

Health Consultation

BAYOU BONFOUCA
POST-HURRICANE EVALUATION

ST. TAMMANY PARISH, LOUISIANA

EPA FACILITY ID: LAD980745632

JANUARY 24, 2007

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

BAYOU BONFOUCA
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Prepared By:

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

Table of Contents

Table of Contents.....	i
List of Acronyms.....	ii
Summary and Statement of Issues.....	1
Background.....	1
Site Description and History.....	1
Demographics.....	2
Discussion.....	2
Environmental Data.....	2
Exposure Pathways.....	5
Evaluation Process.....	6
Health Effects Evaluation.....	7
Cancer Effects Evaluation.....	7
Child Health Considerations.....	7
Conclusions.....	8
Recommendations.....	8
Public Health Action Plan.....	8
Preparers of this Report.....	9
Certification.....	10
References.....	11
Figures.....	12
Site Photographs.....	14
Appendix.....	24

List of Acronyms

ATSDR	Agency for Toxic Substances and Disease Registry
bgs	Below ground surface
CVs	Health based comparison values
EDC	Eastern Drainage Channel
EMEG	Environmental Media Evaluation Guide
EPA	Environmental Protection Agency
kg	Kilograms
LDEQ	Louisiana Department of Environmental Quality
LDHH	Louisiana Department of Health and Hospitals
mg/kg	Milligrams per kilogram
mg/kg/day	Milligrams per kilogram per day
mg/L	Milligrams per Liter
MRL	Minimal Risk Level
MW	Monitoring well
NPL	National Priorities List
O&M	Operations and Maintenance
OPH	Office of Public Health
PAHs	Polycyclic aromatic hydrocarbons
PPM	Parts per million
RBC	EPA Region III Risk-Based Concentration
RfD	Reference dose
RMEG	Reference Media Evaluation Guide
ROD	Record of Decision
SEET	Section of Environmental Epidemiology and Toxicology
SF	Cancer slope factor
SVOCs	Semivolatile organic hydrocarbons
ug/L	Micrograms per liter

Summary and Statement of Issues

On August 29 and September 24, 2005, hurricanes Katrina and Rita made landfall along the Gulf Coast. U.S. Environmental Protection Agency (EPA) contractors collected samples at the National Priority List (NPL) sites in Louisiana to assess any potential impacts that the hurricanes may have had on remedies completed at those sites. On October 1, 2005 and December 7, 2005, EPA collected groundwater, aquatic sediment and surface sediment samples at the Bayou Bonfouca site, located in St. Tammany Parish, Louisiana. The Bayou Bonfouca site is currently in operation and maintenance status, with routine groundwater monitoring to ensure protectiveness of the EPA remedial actions. As part of prudent public health practices, the Louisiana Department of Health and Hospitals/Office of Public Health/Section of Environmental Epidemiology and Toxicology (LDHH/OPH/SEET) have performed a review of the post-hurricane data through a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). SEET staff reviewed the contaminant concentrations found in groundwater, aquatic sediment, and surface sediment from the Bayou Bonfouca monitoring wells to determine whether ingestion of and/or dermal contact with these media would pose a threat to human health and to establish what further public health actions, if any, may be needed.

Background

Site Description and History

The Bayou Bonfouca Superfund site is located near the north shore of Lake Ponchartrain in Slidell, St. Tammany Parish, Louisiana. The site is an abandoned creosote wood treating facility that includes the former American Creosote Works Plant and a portion of the bayou that adjoins the site. The 55-acre site derives its name from Bayou Bonfouca, a navigable waterway that forms the southern boundary of the site proper and flows south for 7 miles into Lake Ponchartrain. The site is bounded by Western Creek to the west, the Eastern Drainage Channel (EDC) to the east, and West Hall Avenue to the north [1].

The nearest water well is reported to be located approximately 0.5 mile northeast of the site. Three aquifers have been identified at the site: a surficial aquifer, a shallow artesian aquifer, and a deep artesian aquifer. The primary aquifer used by the town of Slidell is the Pontchatoula aquifer, which is present at about 1500 feet below ground surface (bgs). Most of the site is situated within the one hundred year flood plain, and the ground elevation is about 9 feet above mean sea level [2].

Creosote preservation of various wood products started at this site in 1892. Numerous releases of creosote occurred during the years of operation. Contamination of soils, sediments, surface water, groundwater and the biota of the bayou resulted from past operating methods and/or disposal practices. In the early 1970s, a fire occurred at the facility, where several large storage tanks were ruptured, causing large amounts of creosote to flow onto the land and into the bayou. Subsequently, approximately 1.5 miles of scenic Bayou Bonfouca became biologically sterile due to creosote so concentrated that it caused second-degree chemical burns to divers, injured or killed aquatic animals and waterfowl, and posed a significant recreational hazard [1].

The Bayou Bonfouca site was placed on the National Priorities List (NPL) in December 1982. The principle pollutants found at the site were creosote compounds, composed mostly of polynuclear aromatic hydrocarbons (PAHs). These constituents were identified in surface soils, groundwater, and in the bayou sediments. The final record of decision (ROD) was signed in

March 1987, which included excavating contaminated sediments from the bayou, onsite incineration of waste piles and contaminated sediments, extraction and treatment of contaminated groundwater, reinjection of the treated groundwater, and capping, onsite any incinerator residue and surface soils with total PAH concentrations greater than 100 parts per million (ppm) [2].

In 1987, LDHH and the Louisiana Department of Environmental Quality (LDEQ) issued a written advisory and posted signs warning citizens not to swim in the bayou or eat fish or shellfish taken from a 7-mile length of the bayou. In September 1994, SEET concluded that the Bayou Bonfouca site was a public health hazard due to extensive soil, sediment, biota, surface water and groundwater contamination [1].

Incineration of contaminated soils and bayou sediments was completed in July 1995. Groundwater treatment began in June 1991 and continues to reduce the volume of contaminated groundwater and prevent migration [3]. In addition, a mile and a half of the Bayou has been restored for aquatic life, as well as human recreational and residential use. A public boat launch was installed by the city of Slidell to allow public access to the restored area [1].

The Bayou Bonfouca site is currently in operation and maintenance (O & M) status, receiving routine monitoring of the groundwater to ensure the protectiveness of the EPA remedial actions [3].

Demographics

The Bayou Bonfouca site is located in St. Tammany Parish, Louisiana. Census 2000 results record a parish population of 191,268. The largest ethnic group in that parish at that time was Caucasian (87%), followed by African American (9.9%), American Indian or Alaska Native (0.4%), Asian (0.7%), with 2% of the population reporting as Other. Eighty-three point nine percent (83.9%) of the population age 25 or older in 2000 had earned at least a high school diploma. The median household income in 1999 was \$47,883 with 9.7% of persons living below poverty level [4]. The largest employers in the parish were the retail trade industry; health care and social assistance; accommodation and food services; professional, scientific and technical services; the manufacturing industry; administrative, support, waste management, and remediation services; and arts, entertainment and recreation [5].

About 750 residents live within one mile of the site. Approximately 26,000 residents live in the surrounding community. The nearest residence to the site is approximately 400 feet southwest from the boundary, across the bayou.

Discussion

Environmental Data

Groundwater samples were collected from monitoring wells MW-1, located along the site's southwest boundary, and MW-5, located in an offsite residential area, on both October 1, 2005 and on December 7, 2005. October samples were analyzed for semi-volatile organic compounds (SVOCs), while December samples were analyzed for SVOCs and metals. From the October 2005 sampling event, carbazole (62.6 ug/L) was the only contaminant detected above health

Bayou Bonfouca Post-hurricane Evaluation
St. Tammany Parish, Louisiana

based comparison values, and was found in MW-1. Health based comparison values are media-specific concentrations of chemicals used by health assessors to select environmental contaminants for further evaluation. They are not used to predict health effects or to set clean-up levels. Contaminants with media concentrations above a health based comparison value do not necessarily represent a health threat, but are selected for further evaluation. Contaminants with media concentrations below a health based comparison value are unlikely to be associated with illness and are not evaluated further. Arsenic and manganese were detected above health based comparison values during the December 2005 sampling event. Arsenic was detected at 0.031 mg/L (milligrams per liter) and 0.012 mg/L in MW-1 and MW-5, respectively, exceeding the health based comparison value of 0.0003 mg/L. Manganese was detected at 0.63 mg/L in MW-1, exceeding the health based comparison value of 0.5 mg/L.

EPA performed site inspections at the Bayou Bonfouca site on September 27, 2005 and October 28, 2005. The treatment plant at the site sustained damage from Hurricane Katrina, however the groundwater monitoring system was unaffected. Groundwater sampling will continue under the current O&M plan. EPA and LDEQ are coordinating the implementation of repairs to the treatment system [3].

Contaminants detected in groundwater monitoring wells at the Bayou Bonfouca site, St. Tammany Parish, LA. October 2005 post-hurricane sampling event.

Detected Contaminants	MW-1	MW-5	Health Based Comparison Values (ug/L) ¹
Semi-Volatiles (ug/L):			
2-Methylnaphthalene	221	ND ²	500 Child EMEG ³
Acenaphthalene	85.4	ND	6000 Child EMEG
Caprolactam	124	61.8	5000 Child RMEG ⁴
Carbazole	62.6	ND	3.3 EPA Region III RBC ⁵
Dibenzofuran	33.9	ND	Not available
Dibutyl phthalate	.652	.643	1000 Child RMEG
Fluorene	19.4	ND	4000 Child EMEG
Naphthalene	3840	ND	6000 Child EMEG

¹ug/L- micrograms per liter; ²ND- Not Detected; ³EMEG- Environmental Media Evaluation Guide; ⁴RMEG- Reference Dose Media Evaluation Guide; ⁵EPA Region III RBC- Environmental Protection Agency Region III Risk Based Comparison Value

Aquatic sediment samples were collected during the December 2005 sampling event from four locations in the bayou and from two locations in the Eastern Drainage Channel (EDC). Identified as AS-015 to AS-020, these samples were collected to assess the potential for erosion of residual contaminants present beneath the granular limestone cover [2]. Samples were submitted to the laboratory for SVOC and metals analysis. Total polycyclic aromatic hydrocarbons (PAHs) exceeded the health based comparison value at every sampling location in the bayou and the EDC. PAH concentrations were however, notably lower than the 14.7 to 71.9 milligrams per kilogram (mg/kg) range detected during the December 2001 sampling event [2].

Bayou Bonfouca Post-hurricane Evaluation
St. Tammany Parish, Louisiana

None of the metals analysis from the aquatic sediment samples exceeded health based comparison values.

Contaminants detected in aquatic sediment at the Bayou Bonfouca site, St. Tammany Parish, LA. December 2005 post-hurricane sampling event.

Detected Contaminants	AS-015	AS-016	AS-017	AS-018	AS-019	AS-020	Health Based Comparison Values (mg/kg) ¹
Semi-Volatiles (mg/kg):							
Total PAHs ²	3.13	2.55	6.99	2.88	1.68	1.48	.087 EPA Region III RBC ³
Carbazole	ND ⁴	ND	ND	ND	ND	.0135	32 EPA Region III RBC
Dibenzofuran	ND	ND	ND	ND	.0957	.121	Not Available
Biphenyl	ND	ND	ND	ND	ND	.139	3000 Child RMEG ⁵
Butyl benzyl phthalate	ND	ND	ND	ND	ND	.051	10,000 Child RMEG
Di-n-octyl phthalate	ND	ND	ND	ND	ND	.0236	5000 Child RMEG

¹mg/kg- milligrams per kilogram; ² PAHs- Polycyclic aromatic hydrocarbons; ³ EPA Region III RBC- Environmental Protection Agency Region III Risk Based Comparison Value; ⁴ ND- Not Detected; ; ⁵ RMEG- Reference Dose Media Evaluation Guide

The December 2005 sampling event also included the collection of ten surface sediment samples identified as SS-004 to SS-013. These samples were collected to ascertain the presence of site-related contaminants in sediment deposited on the land surface by receding floodwaters [2]. Seven of the 10 samples were collected at offsite locations, including residential and wooded areas and the Slidell City Park, while three samples were collected onsite. Samples were submitted to the laboratory for SVOC and metals analysis. Background levels of total PAHs in sediment (determined from a 2001 EPA sampling event) range from 2.1 to 2.3 mg/kg. Total PAHs exceeded the screening value at each onsite and offsite sampling location; however, PAHs only slightly exceeded background levels for the area. None of the metals analysis from the onsite or offsite surface sediment samples exceeded health based comparison values.

**Contaminants detected in onsite and offsite surface sediment at the Bayou Bonfouca site,
St. Tammany Parish, LA. December 2005 post-hurricane sampling event.**

Detected Contaminants	Onsite Sample Locations			Offsite Sample Locations						Health Based Comparison Values (mg/kg) ¹	
	SS-004	SS-005	SS-012	SS-006	SS-007	SS-008	SS-009	SS-010	SS-011		
Semi-Volatiles (mg/kg):											
Total PAHs ²	3.5	3.4	2.1	1.6	4.7	1.1	2.4	3.1	1.4	2.6	.087 EPA Region III RBC ³
Carbazole	ND ⁴	ND	ND	ND	0.0593	ND	ND	ND	ND	ND	32 EPA Region III RBC
Butyl benzyl phthalate	ND	ND	ND	ND	0.118	ND	ND	ND	ND	ND	10,000 Child RMEG ⁵

¹mg/kg- milligrams per kilogram; ²PAHs- Polycyclic aromatic hydrocarbons; ³EPA Region III RBC- Environmental Protection Agency Region III Risk Based Comparison Value; ⁴ND- Not Detected; ; ⁵RMEG- Reference Dose Media Evaluation Guide

Exposure Pathways

SEET evaluated the environmental and human components that lead to exposure in order to determine whether a child or adult would be exposed to contaminants detected in sampled media from the Bayou Bonfouca site. An exposure pathway contains the following five elements: a source of contamination, transport through some kind of environmental medium, a point of exposure, a route of exposure, and a receptor population. ATSDR categorizes an exposure pathway as a completed or potential exposure pathway if the exposure pathway cannot be eliminated. Completed pathways require that the five elements exist and indicate that exposure to a contaminant has occurred in the past, is presently occurring, or will occur in the future. Potential pathways, however, indicate that exposure to a contaminant could have occurred in the past, could be occurring now, or could occur in the future. An exposure pathway can be eliminated if at least one of the five elements is missing and will never be present.

Groundwater

The residential water supply is pumped from the Pontchatoula aquifer approximately 1500 feet bgs. There are three groundwater systems at the Bayou Bonfouca site, including a surficial aquifer, a shallow artisan aquifer at 30 feet, and a deep artisan aquifer at 60 feet. The local population is unlikely to come into contact with contaminants present in this exposure medium unless the contaminants migrate into the domestic groundwater source. There are cohesive confining units that protect the Pontchatoula from any downward migration of contamination in the upper water bearing zones. Therefore, there is no current exposure pathway between shallow groundwater contaminants at the site and the local population.

Aquatic Sediments

Aquatic sediment samples were collected from six locations in the bayou and the EDC. These areas are easily reached from Slidell City Park, via the public boat launch. There has been a swimming advisory in place for Bayou Bonfouca since 1987, and “no swimming” placards are highly visible and abundantly placed throughout City Park along the banister fencing to the bayou. Per the facility site manager, swimming does not occur in the bayou, and the public boat launch is used sparingly, (one boat per week, at most) as there is a much larger one available to the public within a few miles of the area. On September 21, 2006, SEET, along with representatives from LDEQ and EPA, conducted a site visit to Bayou Bonfouca and the Slidell City Park. We did not witness any boat launches or swimming in the area, and confirmed the presence of adequate public notice of the swimming advisory. As such, if the public follows the advisory, there are no exposure pathways between aquatic sediment contaminants and the local population.

Onsite Surface Sediments

Onsite surface sediment samples were collected from three locations along the east and west banks of the bayou within the site perimeter fencing. Total PAHs exceeded screening values at each sample location; however, PAHs were only slightly above background levels found at the site, and below levels of health concern. A potential exposure pathway via incidental ingestion/dermal contact could have occurred in the past for the two onsite facility workers at Bayou Bonfouca. Trespassing and/or recreational use is not expected as the site is access restricted.

Offsite Surface Sediments

Offsite surface sediment samples were collected from six locations, two samples from a residential lawn, two samples from wooded areas, and three samples taken from Slidell City Park. Total PAHs exceeded screening values at each sample location; however, PAHs were only slightly above background levels found at the site, and below levels of health concern. A potential exposure pathway via incidental ingestion/dermal contact may have existed in the past for residents and recreational visitors at City Park.

SEET did not observe any flood related surface sediments during our latest site visit on September 21, 2006, therefore, eliminating any current or future exposures to PAH constituents in the offsite surface sediments.

Evaluation Process

All contaminant concentrations detected in groundwater, aquatic sediments and onsite and offsite surface sediments were first compared to health based comparison values (CVs). These conservative media-specific values are only used to select environmental contaminants for further evaluation. CVs are not used to predict adverse human health effects or to set clean-up levels. Contaminants with media concentrations below CVs are unlikely to be associated with

illness and are not evaluated further. Contaminants detected above CVs are retained for further evaluation.

ATSDR's Reference Media Evaluation Guides (RMEGs), Environmental Media Evaluation Guides (EMEGs), and EPA Region III Risk-Based Concentrations (RBCs) were used as CVs. RMEGs are estimated contaminant concentrations that are unlikely to cause adverse noncancer health effects. They are calculated from EPA's reference dose (RfD), which is an estimate of daily exposures to contaminants that are unlikely to cause adverse noncancer health effects, even if exposure occurs over a lifetime. EMEGs are also estimated contaminant concentrations that are unlikely to cause adverse noncarcinogenic health effects; however, they are calculated by using ATSDR's Minimal Risk Level (MRL), which is also an estimate of daily exposure to contaminants that are unlikely to cause adverse noncancer health effects. RBCs are calculated from the EPA RfD. Cancer risk comparison values used in this health consultation are based on EPA's chemical specific cancer slope factors (SF), representing an estimated lifetime risk of one excess cancer in 10,000 (1×10^{-4}) people exposed for a lifetime of 70 years in duration.

Total PAHs detected in both onsite and offsite surface sediments were selected for further evaluation, as they exceeded the RBC at each of the 10 sampling locations. Total PAHs were further evaluated by calculating and comparing estimated oral exposure doses to the appropriate health guidelines to determine any exceedences. Exposure doses from ingestion of surface sediments at the Bayou Bonfouca site were calculated using default exposure assumptions of 100-200 milligrams per kilogram (mg/kg) of sediment ingestion for a child weighing 16 kilograms (kg) and also for an adult weighing 70 kg. A detailed description of the sediment ingestion exposure dose equation can be accessed in the appendix.

Non-Cancer Health Effects Evaluation

Adult and child ingestion and dermal contact exposure doses estimated for total PAHs identified in onsite and offsite surface sediments did not exceed the EPA RBC of 0.087 milligrams per kilogram per day (mg/kg/day). Therefore, total PAHs identified in onsite and offsite surface sediments are not expected to cause adverse health effects.

Cancer Health Effects Evaluation

SEET estimated the adult cancer risk for ingestion of and dermal contact with total PAH contaminated surface sediments at the Bayou Bonfouca site. Concentrations detected at each of the sampling locations were observed at levels where carcinogenic health effects are unlikely to occur. As a result, no excess cancer risk is expected.

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 can be concluded from the data evaluations and the environmental pathway analyses that no health hazards specific to children are occurring related to site contaminants.

Conclusions

Evaluation of the groundwater, aquatic and surface sediments sampled by EPA during its post-hurricane investigation suggests that there is no increased hazard or potential for site-related exposures resulting from the hurricane. As such, there is no public health hazard present at the Bayou Bonfouca site.

Recommendations

There are no recommendations to be made at this time. LDHH/OPH/SEET will examine future data as needed or requested.

Public Health Action Plan

The information produced within this health consultation will be disseminated by SEET to the public repositories, community members and stakeholders within St. Tammany Parish, Louisiana.

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Bayou Bonfouca Post-hurricane Evaluation
St. Tammany Parish, Louisiana

Certification

This health consultation for Bayou Bonfouca was prepared by Louisiana Department of Health and Hospitals under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It was completed in accordance with approved methodology and procedure existing at the time the health consultation was initiated.

[Signature]

Jeff Kellam

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The Division of Health Assessment and Consultation (DHAC), ATSDR, has reviewed this health consultation and concurs with its findings.

[Signature]

Alan W. Yarbrough

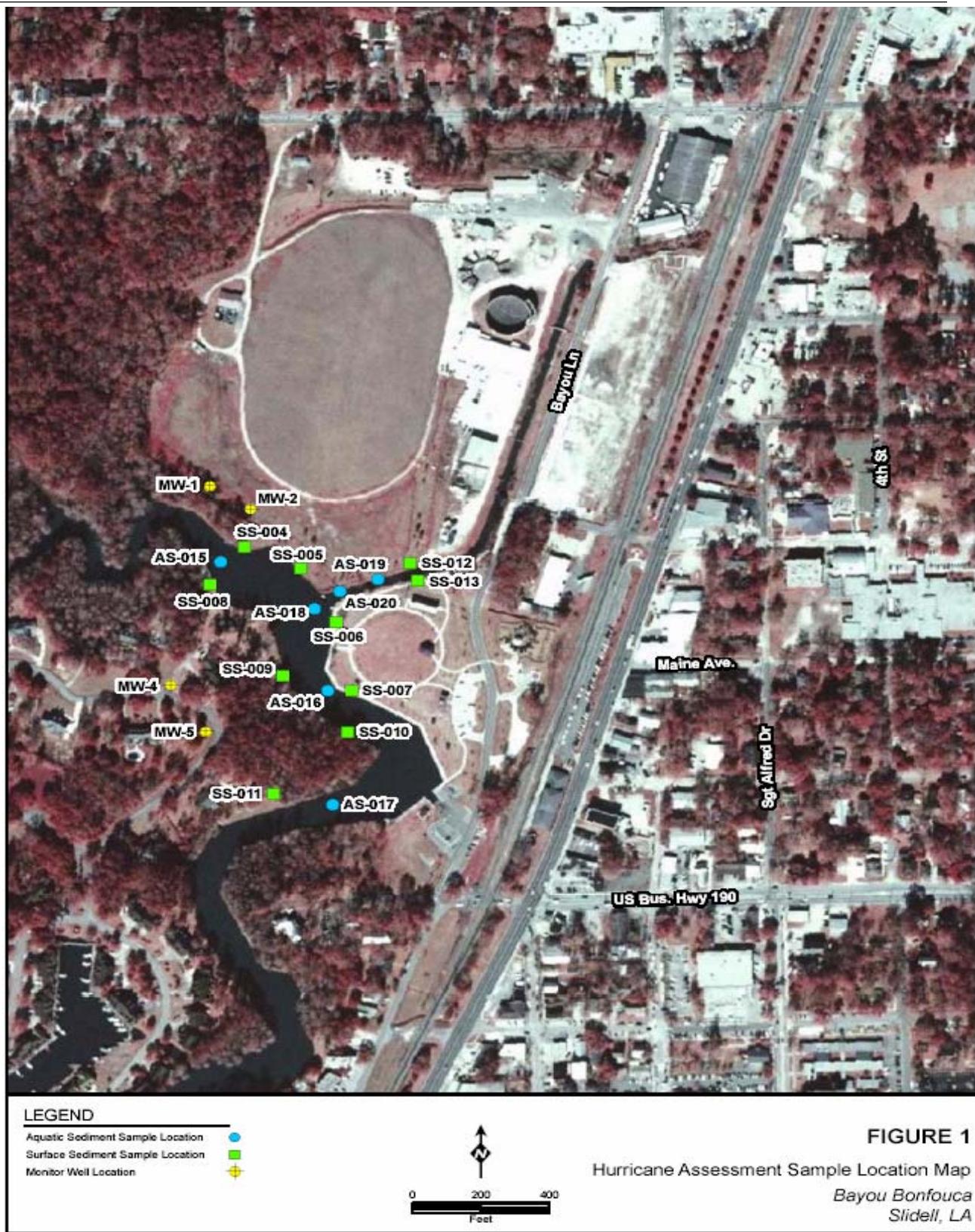
Cooperative Agreement Team Leader, DHAC, ATSDR

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5. U.S. Census Bureau, St. Tammany Parish, Louisiana American Fact Finder. Generated by Darcie Olexia. Accessed 2 Aug 2006 at URL: <http://factfinder.census.gov/>

Figures

Bayou Bonfouca Post-hurricane Evaluation
St. Tammany Parish, Louisiana



Source: CH2MHILL Technical Memorandum, Hurricane Katrina Response Bayou Bonfouca Superfund Site, Louisiana Site Inspection and Sampling Results. February 2006.

Site Photographs

Bayou Bonfouca Post-hurricane Evaluation
St. Tammany Parish, Louisiana



Photo 7: Bottom left, pumps within ground water treatment system, submerged and damaged during Hurricane Katrina. Taken 2/16/2006.

Filename: DSCN2446.jpg



Photo 8: Ground water treatment system piping. Taken 2/16/2006

Filename: DSCN2447.jpg

Bayou Bonfouca Post-hurricane Evaluation
St. Tammany Parish, Louisiana



Photo 17: Looking south across array 1A toward Bayou Bonfouca. Taken 2/16/2006

Filename: DSCN2456.jpg



Photo 18: Looking east along recovery well array 1A, on south side of landfill, toward city maintenance facility in the background. Taken 2/16/2006

Filename: DSCN2457.jpg

Bayou Bonfouca Post-hurricane Evaluation
St. Tammany Parish, Louisiana



Photo 29: Dried sediment on top of sheet pile wall along bayou left behind by floodwaters associated with Hurricanes Katrina/Rita. Taken 2/16/2006

Filename: DSCN2469.jpg



Photo 30: Dried sediment on top of sheet pile wall along bayou and debris left behind by floodwaters associated with Hurricanes Katrina/Rita. Taken 2/16/2006

Filename: DSCN2470.jpg

Source: U.S. EPA Region 6, Third Five-Year Review Report for the Bayou Bonfouca Superfund Site. Slidell, St. Tammany Parish, Louisiana. May 2006.

Bayou Bonfouca Post-hurricane Evaluation
St. Tammany Parish, Louisiana



Looking from Slidell City Park to Bayou Bonfouca. Note placard is easily visible to public.
September 21, 2006.

Bayou Bonfouca Post-hurricane Evaluation
St. Tammany Parish, Louisiana



Public boat launch to Bayou Bonfouca located in Slidell City Park. September 21, 2006.

Bayou Bonfouca Post-hurricane Evaluation
St. Tammany Parish, Louisiana



Looking from Slidell City Park to access restricted onsite capped landfill containing incinerated wastes from the completed 1995 Remedial Action. September 21, 2006.

Bayou Bonfouca Post-hurricane Evaluation
St. Tammany Parish, Louisiana



Slidell City Park approximate location of surface sediment samples taken by EPA contractors in December 2005. September 21, 2006.

Bayou Bonfouca Post-hurricane Evaluation
St. Tammany Parish, Louisiana



Looking from Slidell City Park to residential sampling location across from Bayou Bonfouca where surface sediment samples were taken in December 2005. September 21, 2006.

Bayou Bonfouca Post-hurricane Evaluation
St. Tammany Parish, Louisiana



Slidell City Park no swimming advisory posted for public notice. September 21, 2006.

Source: SEET, LDEQ, and EPA site visit, September 21, 2006.

Appendix

A-1: Sediment Ingestion Exposure Dose Equation

Exposure doses from ingestion of sediment can be calculated as follows:

$$D = (C \times IR \times EF \times CF) / BW$$

Where,

- D= exposure dose (mg/kg/day)
C= contaminant concentration (mg/kg)
IR= intake rate of contaminated sediment (mg/day)
EF= exposure factor (unitless)
CF= conversion factor (10^{-6} kg/mg)
BW= body weight (kg)

Default Sediment Intake Rates:

100 mg/day – adult
200 mg/day – child

A-2: Sediment Dermal Contact Exposure Dose Equation

Exposure doses from dermal contact with sediment can be calculated as follows:

$$D = (C \times A \times AF \times EF \times CF) / BW$$

Where,

- D= exposure dose (mg/kg/day)
C= contaminant concentration (mg/kg)
A= total sediment adhered (mg)
AF= bioavailability factor (unitless)
EF= exposure factor (unitless)
CF= conversion factor (10^{-6} kg/mg)
BW= body weight (kg)

Source: Agency for Toxic Substances and Disease Registry. Public Health Assessment Guidance Manual (Update). Atlanta: U.S. Department of Health and Human Services, Public Health Service; January 2005.

A-3: Quantitative Screening Analysis for Carcinogenic Risk

Cancer risk from ingestion of sediment can be calculated as follows:

$$\text{Cancer risk} = D \times \text{CSF}$$

Where,

D= exposure dose (mg/kg/day) [see above]

CSF= cancer slope factor([mg/kg/day]^{-1})

Source: Agency for Toxic Substances and Disease Registry. Public Health Assessment Guidance Manual (Update). Atlanta: U.S. Department of Health and Human Services, Public Health Service; January 2005.