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Water and Sediment Data for Chemical Indicators of Contamination

by Tyler Bowley, Steven Larson, and Anthony Bednar

INTRODUCTION: This subtask of the Interagency Performance Evaluation Team (IPET) Task 9 project focuses on data mining and compilation for chemical results in four Louisiana parishes affected by flooding from Hurricanes Katrina and Rita – Orleans, Plaquemines, St. Bernard, and St. Charles. The compounds of interest are arsenic, lead, benzo[a]pyrene (BaP) and 1,1-dichloro-2,2-bis(p-chlorophenyl)ethylene (DDE), selected by consensus as likely candidates because of availability of data following the flooding events (Hurricanes Katrina and Rita) and the chemical variability between them. Arsenic and lead, although both inorganic analytes, would behave differently based on soil:solution chemistry. Lead sorbs to soil as a traditional cation, whereas arsenic speciation [As(III) or (V)] would yield little sorption in reduced environments as As(III), compared to increased sorption in the case of As(V) being favored in oxidizing environments. BaP is an organic polycyclic aromatic hydrocarbon which could be used to trace petroleum-impacted floodwaters. The pesticide DDE was selected because of its presence at superfund sites in the New Orleans area and historical production and usage in the area.

Key points…

In the aftermath of Hurricane Katrina, the Engineer Research and Development Center was tasked with compiling chemical concentration data for floodwaters and sediments in New Orleans. This technical note discusses expeditionary sampling trips to gather data on the discharge of potential contaminants into surrounding ecosystems. Data collected are compared to data that existed prior to Katrina. Only slight differences were found in sediment and water concentrations. Sediment volume increased more from levee failure than dewatering activities. The Interagency Performance Evaluation Taskforce (IPET) website can be accessed at: *https://ipet.wes.army.mil*

Three distinct time frames are of interest for this work: 1) pre-Katrina, defined as prior to 28 August 2005; 2) immediately after the flooding events, roughly 1–2 weeks after Hurricanes Katrina and Rita affected the area; and 3) the post-dewatering of New Orleans time period. Possible data sources for this information were ultimately narrowed down primarily to two Federal Government Agencies and two journal articles authored by University Researchers as described below. Investigations of the U.S. Geological Survey National Water Information System (NWIS) database provided only simple water quality parameters such as pH, Total Suspended Solids, Dissolved Oxygen, etc., and not specific analytes of interest found in the U.S. Environmental Protection Agency (USEPA) and U.S. Army Corps of Engineers (USACE) studies.

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The USEPA provided the most temporally and spatially useful data. The USEPA began an extensive sediment and water sampling plan within days of the flooding event, providing thousands of data points in the on-line STORET (STOrage and RETrieval System) database. The U.S. Army Engineer Research and Development Center, Environmental Laboratory (ERDC-EL) made sampling trips to New Orleans in December 2005 and again in March 2006 to collect additional data from pump locations where floodwaters were discharged into marshes surrounding the urban areas. These data were considered 'perishable' because of the limited sampling by other agencies and the time since the floodwaters were discharged. The data published by the Principal University Researchers at Louisiana State University (LSU) and Texas Technical University (TX Tech) provide intimate temporal and spatial data in the weeks immediately after the flood event while the city was being dewatered.

PRE-KATRINA DATA: Using the EPA's STORET data warehouse (*http://oaspub.epa.gov/stormodb/DW_resultcriteria_geo*) no results were found for the period 1 January 2001 through 24 August 2005, for the parishes of interest. A search of the Legacy STORET data warehouse provided some results from the early 1990s. Due to the age of the data, none of the data were usable for this study. Dave Walters with the U.S. Geological Survey New Orleans Office was able to locate four water quality data samples from the NWIS database (*http://waterdata.usgs.gov/nwis*) from 2001 and 2002. None of the four compounds of interest were included in the analyses of these four samples. A search of the Louisiana Department of Environmental Quality database (*http://www.deq.louisiana.gov/portal/*) also turned up no results for the study period and analytes of interest. In general, most of the data available from these sources for the pre-Katrina time period consists of simple water quality parameters, and not the specific analytes of interest.

A review of the peer-reviewed scientific literature yielded two articles (Mielke et al. 2001, Mielke et al. 2004) that report concentrations of PAH and metals in New Orleans inner-city and suburban soils. BaP concentrations reported for New Orleans soils ranged from 0.091–6.859 mg/kg, whereas sediment concentrations for spillways and bayous ranged from non-detect to 4.044 mg/kg. Lead concentrations in city soils ranged from 32-4298 mg/kg, whereas bayou sediment concentrations were in the 4–1587 mg/kg range (Mielke et al. 2001). In a more recent article, Mielke et al. (2004) used census tract information to partition off sections of the city for more detailed spatial analysis of lead and BaP. In addition, site descriptions were used to isolate sources of contamination, i.e., busy streets, residential streets, open areas, etc. The results reported indicate that for most metals and PAHs, 'busy streets' had a higher median concentration than did less impacted areas, such as 'open areas' (Mielke et al. 2004).

IMMEDIATELY AFTER FLOODING: Although some data were found in the EPA STORET database for the first weeks after flooding, perhaps the most detailed data were obtained from two articles in the journal *Environmental Science and Technology*. The articles, authored by Pardue et al. (2005*)* and Presley et al. (2006), are hereafter referred to as the "LSU" and "TX Tech" articles, respectively. The articles contain water chemistry data parameters for three of the four analytes of interest, BaP, arsenic, and lead. Statements are made in the LSU article about the water quality of the floodwater to the effect: "…Katrina floodwater is similar to normal stormwater runoff but with elevated [lead] and [volatile organic compound] concentrations"

(Pardue et al. 2005), yet no specific references or data are given in the article to support this conclusion.

Concentrations were not reported in the LSU and TX Tech articles for DDE. Sediment concentrations of BaP were reported by TX Tech (Presley et al. 2006). Dissolved metal concentrations were also reported, and ranged from 17–54 µg/L for arsenic and 1–72 µg/L for lead. Sediment samples reported in the TX Tech article list arsenic and lead concentrations as 6-24 and 340–640 mg/kg, respectively, in close agreement to the pre-Katrina values reported in the Mielke et al. (2001) study. In fact, the 2001 study found its highest lead concentration in soil to be an order of magnitude higher than the highest value reported by TX Tech (Mielke et al. 2001, Pardue et al. 2005, Presley et al. 2006). The BaP concentrations reported by TX Tech ranged from 0.01–1.26 mg/kg, also in close agreement with the available pre-Katrina data.

POST-KATRINA DATA: Using the EPA's STORET Katrina Central Warehouse, *http://oaspub.epa.gov/storetkp/DW_resultcriteria_geo*, for the same four Louisiana parishes provided a much different data set for the post-Katrina and Rita period. The period from 28 August 2005 through 13 February 2006 produced 4729 results for the four parishes and compounds of interest, with the exception being St. Charles Parish. No samples were taken in St. Charles Parish, post-Katrina, according to the STORET Katrina Central Warehouse.

Concentrations of arsenic and lead in soil ranged from 5–12 and 20–117 mg/kg, respectively, in close agreement to those previously reported and discussed for pre-Katrina and immediately after the flooding event timeframes. The organic compounds of interest also showed similar levels as reported prior to the flooding event in soil, with BaP ranging from 0.01–0.5 mg/kg and DDE ranging from 0.007–0.013 mg/kg. The one outlying point would be the maximum concentrations of BaP reported by Mielke et al. (2001) of over 6.5 mg/kg. Water concentrations for arsenic, lead, BaP, and DDE in the EPA database ranged from 1–5, 1–100, non-detect or 0.01–2 µg/L and non-detect or 0.01–1 µg/L, respectively, which also agree closely with the limited pre-Katrina values available.

Water samples were not collected for analysis on the two ERDC-EL sampling trips in the New Orleans and Violet Marsh areas in December 2005 and March 2006. Of the sediment samples collected, arsenic and lead concentrations found ranged from 3–13 and 27–181 mg/kg, respectively. The DDE concentrations found ranged from 0.003–0.015 mg/kg. These values are in close agreement with the limited pre-Katrina data available, as well as the USEPA data reported after the flooding events. In the following section, maps and data tables are provided for each parish to more clearly illustrate the levels of contamination from arsenic, lead, BaP and DDE in floodwater and sediment.

GENERAL ANALYTE TRENDS AND OBSERVATIONS: The Louisiana Department of Environmental Quality (LDEQ) Risk Evaluation/Corrective Action Program (RECAP) standards for residential soil and water were used to qualify the EPA STORET data. LDEQ developed RECAP to address risks to human health and the environment posed by the release of chemical constituents to the environment. The LDEQ RECAP table can be found at the following URL: *http://www.deq.louisiana.gov/portal/Portals/0/technology/recap/2003/RECAP%202003%20Text%20Table%201.pdf*.

ORLEANS PARISH

Arsenic. Of the samples tested for arsenic, 36 percent had a level greater than or equal to the LDEQ RECAP level of 12 mg/kg. The average arsenic level in sediment for Orleans Parish was 11.8 mg/kg (Table 1). In the Mid-City district, at the intersection of Euphrosine and S. Lopez Streets, a sample with an arsenic level of 78 mg/kg was taken. All other locations with an arsenic detection level greater than the RECAP level are also shown in Figure 1. This was the maximum level found in a sediment sample in Orleans Parish and is the red square with yellow center shown in Figure 1. In New Orleans, elevated metals levels, including arsenic and lead, may result in large part from the incorporation of the pre-hurricane local urban soil (Mielke et al. 2001, Plumlee et al. 2006). Arsenic may also be so widespread in the New Orleans area because of past use of arsenic-based pesticides, trash incineration, leakage from industrial sites, and the use of building materials pressure-treated with chromium-copper arsenate (Solomon et al. 2006).

Table 1. EPA STORET sediment data in Orleans Parish.

Compound	Samples	Average mg/kg	Std Dev	Maximum mg/kg	LDEQ RECAP mg/kg	Greater than LDEQ RECAP, %
Arsenic	273	11.8	11.2	78	12	36%
Lead	265	117	157	1160	400	7%
BaP	277	0.50	2610	35.5	0.33	23%
DDE	280	0.01	46.6	0.44	1.7	0%

The LDEQ RECAP level for arsenic in groundwater is 0.01 mg/L. Figure 2 shows locations of all floodwater samples that exceeded the RECAP level with the maximum level location shown in red with yellow center. Of the floodwater samples taken in Orleans Parish, 13 percent had an arsenic level of 0.01 mg/L or greater. In East Gentilly, a sample taken at the intersection of Lake Forest Blvd. and Glouster Rd. had an arsenic level of 0.357 mg/L. This was the highest level of arsenic found in Orleans Parish. Three other samples taken along Lake Forest Blvd. had levels between 0.05 and 0.27 mg/L.

Lead. For lead, the sediment RECAP level is 400 mg/kg. Only 7 percent of the samples (shown in Figure 3) had a level above the RECAP level. The highest level of lead, 1160 mg/kg, was found on the south side of the University of New Orleans Campus at the intersection of Leon C. Simon Dr. and Milneburg Rd. The high levels of lead found in the Orleans' sediments are likely due to past use of lead in paint and gasoline, or to leakage from industrial sites in and around New Orleans (Solomon et al. 2006).

Lead concentrations in water greater than or equal to the LDEQ RECAP level of 0.15 mg/L were found in 11 percent of the samples in Orleans Parish (see Figure 4). The highest level of lead in water, 1.34 mg/L, was found in the northwest part of the Gentilly District near the intersection of Paris Ave. and Burbank Dr. In the Bywater District, seven samples with lead levels above the RECAP level were found, ranging from 0.846 mg/L near the I-10 exit 236 and 0.026 mg/L at the intersection of Marais and Poland Ave.

Figure 1. Arsenic in sediment with concentration greater than the LDEQ RECAP level.

Other inorganic analytes. Other inorganic analytes in Orleans Parish include 15 metals analytes that were found in all 265 sediment samples – Aluminum (Al), Barium (Ba), Beryllium (Be), Calcium (Ca), Chromium (Cr), Cobalt (Co), Iron (Fe), Lead (Pb), Magnesium (Mg), Manganese (Mn), Nickel (Ni), Sodium (Na), Potassium (K), Vanadium (V), and Zinc (Zn). Another four analytes (Copper (Cu), Arsenic (As), Cadmium (Cd), and Mercury (Hg)) were detected on at least 90 percent of the 265 sediment samples taken. Since cadmium and mercury are known to be especially toxic to humans, these results were compared to the LDEQ RECAP levels of 3.9 and 2.3 mg/kg, respectively. Only one sample exceeded the mercury RECAP level. Of the cadmium concentrations reported, 17 percent were higher than the RECAP level, with the maximum level of 45.3 mg/kg found at the same location (the intersection of Euphrosine and S. Lopez Streets) as the maximum level of arsenic.

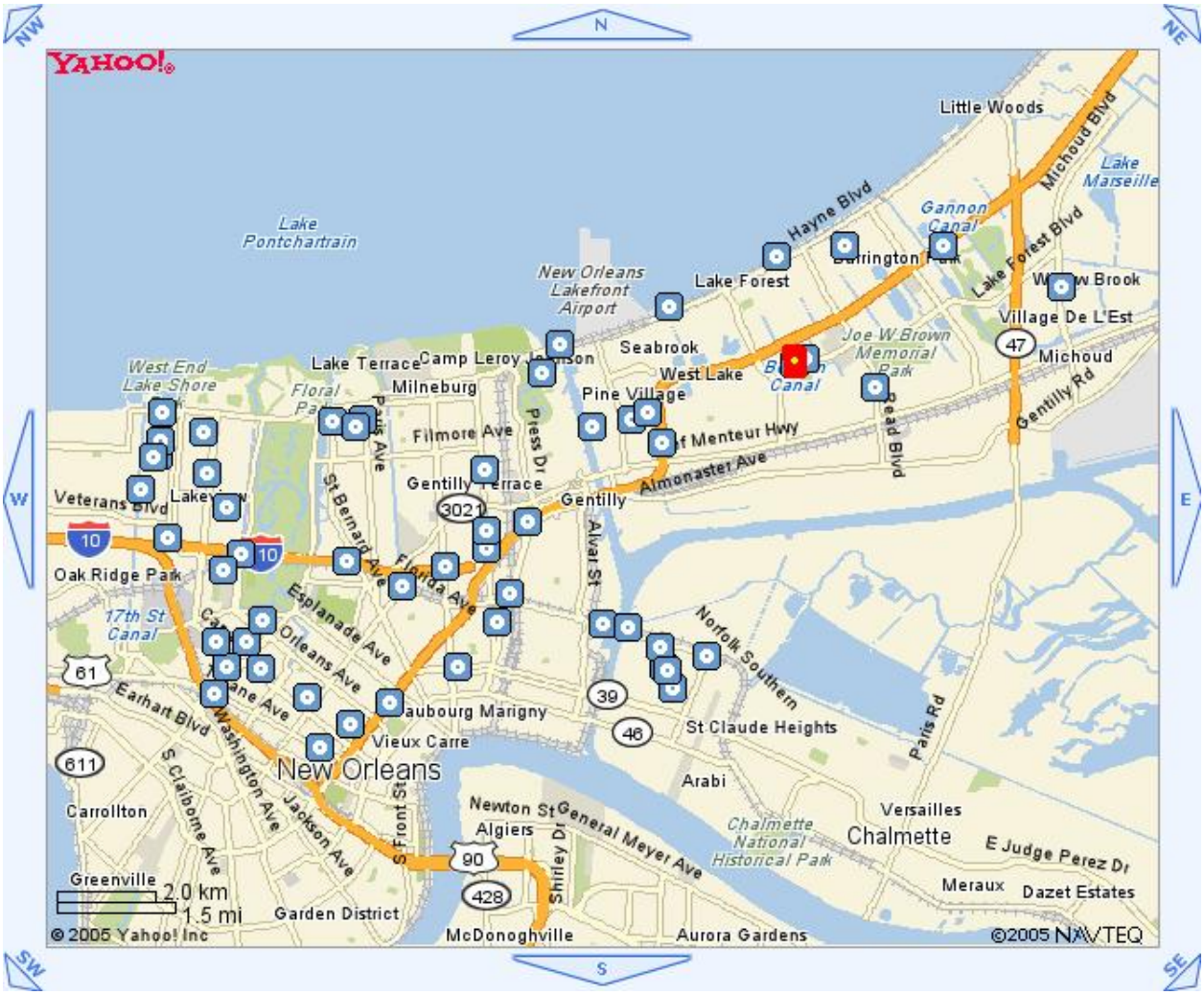

Figure 2. Arsenic in water with concentration greater than the LDEQ RECAP level.

For comparison, only three metals analytes (Ba, Mn, and Ca), were detected on 100 percent of the 360 water samples taken. There are no LDEQ RECAP levels for calcium or manganese. For barium, an LDEQ RECAP level of 2 mg/L has been set. None of the samples contained a level of barium that met or exceeded that level. Another five metals, Mg, Na, Fe, K, and Zn, had detection percentages of 90 percent or higher. Only zinc has an LDEQ RECAP level, which is 1.1 mg/L. Four percent of the samples tested for zinc met or exceeded that level. Two samples taken in East Gentilly, at the intersection of Lake Forest Blvd. and Glouster Rd., contained 20 and 30 times the zinc RECAP level, respectively. Another toxic metal, hexavalent chromium, was found in 55 percent of the 209 water samples taken, but none had a level greater than or equal to the LDEQ RECAP level of 0.1 mg/L.

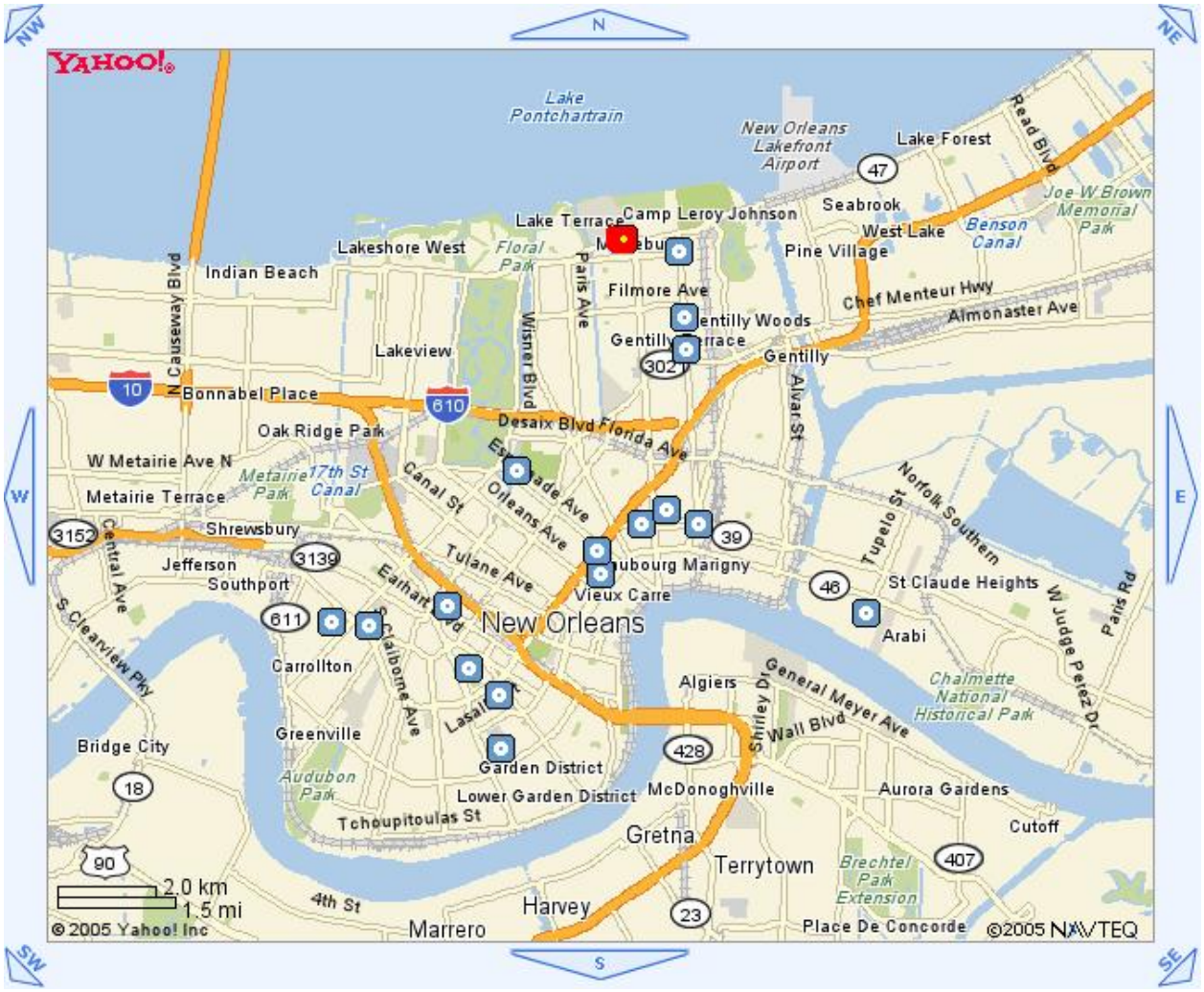

Figure 3. Lead in sediment with concentration greater than the LDEQ RECAP level.

Figure 5 shows detected concentrations of the PAH BaP in sediments and soils that are above the LDEQ RECAP level of 0.33 mg/kg. Of the samples tested for BaP, 23 percent met or exceeded this level. Near the Agriculture Street Landfill, four samples ranging from 0.43 mg/kg to 17.7 mg/kg were taken. The maximum level found, 35.5 mg/kg, was along the Chef Menteur Highway just east of I-510 in Michoud (depicted by the red square with yellow center in Figure 5). High levels of BaP may be due to the numerous spills of petroleum products, such as diesel fuel, during the hurricanes, or may be due to historic contamination from burning of debris (Solomon et al. 2006).

Only one water sample in Orleans Parish had a BaP level higher than the LDEQ RECAP level of 0.0002 mg/L and it was an estimated concentration (Figure 6). The value is an estimated value because it was detected at a concentration between the calculated method detection limit of 0.01mg/L and the laboratory reporting limit. The sample was taken near the intersection of Florida Ave. and Almonaster Ave. and had a level of 0.0004 mg/L.

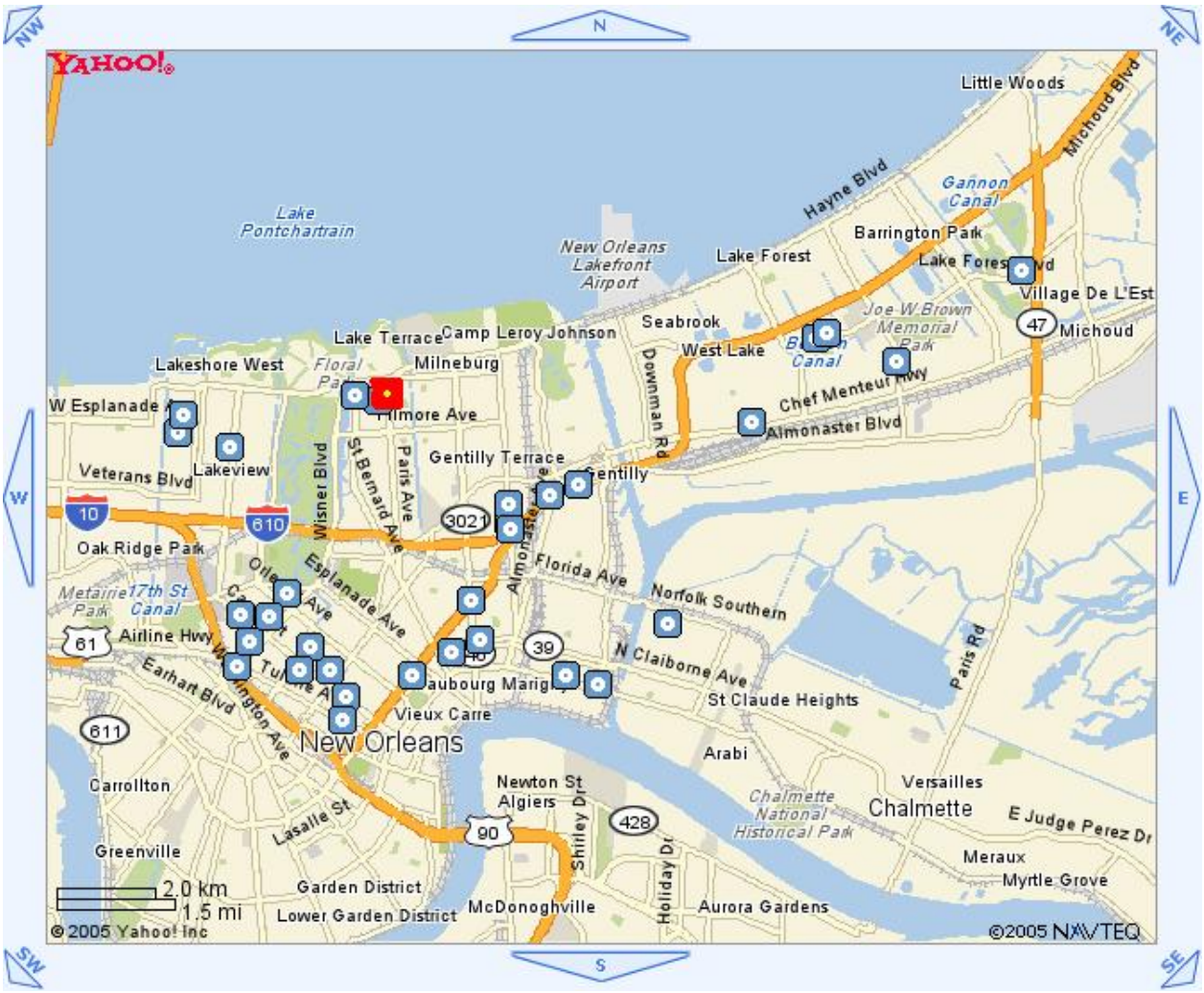

Figure 4. Lead in water with concentration greater than the LDEQ RECAP level.

Other hydrocarbons detected include oil range organics occurring in all of 41 samples taken (41 of 41), petroleum hydrocarbon mix (151 of 159) and diesel range organics (246 of 280), yielding an 87-percent detection rate or better in Orleans Parish sediment samples. For comparison, the PAH of interest, BaP, was found in 48 percent of the sediment samples taken. Oil range organic detections exceeded the RECAP level of 180 mg/kg on 46 percent of the samples taken in Orleans Parish. Diesel range organics exceed the RECAP level of 65 mg/kg on 76 percent of the samples. The petroleum hydrocarbon mix does not have a specific RECAP level because it is a group of hydrocarbons that are broken down individually in the LDEQ RECAP table. Chrysene, fluoranthene, benzo[b]fluoranthene, and pyrene all had a higher percentage of positive results than did BaP. BaP was detected in only 1 of 266 water samples taken. All PAH compounds were less prevalent in the water samples than in sediment, with the most prevalent being diesel range organics at a 35-percent detection frequency.

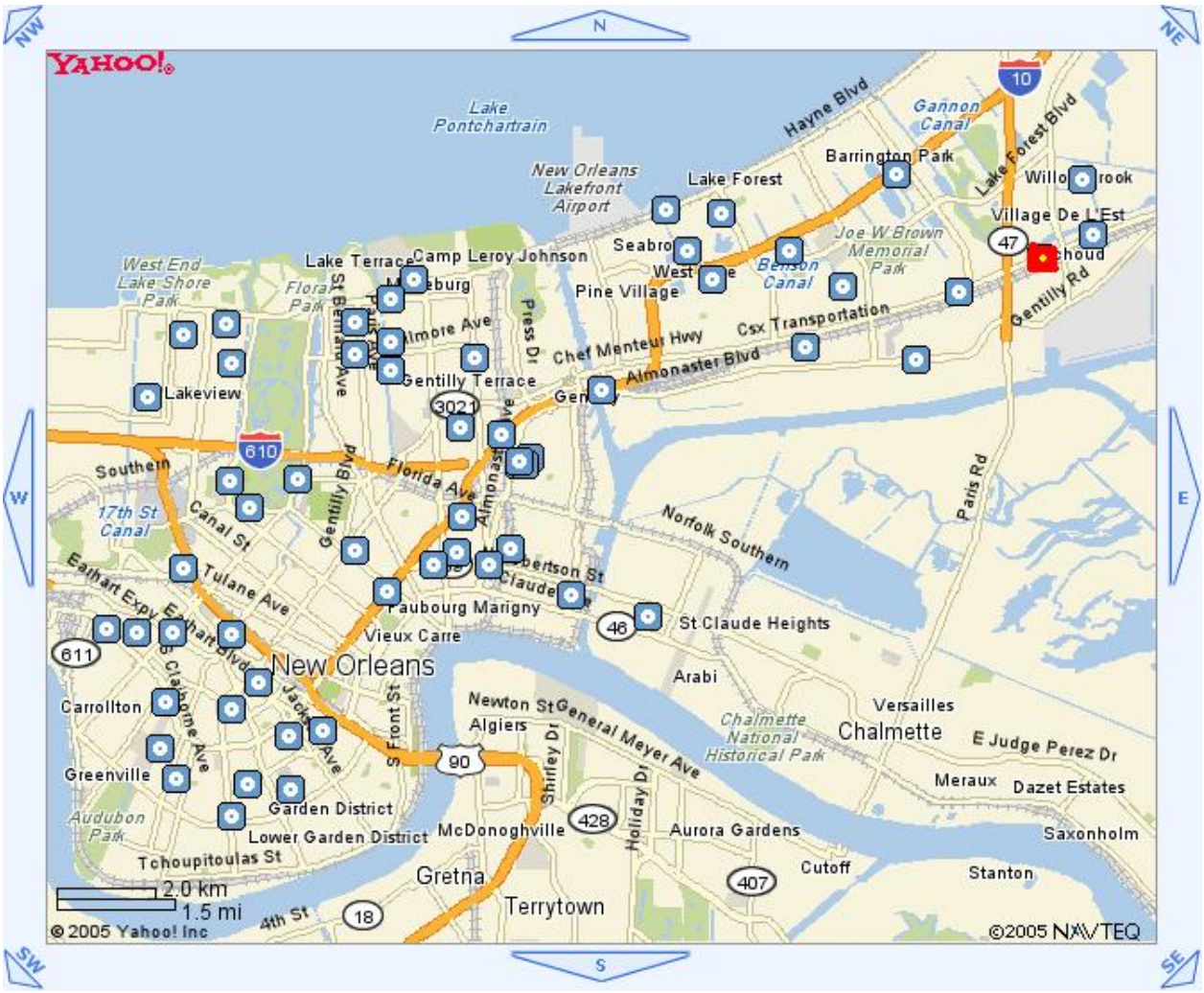

Figure 5. BaP in sediment with concentration greater than the LDEQ RECAP level.

No sediment or water samples in Orleans Parish contained a DDE level greater than or equal to the 1.7 mg/kg or 0.0002 mg/L LDEQ RECAP levels, respectively.

The pesticide of interest in this study, DDE, was detected in 12 percent of the 280 sediment samples taken. For comparison, Chlordane, cis (30 percent), 1,1,1-trichloro-2,2-bis(p-chlorophenyl)ethane (DDT) (24 percent), Chlordane (24 percent), Dieldrin (21 percent) and dichlorodiphenyldichloroethane (DDD) (14 percent) all had higher percentages of concentrations than the detection limit. Chlordane, trans, was found in 59 percent of the 73 sediment samples that were tested. Chlordane, cis does not have an LDEQ RECAP level. For Chlordane, the RECAP level is 1.6 mg/kg and only one sample in 207 exceeded that figure in Orleans Parish. Dieldrin's RECAP level is 0.03 mg/kg. That level was exceeded in 15 percent of the samples tested for Dieldrin. No sediment samples exceeded the LDEQ RECAP level for DDD or DDT. In water, only 3 percent of the 269 samples taken had a result greater than the detection limit, 0.0001 mg/L, for DDE.

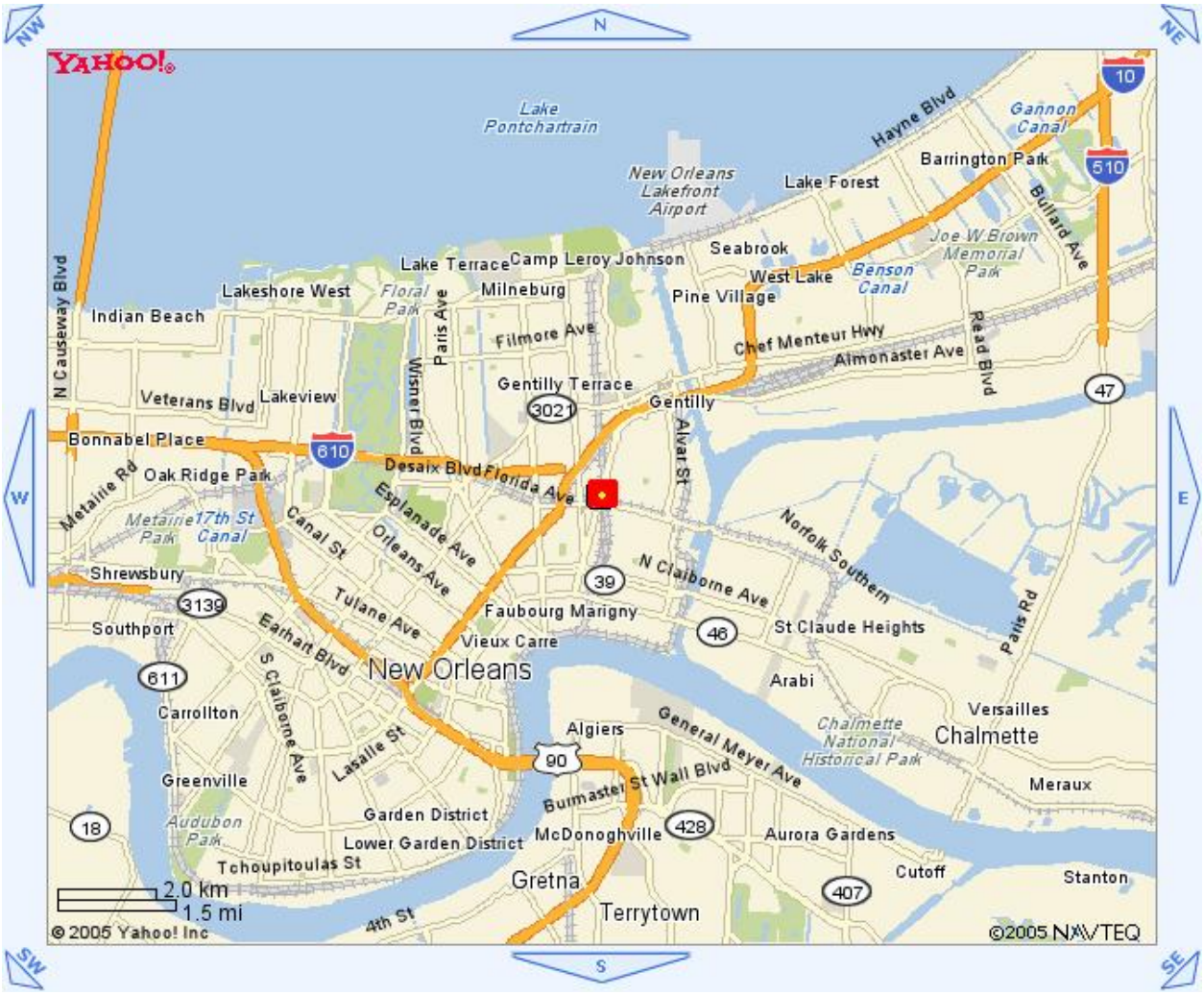

Figure 6. BaP in water with concentration greater than the LDEQ RECAP level.

Tables 1 and 2 summarize the sediment and water concentrations from the EPA STORET data set for Orleans Parish. The LDEQ RECAP limits and the percent of detections above the LDEQ RECAP limit for the four compounds are listed.

Table 2. EPA STORET groundwater data in Orleans Parish.

Compound	Samples	Average mg/L	Std Dev	Maximum mg/L	LDEQ RECAP mg/L	Greater than LDEQ RECAP, (%)
Arsenic	467	0.005	0.02	0.357	0.01	13%
Lead	365	0.98	0.08	1.34	0.015	10%
BaP	266	0.000002	0.03	0.0004	0.0002	0%
DDE	269	0.0000009	0.006	0.00007	0.0002	0%

PLAQUEMINES PARISH: One sediment sample in Plaquemines Parish exceeded the RECAP level of 12 mg/kg for arsenic. It was found near Home Place just off of Highway 23, north of Milan Dr. and had an arsenic level of 14.5 mg/kg (see Figure 7).

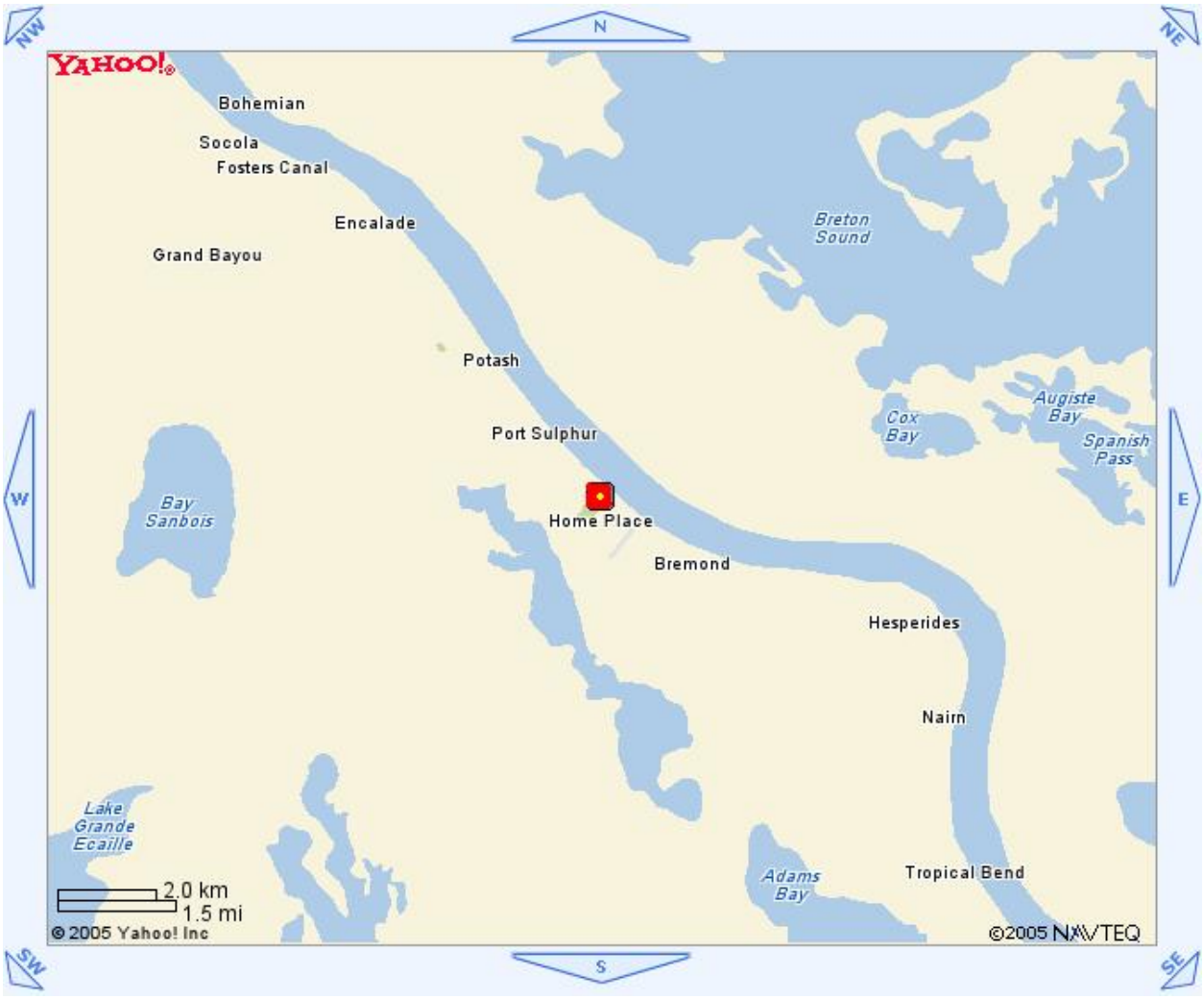

Figure 7. Arsenic in sediment with concentration greater than the LDEQ RECAP level.

Arsenic levels in water greater than or equal to the LDEQ RECAP value of 0.01 mg/L were found in only 2 of the 87 samples tested. Of the two, the higher level of 0.047 mg/L of arsenic was found in a sample taken along Highway 11 just east of Cat Bay Rd., shown in Figure 8 as a red square with yellow center.

Figure 8. Arsenic in water with concentration greater than the LDEQ RECAP level.

Figure 9 shows a BaP sample with a level of 12.2 mg/kg, which is nearly 40 times greater than the RECAP level of 0.33 mg/kg. The sample was collected northwest of Buras at Bougon Lane and Highway 11. This was the only sediment sample of 29 taken that had a BaP detection in Plaquemines Parish.

This same sample also contained a benzo(a)anthracene level of 16.2 mg/kg, which is 26 times the RECAP level of 0.62 mg/kg. Another hydrocarbon analysis, for Diesel Range Organics, was reported above the RECAP level of 65 mg/kg in half of the samples tested. The highest level was found north of Nairn at Highway 11 and Becnal Lane, where a level of 12200 mg/kg was reported.

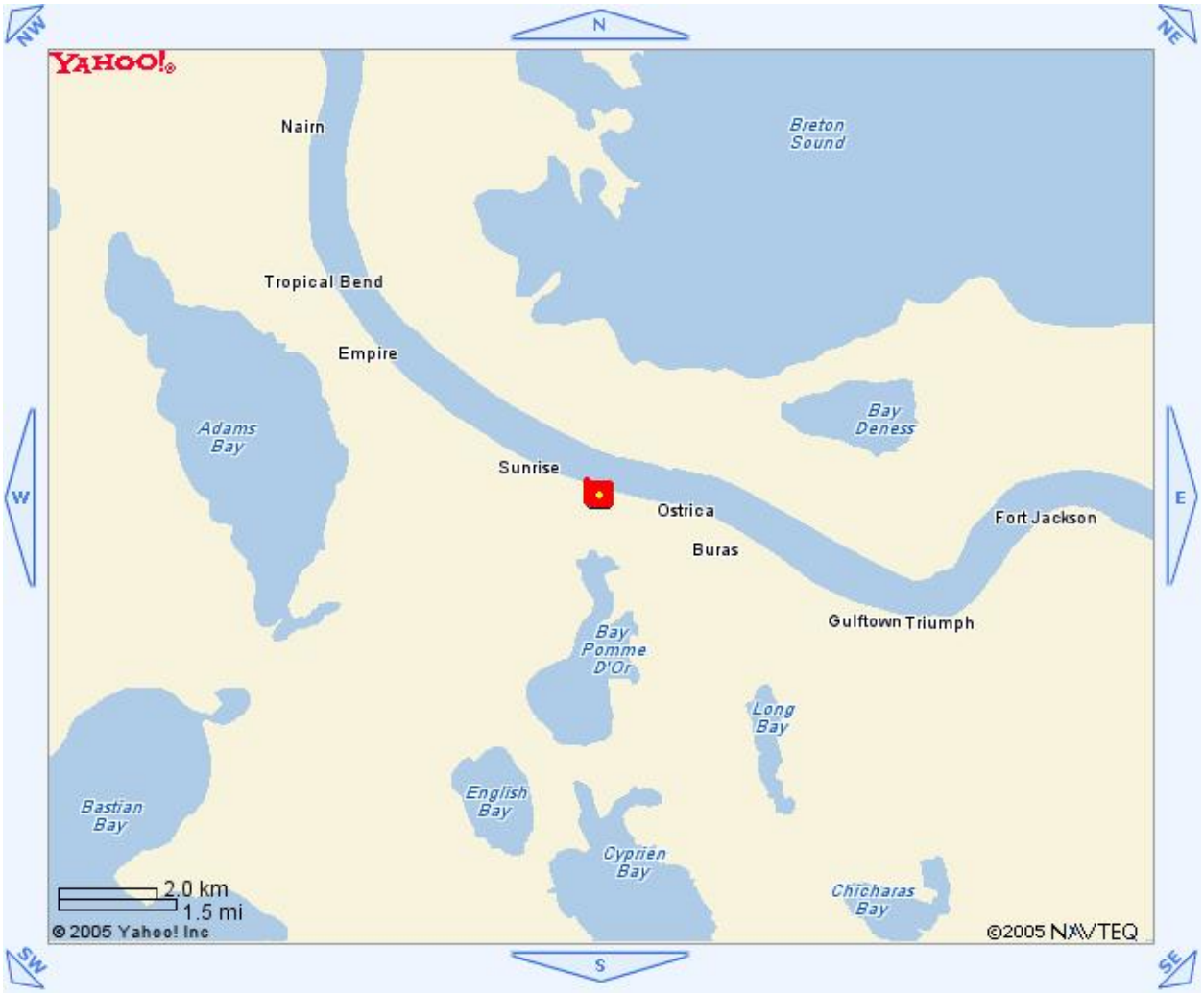

Figure 9. BaP in sediment with concentration greater than the LDEQ RECAP level.

No water or sediment samples in Plaquemines Parish contained a DDE or lead level equal to or greater than the LDEQ RECAP. Benzo(a)pyrene was not detected in any of the water samples taken.

Tables 3 and 4 summarize the sediment and water concentrations from the EPA STORET data set for Plaquemines Parish. The LDEQ RECAP limits and the percent of detections above the LDEQ RECAP limit for the four compounds are listed.

Table 3. EPA STORET sediment data in Plaquemines Parish.

Compound	Samples	Average mg/kg	Std Dev	Maximum mg/kg	LDEQ RECAP mg/kg	Greater than LDEQ RECAP, %
Arsenic	29	4.9	3.5	14.5	12	3%
Lead	29	22	13	60	400	0%
BaP	29	0.42	2265	12.2	0.33	3%
DDE	29	0.01	50	0.26	1.7	0%

Table 4. EPA STORET groundwater data in Plaquemines Parish.

Compound	Samples	Average mg/L	Std Dev	Maximum mg/L	LDEQ RECAP mg/L	Greater than LDEQ RECAP, %
Arsenic	87	0.001	0.006	0.047	0.01	2%
Lead	64	0.00001	0.001	0.008	0.015	0%
BaP	53	0	0	0	0.0002	0%
DDE	56	0	0	0	0.0002	0%

ST. BERNARD PARISH: Figure 10 illustrates that only 10 of the 304 sediment samples tested for arsenic exceeded the RECAP level of 12 mg/kg. The highest level detected was 22.8 mg/kg (red with yellow center on the map in Figure 10) in Kenilworth south of Bayou Rd. on Billot Lane. Six of the ten samples were taken in Poydras. Levels ranged from 14.8 mg/kg at 2412 Meadowlark Street to 19.1 mg/kg at 1904 Goldfinch Street.

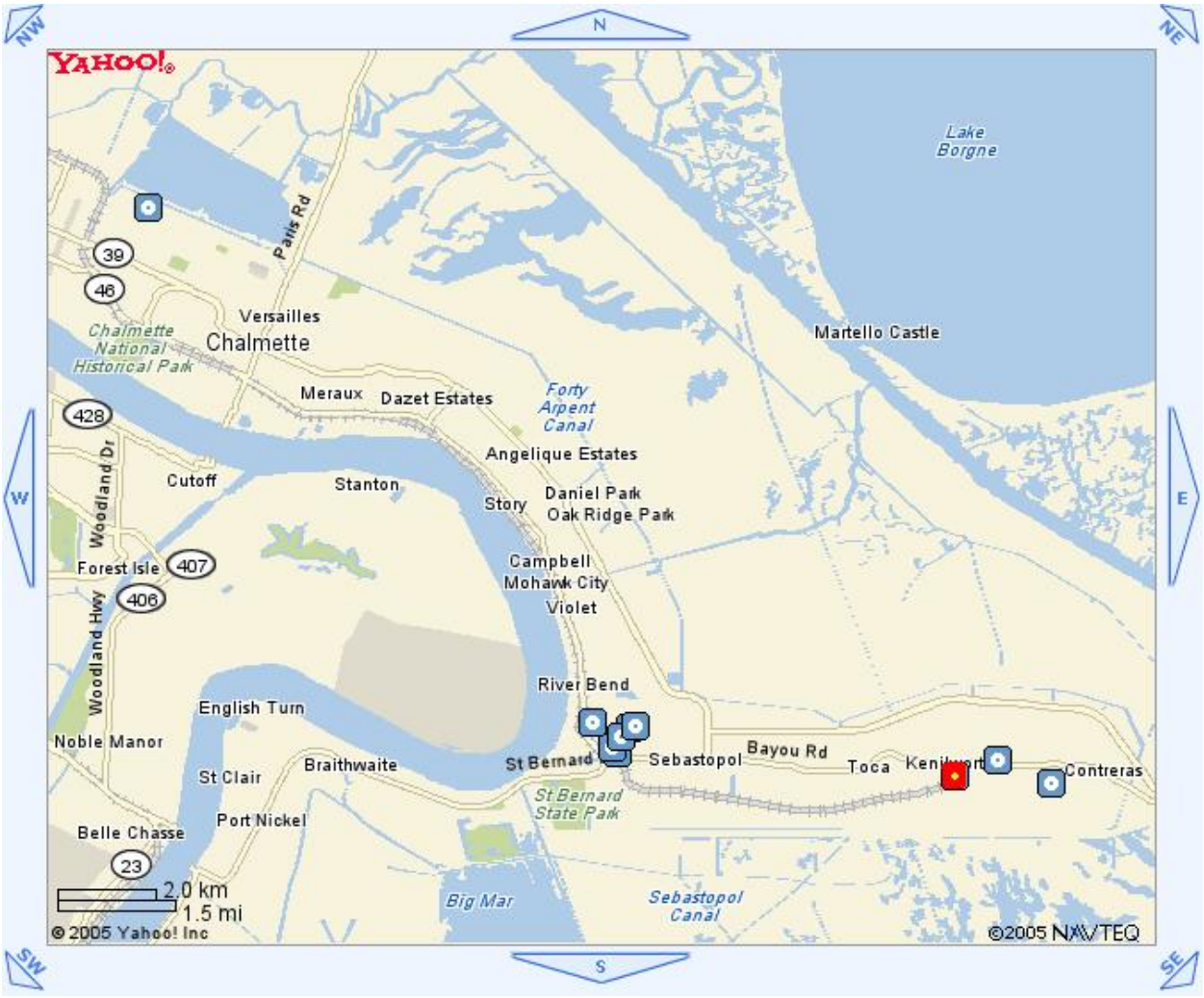

Figure 10. Arsenic in sediment with concentration greater than the LDEQ RECAP level.

Of the water samples tested for arsenic in St. Bernard Parish, 12 percent had a level greater than or equal to the LDEQ RECAP level of 0.01 mg/L. The highest level of arsenic (0.059 mg/L) was found just north of Chalmette near the intersection of Highway 47 and Agriculture Street (see Figure 11).

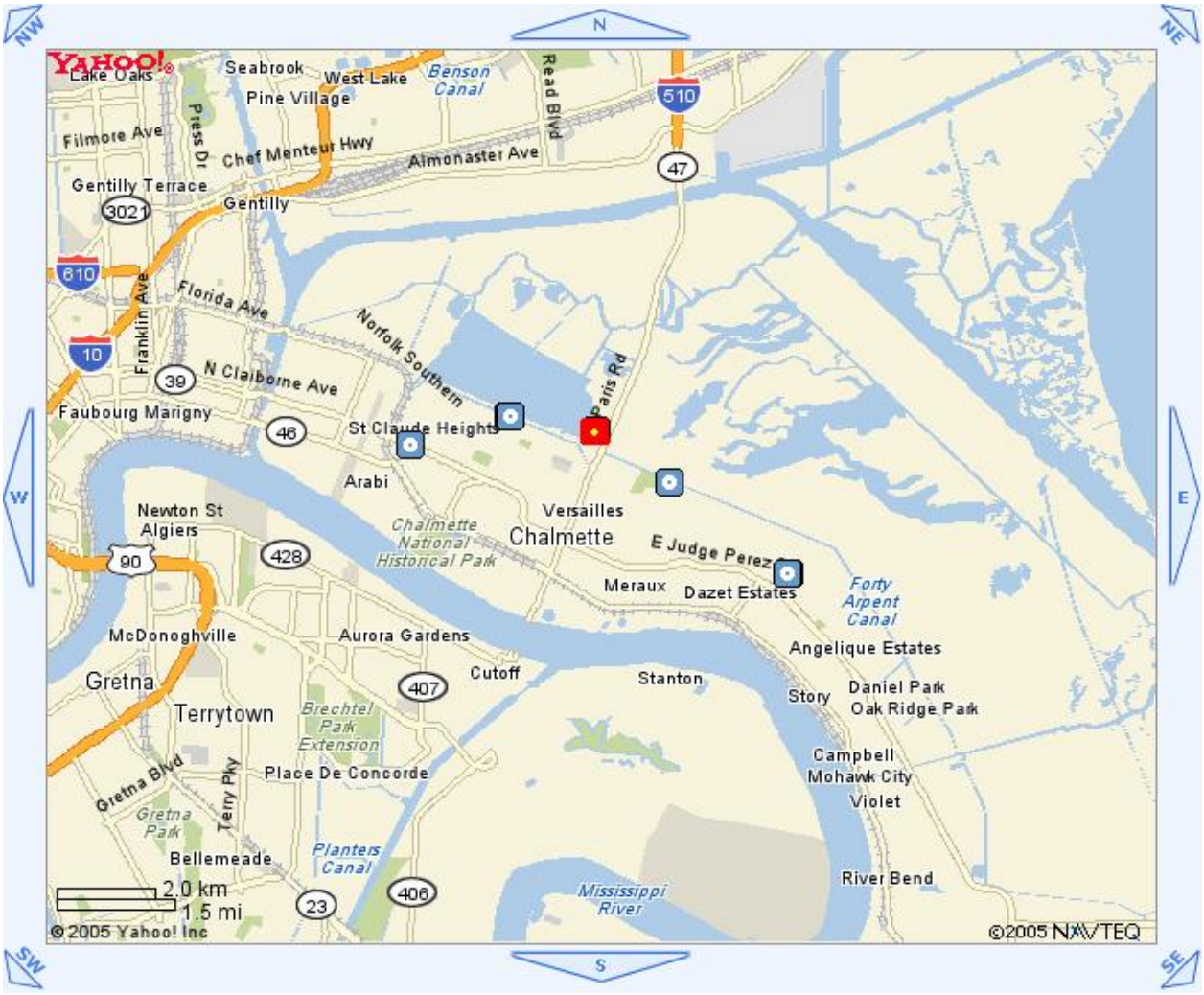

Figure 11. Arsenic in water with concentration greater than the LDEQ RECAP level.

With a level of 0.41 mg/kg, the lone sample that exceeded the sediment RECAP level for BaP was taken on the west side of Chalmette near West Judge Perez Dr. east of Norton Ave. (Figure 12). Plumlee et al. (2006) also reported elevated levels of BaP in five USGS sediment samples taken in Chalmette on 16 September and 6 and 7 October 2005. No concentrations in water samples tested for BaP were above the detection limit.

Figure 12. BaP in sediment with concentration greater than the LDEQ RECAP level.

Three of the 304 sediment samples in St. Bernard Parish tested for lead exceeded the RECAP level of 400 mg/kg. Like arsenic, the highest lead level detected (1370 mg/kg) was in Kenilworth along Bayou Rd. just west of Billot Lane (Figure 13).

Figure 14 shows the location of the only three water samples tested for lead that produced a level greater than or equal to the LDEQ RECAP level of 0.015 mg/L. A concentration of 0.022 mg/L was found near Archbishop Hannan High School in Chalmette (shown as red with yellow center marker in Figure 14).

No water or sediment samples in St. Bernard Parish contained a DDE level equal to or greater than the LDEQ RECAP level of 0.0002 mg/L or 1.7 mg/kg, respectively.

Figure 13. Lead in sediment with concentration greater than the LDEQ RECAP level.

Tables 5 and 6 summarize the sediment and water concentrations from the EPA STORET data set for St. Bernard Parish. The LDEQ RECAP limits and the percent of detections above the LDEQ RECAP limit for the four compounds are listed.

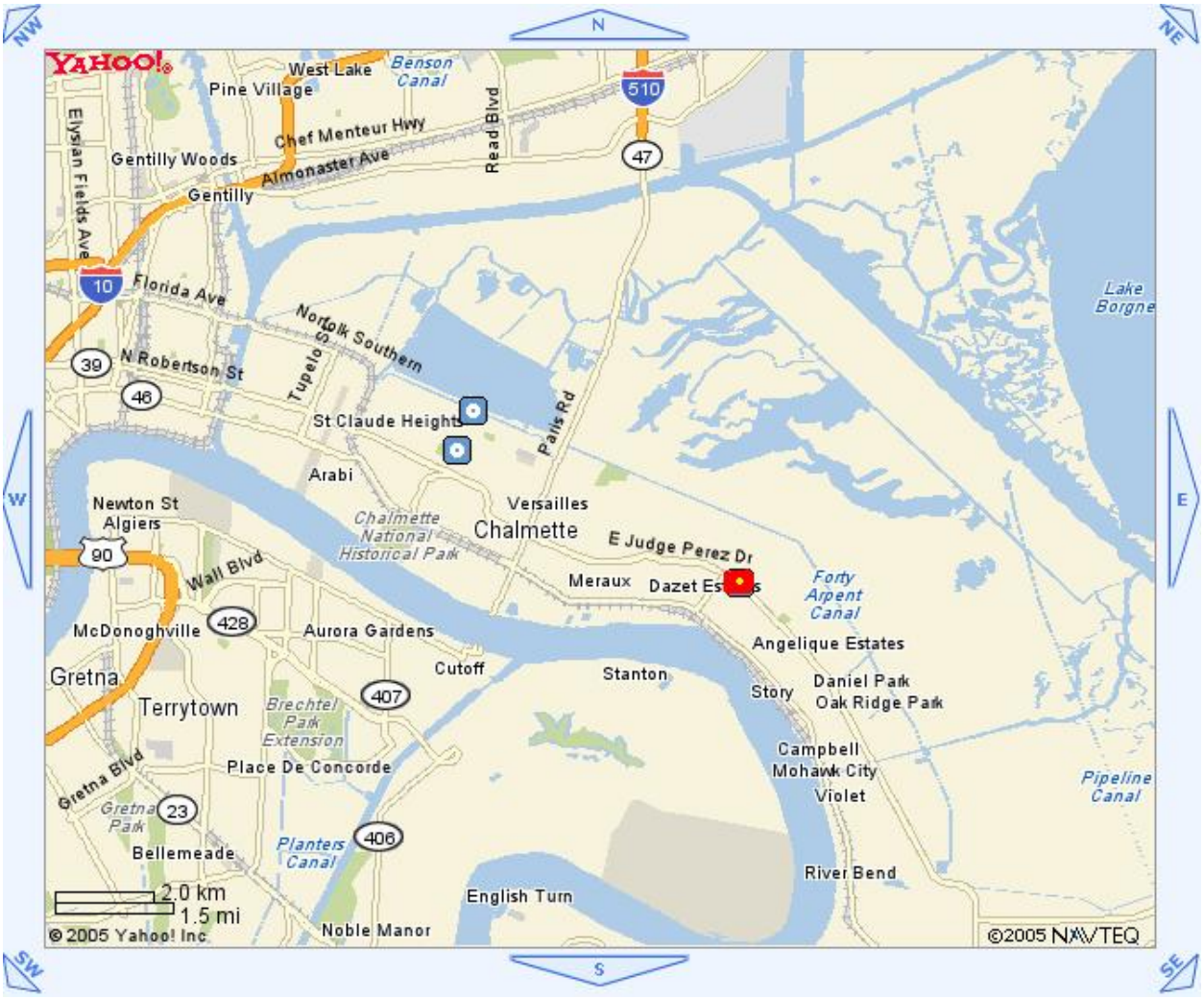

Figure 14. Lead in water with concentration greater than the LDEQ RECAP level.

Table 5. EPA STORET sediment data in St. Bernard Parish.

Compound	Samples	Average mg/kg	Std Dev	Maximum mg/kg	LDEQ RECAP mg/kg	Greater than LDEQ RECAP, %
Arsenic	187	5.7	4.4	22.8	12	5%
Lead	187	42	93	1370	400	2%
BaP	187	0.01	81	0.41	0.33	1%
DDE	191	0.01	67	0.76	1.7	0%

Table 6. EPA STORET groundwater data in St. Bernard Parish.

Compound	Samples	Average mg/L	Std Dev	Maximum mg/L	LDEQ RECAP mg/L	Greater than LDEQ RECAP, %
Arsenic	58	0.003	0.009	0.059	0.01	12%
Lead	41	0.001	0.005	0.022	0.015	7%
BaP	32	0	0	0	0.0002	0%
DDE	32	0	0	0	0.0002	0%

LAKE PONTCHARTRAIN INFLOW: No Lake Pontchartrain sediment data was found in the STORET database. For water, there are three sites where samples were collected at pump houses adjacent to the lake. Pump 10 is located at Hayne Blvd. near Trapier Street, Pump 14 is located at Hayne Blvd. and Jahnke Street and Pump 16 is located at Hayne Blvd. and Danube Street. Pump 16 pumps from the St. Charles Canal into Lake Pontchartrain. Figure 15 shows the location of the three pumps adjacent to and flowing into Lake Pontchartrain.

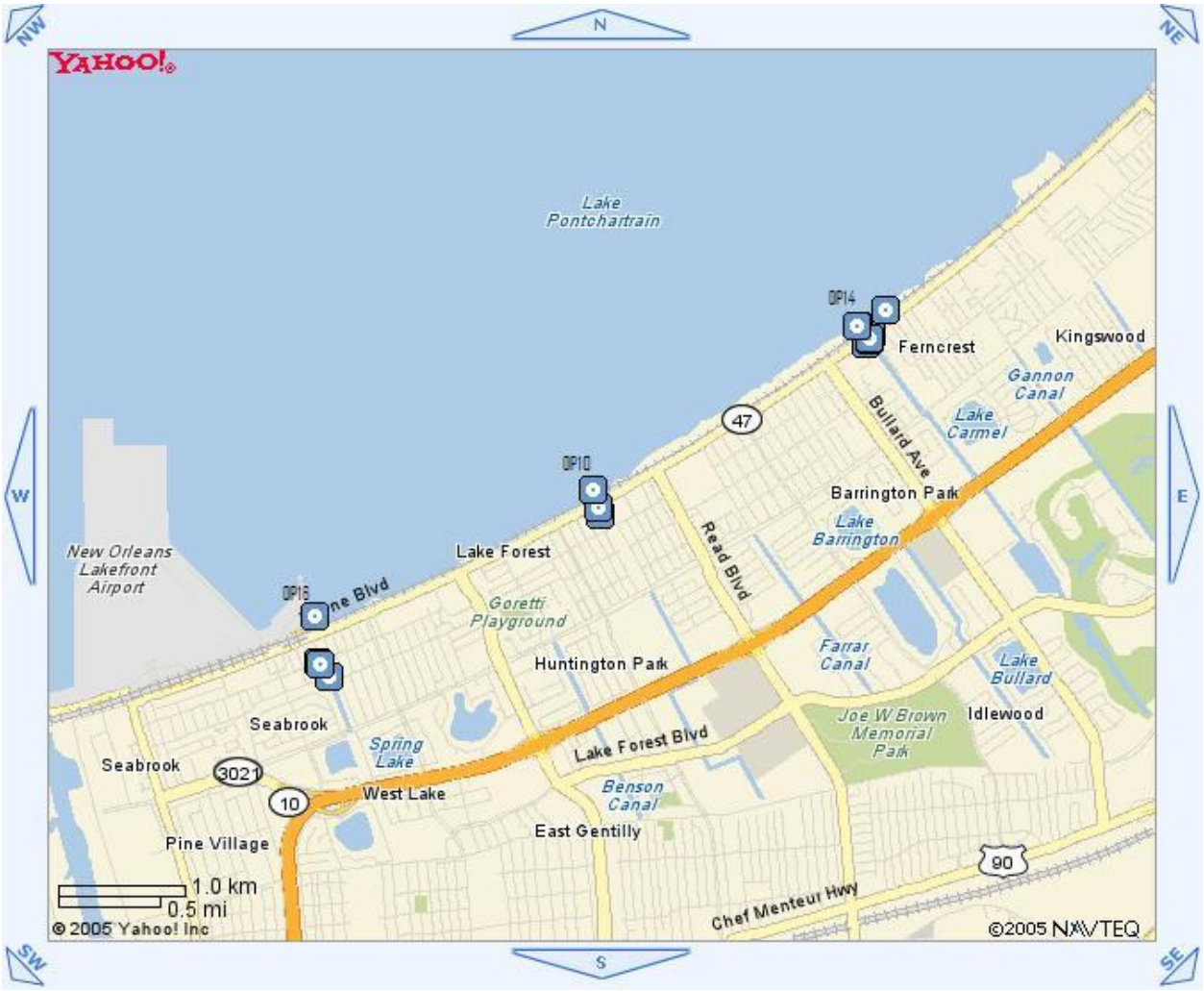

Figure 15. Pumps adjacent to Lake Pontchartrain.

Arsenic. For arsenic, 10 of 34 (29 percent) sample results were above the detection limit, but only one exceeded the LDEQ RECAP level of 0.01 mg/L. The detection limits for arsenic ranged from 0.005 mg/L to 0.04 mg/L. As shown in Figure 16, this sample was taken from the St. Charles (Pump 16) outfall on 14 September 2005 and had a level of 0.011 mg/L (red square with yellow center). Five of the ten samples were taken at Pump 16. Four of the ten samples were from Pump 14 and one from Pump 10.

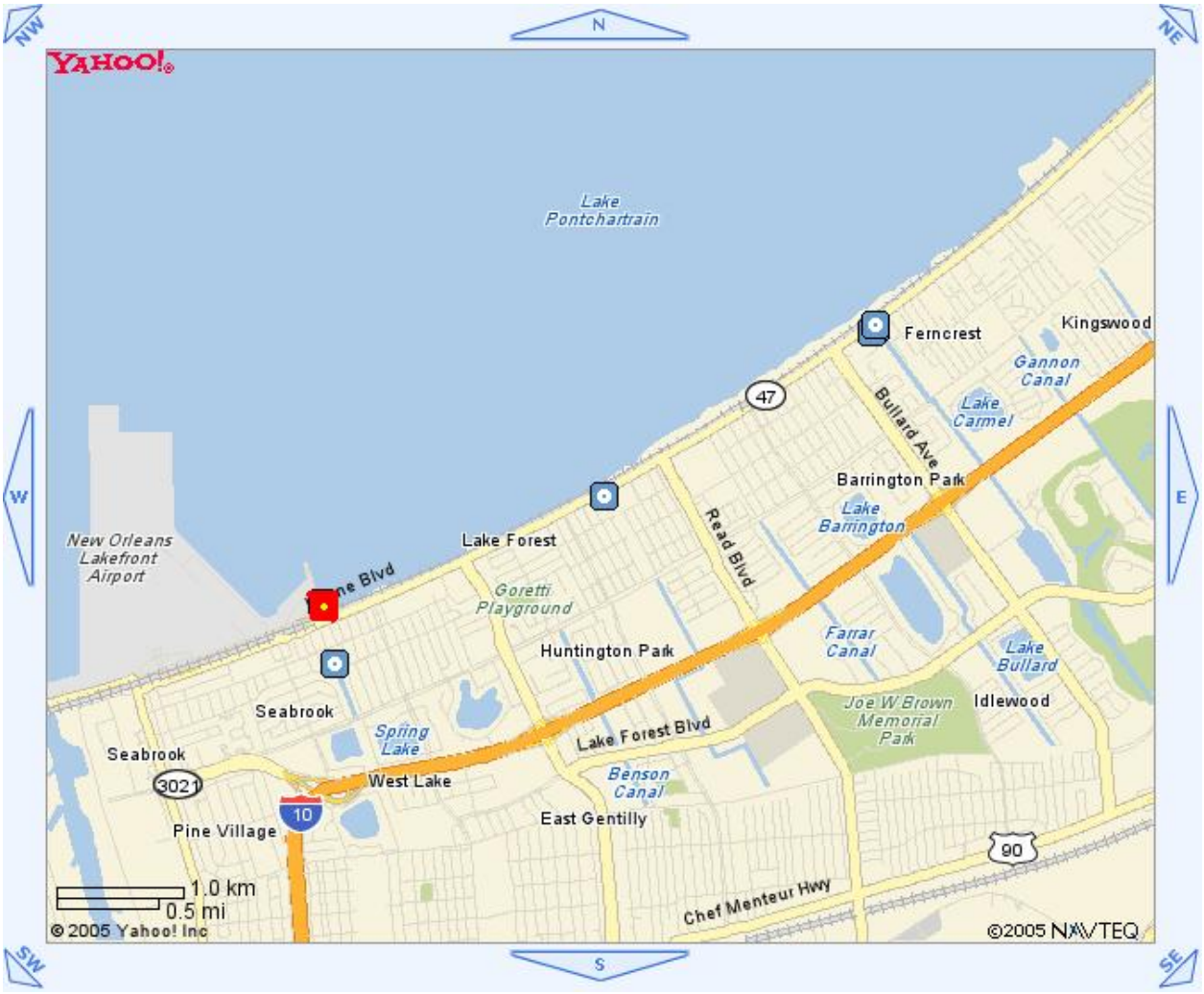

Figure 16. Arsenic in water flowing into Lake Pontchartrain.

Lead. Thirty samples were tested for lead at the pump station sites. Figure 17 shows the locations of the St. Charles outfall (Pump 16) had the highest lead level (0.007 mg/L) (see Table 7). This level does not exceed the LDEQ RECAP level, 0.015 mg/L for lead. The other result shown on the map is 0.0029 mg/L, located at the Pump 16 station.

The other two analytes of interest, BaP and DDE, were not found in any of the samples taken from these sites. Another pesticide, DDT, was found at a level of 0.022 mg/L at the Orleans Parish pump station (OP) 16 sampling site on 12 October 2005. The LDEQ RECAP level for DDT is 0.0003 mg/L. Two samples tested had results greater than the 0.15 mg/L LDEQ RECAP level for Diesel Range Organics (DRO). The higher of the two was found at OP 14 on 6 October 2005 and had a level of 0.18 mg/L. The other sample was taken at OP 16 on 12 October 2005 and had a level of 0.16 mg/L.

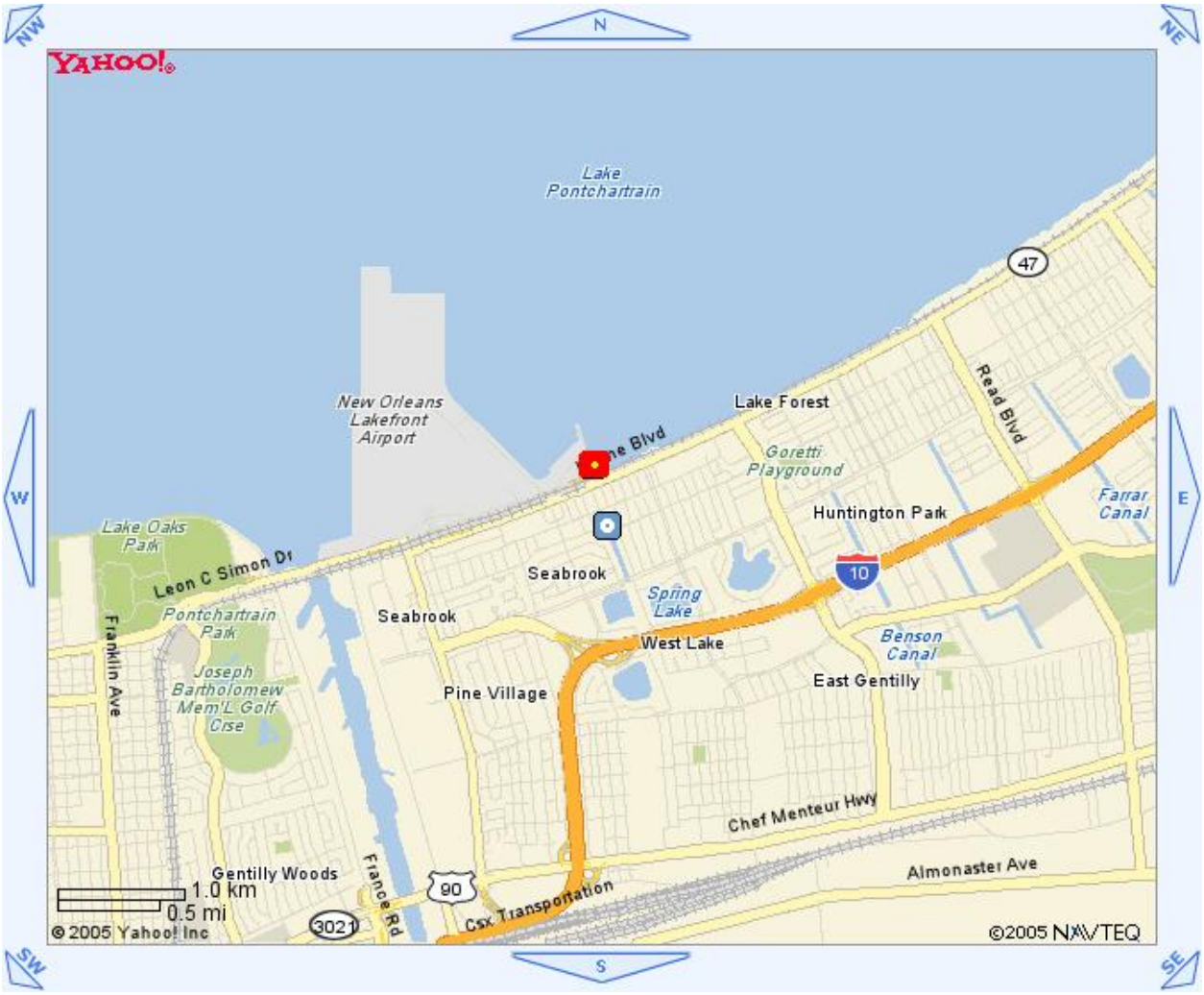

Figure 17. Lead in water flowing into Lake Pontchartrain.

Table 7. EPA STORET floodwater data into Lake Pontchartrain.

Compound	Samples	Average mg/L	Maximum mg/L	LDEQ RECAP mg/L	Greater Than LDEQ RECAP, %
Arsenic	34	0.002	0.011	0.01	3%
Lead	30	0.0003	0.007	0.015	0%
BaP	20	-	-	0.0002	0%
DDE	19	-	-	0.0002	0%

DISCUSSION AND CONCLUSIONS: An exhaustive evaluation of the available data on the concentrations of organic and inorganic contamination in sediment and water prior to, during, and following the dewatering of New Orleans after the effects of Hurricane Katrina and the subsequent flooding shows no large-scale increases in water or sediment levels as a result of the dewatering activity. Figure 18 gives a graphical representation of pre- and post-Katrina data for lead and BaP, showing no significant differences. The four contaminants examined in this technical note were selected based on their presence in the current data set and the fact that they represented important classes of contamination with regards to contaminant behavior: divalent, cationic heavy metals (Pb), anionic heavy metals (As), and hydrophobic organics with various degrees of solubility and sorptive behavior (BaP) and (DDE). From the city to Violet Marsh, none of these four representative contaminants exhibited extensive changes in concentration or mobility from soils or surface waters as a result of the dewatering effort. Comparisons between data available prior to the flooding events and data obtained both during and following the dewatering process do not show significant differences with regards to sediment and water concentrations. However, the volume of sediment within the city increased significantly and therefore, the total mass of both organic and inorganic contaminants within these sediments increased and could be potential vectors of contaminants. Concentrations of the four analytes of interest were detected in sediment and water that sometimes exceeded drinking water and other regulatory levels.

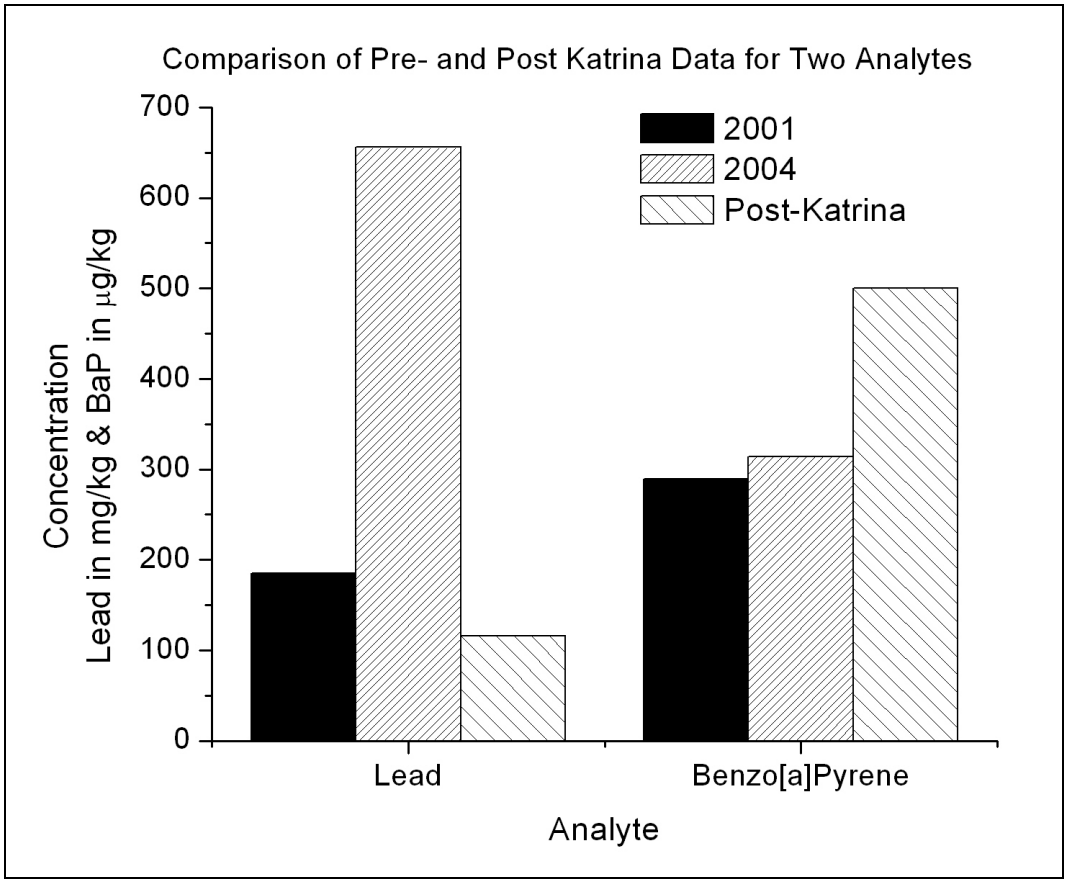

Figure 18. Comparison of pre- and post-Katrina data for lead and benzo[a]pyrene.

SUMMARY: The U.S. Army Engineer Research and Development Center's Environmental Laboratory (ERDC-EL) was tasked with compiling available chemical concentration data in floodwaters and sediments related to the flooding and dewatering events in New Orleans, LA. The investigation focused on available sources of this data, including peer-reviewed scientific journal articles, documents from private organizations, and Federal and State Government agency projects. By far, the largest single source of data was the U.S. Environmental Protection Agency's STORET database, which housed thousands of data points collected in the weeks and months following the flooding and dewatering of the city. In addition to this data, however, 'snapshots' of the floodwaters and sediments were obtained from two journal articles published by university researchers that document the floodwaters and deposited sediments immediately after the flooding event. Historical data for some analytes of interest were also found in the published literature and were used to establish analyte concentrations prior to the flooding event. Furthermore, ERDC-EL made two expeditionary sampling trips to New Orleans during December 2005 and March 2006 to secure additional, site-specific samples to provide data on discharge of potential contaminants into surrounding ecosystems, specifically, the Violet Marsh. This technical note discusses these data gathering and collection efforts. General observations on the available data prior to the flooding events and data obtained both during and following the dewatering process show only slight differences with regards to sediment and water concentrations. Whereas the volume of sediment within the city did increase as the result of the flooding and therefore caused the total mass of both organic and inorganic contaminants within these sediments to increase, this effect was primarily the result of levee failure due to the hurricane and not the dewatering activities. However, concentrations of the four analytes of interest were detected in sediment and water that sometimes exceeded drinking water and other regulatory levels.

ACKNOWLEDGEMENTS: The use of trade, product, or firm names in this report is for descriptive purposes only and does not imply endorsement by the U.S. Government. Yahoo! Maps NOTICE OF USE CONTRACTOR (MANUFACTURER/ SUPPLIER) NAME: NAVTEQ CONTRACTOR (MANUFACTURER/SUPPLIER) ADDRESS: 222 Merchandise Mart Plaza, Suite 900, Chicago, Illinois 60654. This data is a commercial item as defined in FAR 2.101 and is subject to the Yahoo! Maps Terms of Use. (*http://help.yahoo.com/l/us/yahoo/maps/using/maps-24.html*) under which this data was provided. © 2005 NAVTEQ - All rights reserved.

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> Bowley, T., S. Larson, and A. Bednar. 2006. *Water and sediment data for chemical indicators of contamination*. Environmental Laboratory Technical Notes Collection (ERDC/EL TN-06-5). Vicksburg, MS: U.S. Army Engineer Research and Development Center. *http://el.erdc.usace.army.mil/*

REFERENCES

EPA STORET Data Warehouse, *http://oaspub.epa.gov/stormodb/DW_resultcriteria_geo*

Louisiana Department of Environmental Quality RECAP Table, http://www.deq.louisiana.gov/portal/Portals/0/technology/recap/2003/RECAP%202003%20Text%20Table%201.pdf

Mielke, H. W., G. Wang, C. R. Gonzales, B. Le, V. N. Quach, and P. W. Mielke. 2001. PAHs and metals mixtures in New Orleans soils and sediments. *Sci of the Total Envir.* 281: 217-27.

Mielke, H. W., G. Wang, C. R. Gonzales, E. T. Powell, B. Le, and V. N. Quach. 2004. PAHs and metals in the soils of inner-city and suburban New Orleans, Louisiana, USA. *Envir. Tox., and Pharm*. 18: 243-7.

Pardue, J. H., W. M. Moe, D. McInnis, L. J. Thibodeaux, K. T. Valsaraj, E. MacIasz, I. Van Heerden, N. Korevec, and Q. Z. Yuan. 2005. Chemical and microbiological parameters in New Orleans floodwater following Hurricane Katrina. *Envir. Sci. and Tech*. 39: 8591-9.

Plumlee, G. S., G. P. Meeker, J. K. Lovelace, R. Rosenbauer, P. J. Lamothe, E. T. Furlong, and C. R. Demas. 2006. *USGS environmental characterization of flood sediments left in the New Orleans area after Hurricanes Katrina and Rita,2005—Progress Report*, U.S. Geological Survey Open-File Report 2006-1023.

Presley, S. M., T. R. Rainwater, G. P. Austin, S. G. Platt, J. C. Zak, G. P. Cobb, E. J. Marsland, K. Tian, B. Zhang, T. A. Anderson, S. B. Cox, M. T. Abel, B. D. Leftwich, J. R. Huddleston, R. M. Jeter, and R. J. Kendall. 2006. Assessment of pathogens and toxicants in New Orleans, LA, following Hurricane Katrina. *Envir. Sci. and Tech*. 40: 468-74.

Solomon, G. M., and M. Rotkin-Ellman. 2006. *Contaminants in New Orleans sediment, an analysis of EPA data: Natural Resources Defense Council*, *www.nrdc.org/health/effects/katrinadata/contents.asp*, 24 p.