estuary during recreational activities and incidental ingestion of that water pose no apparent health risk. Exposure doses estimated for the COCs identified in the estuary are lower than the established health guideline values for these contaminants and are therefore unlikely to cause adverse health effects.

The highest concentration of lead was detected in a sample from Lake Charles at 25.9 micrograms per liter (µg/L), which is higher than EPA's lead action level (AL) of 15 µg/L for tap water. However, this concentration is also more than 5 times higher than lead concentrations measured in any other water samples from the estuary. The average lead concentration in the entire Upper Calcasieu area is 3.94 µg/L, and the average lead concentration in all water samples from the Calcasieu Estuary is 2.01 µg/L. The high concentration detected in the Lake Charles sample may have been due to the presence of a solid particle with lead adhered to it. Lead does not dissolve in water, and Lake Charles does not serve as part of the municipal water supply in Calcasieu Parish. Therefore, this concentration is unlikely to pose a health risk during incidental ingestion of water from the Calcasieu Estuary [6].

Cancer Health Effects Evaluation

The Calcasieu Estuary water COCs evaluated for cancer health effects were arsenic, cadmium, aldrin, and heptachlor. The calculation of lifetime cancer risks is discussed in Appendix B. Estimated lifetime cancer risks for recreational exposure to these contaminants in estuary water do not exceed EPA's upper limit of acceptable cancer risk levels of 1 excess cancer per 10,000 people exposed for a lifetime (1.00×10^{-4}).

Child Health Considerations

In communities faced with air, water, or food contamination, the many physical differences between children and adults demand special emphasis. Children could be at greater risk than are adults from certain kinds of exposure to hazardous substances. Children play outdoors and sometimes engage in hand-to-mouth behaviors that increase their exposure potential. Children are shorter than are adults; this means they breathe dust, soil, and vapors close to the ground. A child's lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. Finally, children are dependent on adults for access to housing, for access to medical care, and for risk identification. Thus, adults need as much information as possible to make informed decisions regarding their children's health.

It is unlikely that children younger than 6 years would be exposed to the water bodies under consideration in this health consultation. SEET therefore evaluated the potential public health hazard to children ages 6–17 years who might recreate within the Calcasieu Estuary water bodies under study. SEET found no public health hazard to children under these conditions.

Conclusions

Evaluation of the water sampled by the EPA during its remedial investigation suggests that there is no public health hazard involved with skin contact or ingestion of water in the Calcasieu Estuary during recreational exposure. Residential exposure to these waters is unlikely because the estuary does not serve as the parish's main water source.

Recommendations

There are no recommendations to be made at this time regarding Calcasieu Estuary water. LDHH/OPH/SEET will examine future Calcasieu Estuary data as needed.

Public Health Action Plan

The information produced within this health consultation should be disseminated to the community members and stakeholders within Calcasieu Parish, Louisiana.

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2. US Census Bureau. Calcasieu Parish, Louisiana QuickFacts. Generated by Rosalind M. Green, using State and County QuickFacts search engine; Accessed 3 May 2004 at URL: http://quickfacts.census.gov/qfd/states/22/22019.html.

3. Louisiana Department of Environmental Quality (LDEQ). Fish consumption and swimming advisories: Human health protection through fish consumption and swimming advisories in Louisiana (10 June 2003 update). Accessed 3 May 2004 at URL: http://www.deq.state.la.us/surveillance/mercury/fishadvi.htm.

4. Agency for Toxic Substances and Disease Registry. Toxicological profile for polycyclic aromatic hydrocarbons. Atlanta: US Department of Health and Human Services; 1995Aug.

5. US Environmental Protection Agency. Guidelines for carcinogen risk assessment. EPA/630/P-03/001A. Washington, DC: Risk Assessment Forum, US Environmental Protection Agency; 2003 Feb.

6. Agency for Toxic Substances and Disease Registry. Toxicological profile for lead (update). Atlanta: US Department of Health and Human Services; 1999 Jul.

Certification

This Water Sample Evaluation, Calcasieu Estuary, health consultation was prepared by the Louisiana Department of Health and Hospitals under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures at the time the health consultation was begun.

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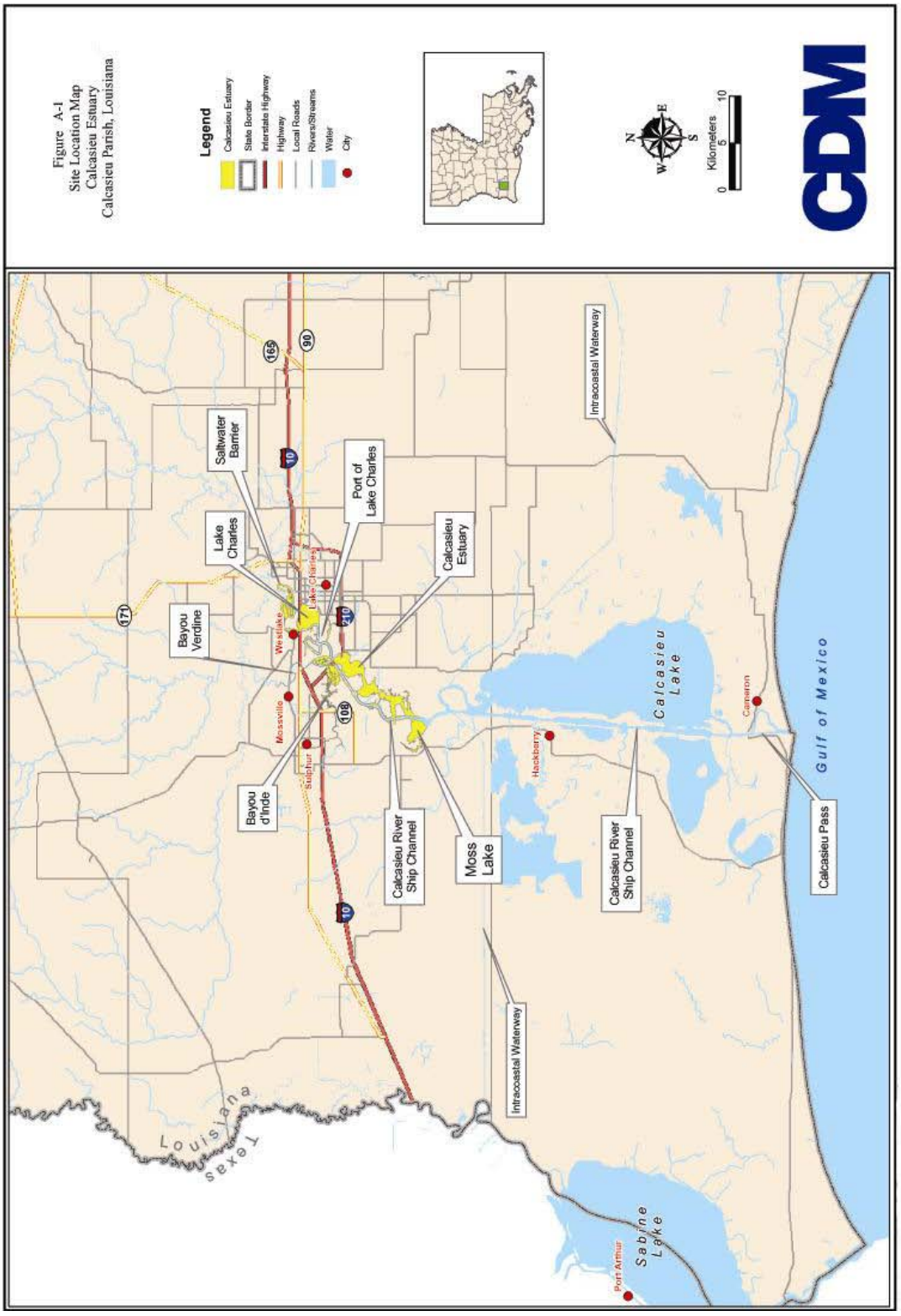
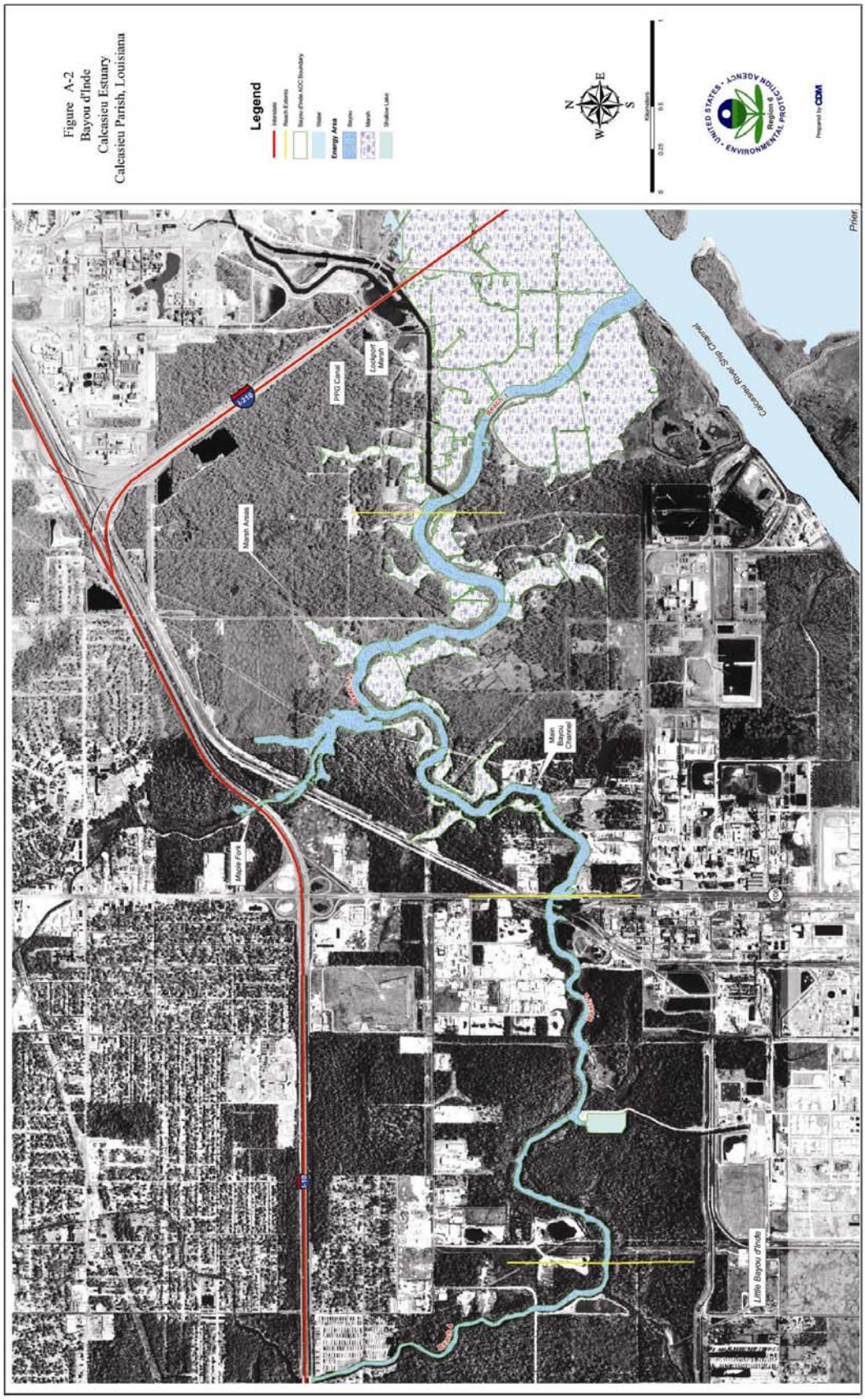
The Division of Health Assessment and Consultation, ATSDR, has reviewed this public health consultation and concurs with the findings.

Roberta Erlwein
Cooperative Agreement Team Leader, DHAC, ATSDR

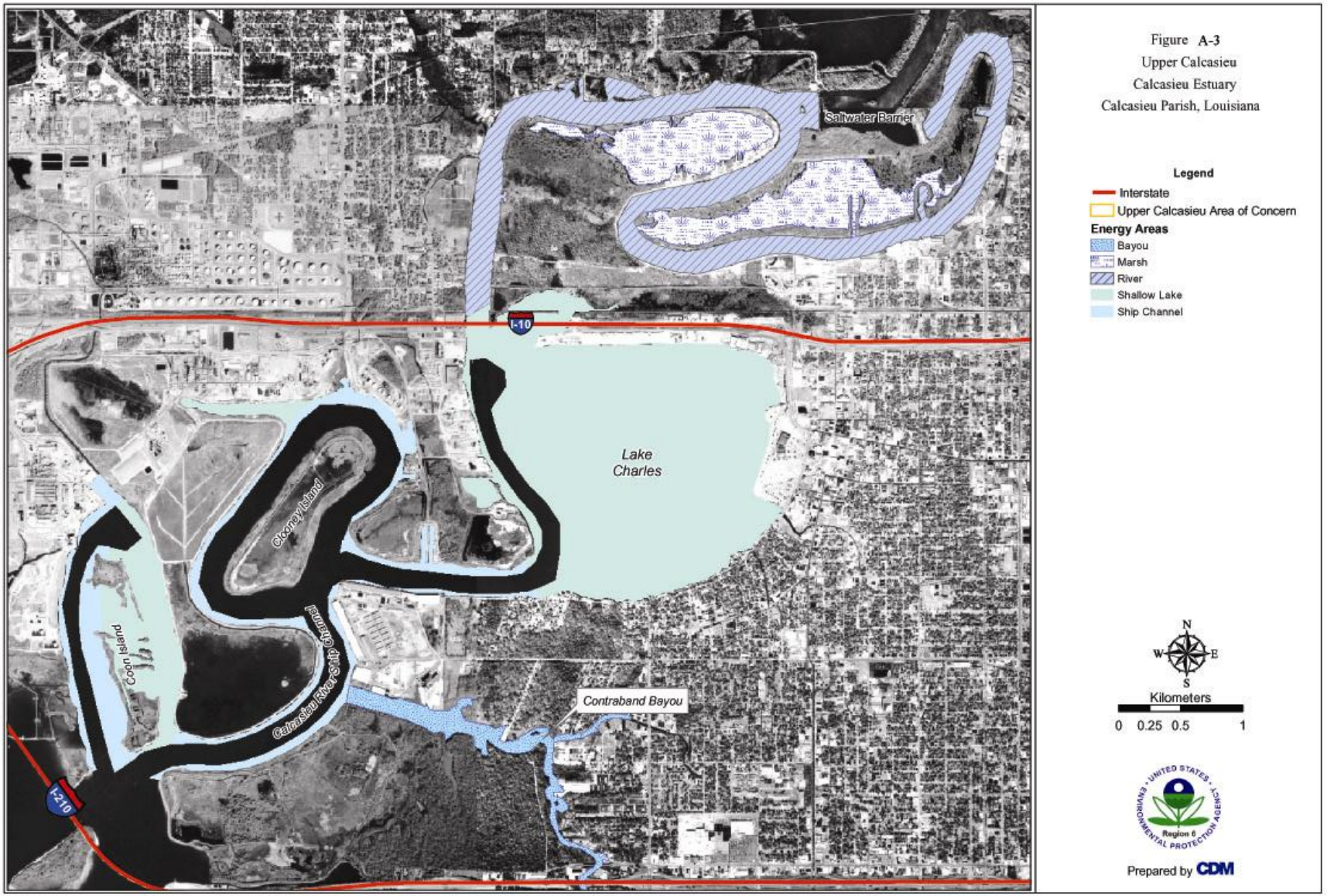
Appendix A: Maps of the Calcasieu Estuary Sampling Area



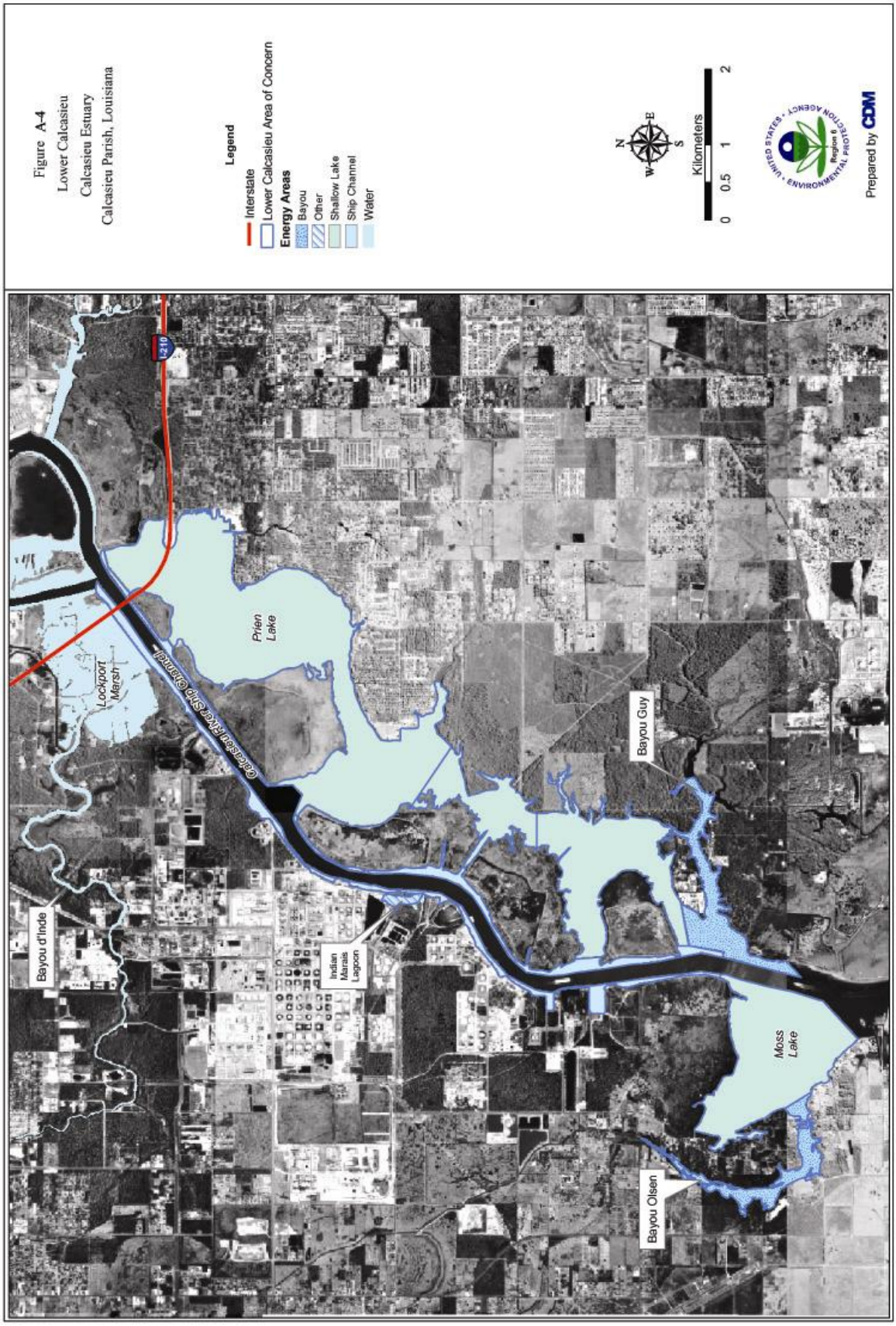
Site Location Map, Calcasieu Estuary Remedial Investigation, Calcasieu Parish, Louisiana. Figure 1-1. In: US Environmental Protection Agency. Calcasieu Estuary Remedial Investigation: Lake Charles, Louisiana. Draft Remedial Investigation Report. Prepared by CDM, Cambridge, Massachusetts. EPA Contract No. 68-W5-0022, Work Assignment No. 941-RICO-06ZZ. 2002 Nov.



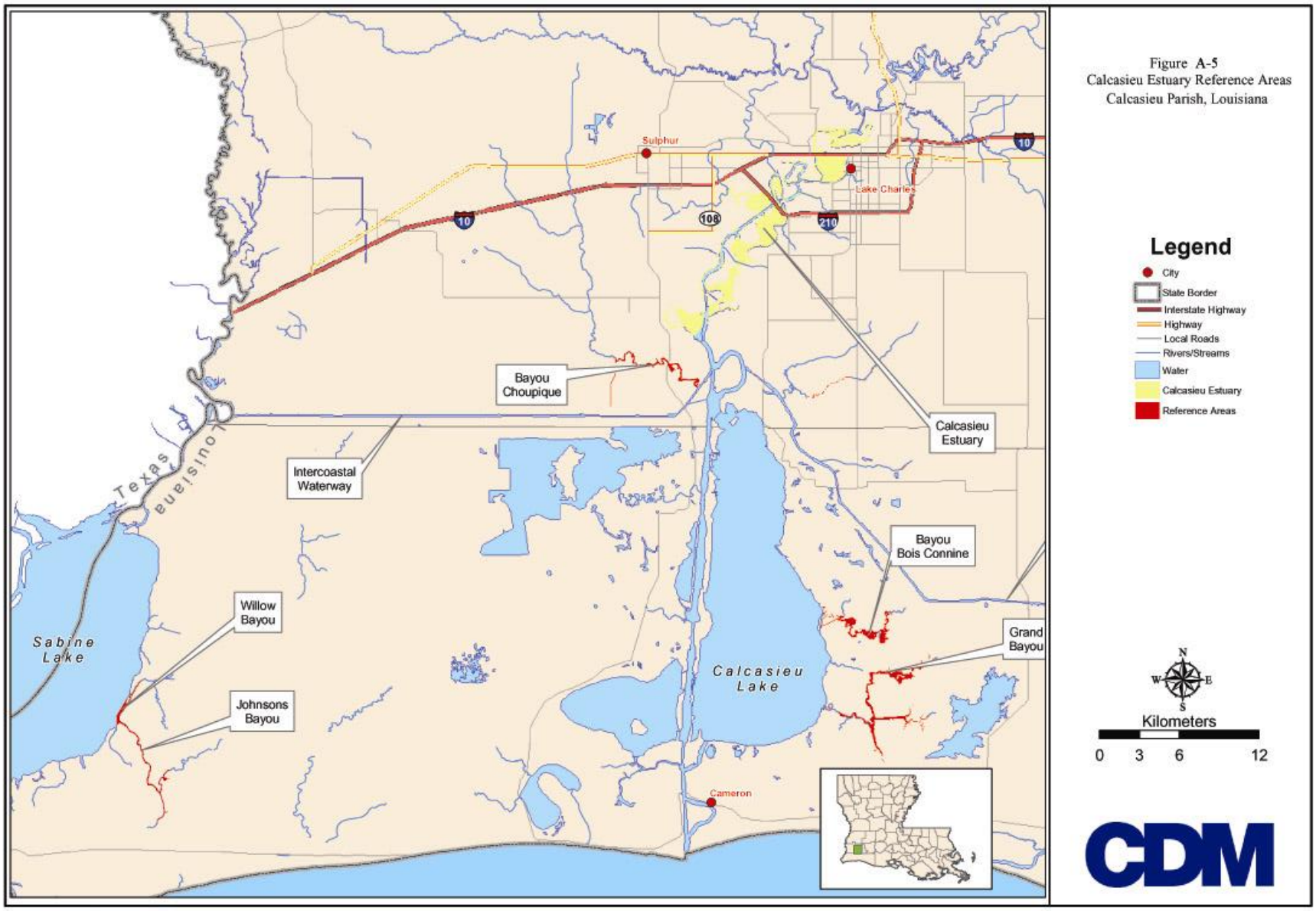
Bayou d'Inde Energy Areas and Reaches, Calcasieu Estuary Remedial Investigation, Calcasieu Parish, Louisiana. Figure 7-1. In: US Environmental Protection Agency. Calcasieu Estuary Remedial Investigation: Lake Charles, Louisiana. Draft Remedial Investigation Report. Prepared by CDM, Cambridge, Massachusetts. US EPA Contract No. 68-W5-0022, Work Assignment No. 941-RICO-06ZZ. 2002 Nov.



Upper Calcasieu Energy Areas and Reaches, Calcasieu Estuary Remedial Investigation, Calcasieu Parish, Louisiana. Figure 9-1. In: US Environmental Protection Agency. Calcasieu Estuary Remedial Investigation: Lake Charles, Louisiana. Draft Remedial Investigation Report. Prepared by CDM, Cambridge, Massachusetts. US EPA Contract No. 68-W5-0022, Work Assignment No. 941-RICO-06ZZ. 2002 Nov.



AOC and Energy Areas, Lower Calcasieu AOC, Calcasieu Estuary Remedial Investigation, Calcasieu Parish, Louisiana. Figure 10-1. In: US Environmental Protection Agency. Calcasieu Estuary Remedial Investigation: Lake Charles, Louisiana. Draft Remedial Investigation Report. Prepared by CDM, Cambridge, Massachusetts. US EPA Contract No. 68-W5-0022, Work Assignment No. 941-RICO-06ZZ. 2002 Nov.



Calcasieu Estuary RI Reference Areas, Calcasieu Estuary Remedial Investigation, Calcasieu Parish, Louisiana. Figure 2-7. In: US Environmental Protection Agency. Calcasieu Estuary Remedial Investigation: Lake Charles, Louisiana. Draft Remedial Investigation Report. Prepared by CDM, Cambridge, Massachusetts. US EPA Contract No. 68-W5-0022, Work Assignment No. 941-RICO-06ZZ. 2002 Nov.

Appendix B: Evaluation Process

Screening Process

Comparison values were initially used to determine which samples needed to be closely evaluated. Comparison values are media-specific concentrations of chemicals that are used by health assessors to select environmental contaminants for further evaluation. Comparison values are not used as predictors of adverse health effects. The comparison values used in the evaluation of Calcasieu Estuary water samples are listed below:

Environmental media evaluation guides (EMEGs) are estimated contaminant concentrations at which noncarcinogenic health effects are unlikely. They are calculated from the Agency for Toxic Substances and Disease Registry's (ATSDR) minimal risk levels (MRLs).

Reference media evaluation guides (RMEGs) are estimated contaminant concentrations at which noncarcinogenic health effects are unlikely. They are calculated from the U.S. Environmental Protection Agency's (EPA) reference dose (RfD).

Cancer risk evaluation guides (CREGs) are estimated contaminant concentrations that would be expected to cause no more than one additional excess cancer in one million exposed persons over a lifetime. CREGs are calculated from EPA's cancer slope factors (CSFs).

Risk-based concentrations (RBCs) are estimated contaminant concentrations in a media at which noncarcinogenic or carcinogenic health effects are unlikely. The RBCs used in this health consultation were last updated in April 2004.[*]

Maximum contaminant levels (MCLs) are the highest concentration, or level, of a contaminant that is allowed in drinking water, as established by EPA.

An *action level* (AL) is the concentration of a contaminant that, if exceeded, triggers a treatment or other requirement which a water system must follow.

Water quality criteria (WQC) are the recommended maximum permissible pollutant concentrations protective of aquatic organisms and human health. The WQCs used in this health consultation were last updated on December 31, 2003.[†]

A *lifetime health advisory* (LTHA) for drinking water is the amount of contaminant a human can consume drinking two liters of water per day over a 70-year lifetime without adverse health

[*] Agency for Toxic Substances and Disease Registry. Health assessment for former Nansemond Ordnance Depot; Suffolk, Virginia; Atlanta: US Department of Health and Human Services; 2004 Feb 19.

[†] US Environmental Protection Agency. Compilation of National Water Quality Criteria. Washington, DC: US Environmental Protection Agency; 2003 Dec 31. Available at URL: http://epa.gov/waterscience/humanhealth/15table-fs.htm#crit.

effects. Established by EPA, LTHAs are not legally enforceable standards but serve as technical guidance to assist regulators with water consumption advisories.[‡]

Noncancer Health Effects

Exposure doses were estimated for dermal exposures and incidental consumption of water under recreational and residential exposure conditions. Doses for the majority of contaminants were calculated using the arithmetic mean of the contaminant concentrations measured in each sampling area. Polycyclic aromatic hydrocarbons (PAHs) were evaluated as mixtures of compounds with similar mechanisms of toxicity. A toxicity equivalency factor (TEF) was used to weight each PAH's relative toxicity compared to benzo(a)pyrene, one of the most toxic and most studied of the PAHs. Multiplying the actual concentration of each PAH by its TEF produced a toxicity equivalence quotient (TEQ). The sum of PAH TEQs within each sampling area was used to evaluate the health effects of the PAH mixtures present[§].

The following equation was used to calculate the water dermal doses:

$$\text{Water Dermal Dose (mg/kg/day)} = \frac{\text{CW x PC x SA x ET x EF x ED}}{\text{BW x AT}} x \text{ CF}$$

Table B-1 lists the variables of the water ingestion exposure dose formula and their corresponding values.

The following equation was used to calculate the water ingestion doses:

$$\text{Water Ingestion Dose (mg/kg/day)} = \frac{\text{CW x IR x EF x ED}}{\text{BW x AT}}$$

Table B-2 lists the variables of the water ingestion exposure dose formula and their corresponding values.

The calculated exposure doses were compared to the appropriate health guideline values. Health guideline values are doses below which adverse health effects are unlikely. These values are based on valid toxicological studies with appropriate safety factors built in to account for uncertainty such as that caused by differences in human sensitivities and animal to human differences. The health guideline values used in the evaluation of Calcasieu Estuary water samples are listed below:

A *reference dose* (RfD) is an estimated daily lifetime exposure to a hazardous substance that is

[‡] US Environmental Protection Agency. Drinking water standards and health advisories; 2004 ed. Washington, DC: US Environmental Protection Agency; 2004. Available at URL: http://www.epa.gov/waterscience/drinking/standards/dwstandards.pdf.

[§] Agency for Toxic Substances and Disease Registry. Toxicological profile for polycyclic aromatic hydrocarbons. Atlanta: US Department of Health and Human Services; 1995 Aug.

Table B-1: Equation Variables for Water Dermal Dose, Calcasieu Estuary, Louisiana, 1999.

Variable	Value used
CW = Concentration in water	Chemical-specific (mg/L)
PC = Permeability Constant	Chemical-specific (cm/hour)
SA = Surface Area (averaged between male and female)*	
child 6–8 child 9–11 child 12–14 child 15–17 adult (>18)	0.8905 cm^2 1.1200 cm^2 1.4225 cm^2 1.6575 cm^2 1.8150 cm^2
ET = Exposure time	Recreational: 5 hours/day (estimated)
EF = Exposure frequency	Recreational: 184 days/year†
ED = Exposure Duration	7 years (6–8) 10 years (9–11) 13 years (12–14) 16 years (15–17) 44 years (18–70)
CF = Conversion factor	1 liter/1,000 cm^3
BW = Body weight‡	
child 6–8 years child 9–11 years child 12–14 years child 15–17 years adult (>18 years)	26.0 kg 37.9 kg 52.3 kg 62.8 kg 70.0 kg
AT = Averaging time	Recreational: 24 hours/day x 365 days/year x ED*

* US Environmental Protection Agency. Risk assessment guidance for Superfund. Volume I: Human health evaluation manual (Part A). Interim final. Washington, DC: US Environmental Protection Agency; 1989. EPA/540/1-89/002.

† Louisiana Department of Environmental Quality (LDEQ). 1999. Human health protection through fish consumption and swimming advisories in Louisiana. Baton Rouge: Louisiana Department of Environmental Quality; 1999 Feb.

‡ US Environmental Protection Agency. Exposure factors handbook. Washington, DC: US Environmental Protection Agency; 1997. EPA/600/P-95/002.

Table B-2: Equation Variables for Water Ingestion Dose, Calcasieu Estuary, Louisiana, 1999.

Variable	Value used
CW = Concentration in water	Chemical-specific (mg/L)
IR_c = Ingestion rate child (1–10 years)	1 L/day[*]
IR_a = Ingestion rate adult	2 L/day[*]
For recreational ingestion (accidental swallowing)	Reduce dose by factor of 10–100
EF = Exposure frequency	Recreational: 5 hours/day (estimated) 184 days/year[†] Residential: 365 days/year
ED=Exposure duration	4 years (1–6) 7 years (6–8) 10 years (9–11) 13 years (12–14) 16 years (15–17) 44 years (18–70)
BW_c = Body weight[‡]	
child 1–6 child 6–8 child 9–11 child 12–14 child 15–17 adult (>18)	18.2 kg 26 kg 37.9 kg 52.3 kg 62.8 kg 70 kg
AT = Averaging time	Recreational: 24 hours/day x 365 days/year x ED[§] Residential: 365 days/year x ED

[*] US Environmental Protection Agency. Estimated per capita water ingestion in the United States. Washington, DC: US Environmental Protection Agency; 2000. EPA-822-R-00-008.

[†] Louisiana Department of Environmental Quality (LDEQ). Human health protection through fish consumption and swimming advisories in Louisiana. Baton Rouge: Louisiana Department of Environmental Quality; 1999 Feb.

[‡] US Environmental Protection Agency. Exposure Factors Handbook. Office of Health and Environmental Assessment, Washington, DC: US Environmental Protection Agency; 1997. EPA/600/P-95/002.

[§] US Environmental Protection Agency. Risk assessment guidance for Superfund. Volume I: Human health evaluation manual (Part A). Interim final. Washington, DC: US Environmental Protection Agency; 1989. EPA/540/1-89/002.

Table B-3: Sample Evaluation for Ingestion of Water Contaminants During Recreation in Calcasieu Estuary, Louisiana, 1999.

Exposure area name	Bayou d'Inde, Reach 1
Contaminant	Arsenic
Mean concentration	4.15×10^{-3} ppm*
Dose for child 6–8 years	1.68×10^{-6} mg/kg/day†
Dose for child 9–11 years	1.15×10^{-6} mg/kg/day
Dose for child 12–14 years	1.67×10^{-6} mg/kg/day
Dose for child 15–17 years	1.39×10^{-6} mg/kg/day
Dose for adult 18 and over	1.25×10^{-6} mg/kg/day
Reference dose	3.00×10^{-4} mg/kg/day
Cancer slope factor	$1.5\ (\text{mg/kg/day})^{-1}$
Cancer risk	3.75×10^{-6} or 3.75 excess cancers per 1,000,000 people

*Parts per million

† Milligrams per kilograms per day

not likely to cause adverse noncancer health effects to human populations. RfDs are developed by the EPA and may be found at http://www.epa.gov/iris.

A *minimal risk level* (MRL) is an estimated daily human exposure to a hazardous substance that is not likely to cause adverse noncancer health effects over a specified duration of exposure. Developed by the ATSDR, MRLs are not intended to be used as predictors of adverse health effects. MRLs may be found at http://www.atsdr.cdc.gov/mrls.html.

Calculation of Carcinogenic Risk

Because of the uncertainties involved in estimating carcinogenic risk, ATSDR uses a weight-of-evidence approach in evaluating all relevant carcinogenic data, describing carcinogenic risk in words and numerical terms.** The estimated risk of developing cancer resulting from exposure to the contaminants within the water bodies was calculated by multiplying the exposure dose

** Agency for Toxic Substances and Disease Registry. Cancer policy framework. Atlanta: US Department of Health and Human Services; 1993.

Table B-4: Sample Evaluation for Residential Ingestion of Water Contaminants, Calcasieu Estuary, Louisiana, 1999.

Exposure area name	Bayou d'Inde, Reach 1
Contaminant	Arsenic
Mean concentration	4.15×10^{-3} ppm*
Dose for child 6–8 years	1.60×10^{-4} mg/kg/day†
Dose for child 9–11 years	1.09×10^{-4} mg/kg/day
Dose for child 12–14 years	1.59×10^{-4} mg/kg/day
Dose for child 15–17 years	1.32×10^{-4} mg/kg/day
Dose for adult 18 and over	1.19×10^{-4} mg/kg/day
Reference dose	3.00×10^{-4} mg/kg/day
Cancer slope factor	$1.5\ (\text{mg/kg/day})^{-1}$
Cancer Risk	1.79×10^{-4} or 1.79 excess cancers per 10,000 people

*Parts per million

† Milligrams per kilograms per day

over a 70-year (lifetime) period by EPA's *cancer slope factor* (CSF: available at http://www.epa.gov/iris). The results estimate the worst-case maximum increase in the risk of developing cancer after exposure to the contaminant. This estimation is accurate within one order of magnitude; a calculated cancer risk of 2 excess cancers per 10,000 people might actually be 2 excess cancers per 1,000 people or 2 excess cancers per 100,000 people.

Appendix C: Water Contaminants of Concern (COCs) in the Calcasieu Estuary Sampling Area

Table C-1: Water Contaminations of Concern in the Calcasieu Estuary Reference Area

COC	Concentration Range (µg/L) Low	High	Drinking Water CV (µg/L)	CV reference
Metals				
Arsenic	ND[*]	5.4	3	child EMEG[†]
Thallium	ND	9.5	5.00E-01	LTHA[‡]

[*]Contaminant not detected
[†]Environmental media evaluation guide
[‡]Lifetime Health Advisory

Table C-2: Water Contaminations of Concern in Bayou d'Inde

COC	Concentration Range (µg/L) Low	High	Drinking Water CV (µg/L)	CV reference
Metals				
Arsenic	ND[§]	6.6	3	child EMEG[¶]
Barium	50.9	712	700	child RMEG[**]
Manganese	76.2	596	500	child RMEG
Thallium	ND	9.6	5.00E-01	LTHA[††]
Pesticides/Polychlorinated Biphenyls				
Aroclor 1254	ND	2.10E-01	2.00E-01	child EMEG
Beta-BHC	ND	4.60E-02	3.70E-02	RBC[‡‡]

[§]Contaminant not detected
[¶]Environmental media evaluation guide
[**]Reference dose media evaluation guide
[††]Lifetime health advisory
[‡‡]Risk-based concentration

Table C-3: Water Contaminations of Concern in Lower Calcasieu

COC	Concentration Range (µg/L) Low	High	Drinking Water CV (µg/L)	CV reference
Metals				
Arsenic	ND[*]	7.4	3	child EMEG[†]
Cadmium	ND	2.4	2	child EMEG
Manganese	35.2	546	500	child RMEG[‡]
Thallium	ND	9	5.00E-01	LTHA[§]
Semivolatile Organic Compounds				
Bis(2-Ethylhexyl)phthalate	ND	5	4.8	RBC[¶]

[*]Contaminant not detected
[†]Environmental media evaluation guide
[‡]Reference dose media evaluation guide
[§]Lifetime health advisory
[¶]Risk-based concentration

Table C-4: Water Contaminations of Concern in Upper Calcasieu

COC	Concentration Range (µg/L) Low	High	Drinking Water CV (µg/L)	CV reference
Metals				
Antimony	ND[**]	84	4	child RMEG[††]
Arsenic	ND[**]	64.2	3	child EMEG[‡‡]
Lead	ND[**]	25.9	15 µg/L	AL[§§]
Thallium	ND[**]	5.9	5.00E-01	LTHA[¶¶]

[**]Contaminant not detected
[††]Reference dose media evaluation guide
[‡‡] Environmental media evaluation guide
[§§]Action level
[¶¶] Lifetime health advisory