Public Health Assessment
Initial Release for Public Comment

PLANTATION PIPE LINE COMPANY –
CENTER PUMPING STATION BLOCK VALVE RELEASE SITE
Hull, Madison County, Georgia

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GEORGIA DEPARTMENT OF
COMMUNITY HEALTH
Division of Public Health

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Agency for Toxic Substances and Disease Registry

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SUMMARY AND STATEMENT OF ISSUES

Introduction:

In 2009, the Georgia Department of Community Health, Division of Public Health (GDPH), received a request from a community action group for information regarding the potential for community health effects from exposure to environmental contamination following a petroleum pipeline spill near Hull, Georgia. GDPH's top priority is to ensure that all stakeholders have the best health information possible to protect the community from current and future health hazards associated with the petroleum pipeline spill in Hull, GA. To answer community concerns, GDPH reviewed on-site groundwater monitoring data, on-site soil sampling data, off-site private well sampling data, and surface water sampling data following the release. These data, to be detailed in this report, revealed that an appreciable amount of gasoline was spilled and that private drinking water wells are close enough to the spill site to potentially be affected. For these reasons, GDPH determined that there was sufficient cause to conduct a public health assessment.

The purpose of this public health assessment is to determine the nature and extent of exposure to hazardous chemicals in the environment, whether exposure might result in adverse health effects, and assess the concerns and health education needs of the public. The information in this public health assessment is specifically designed to provide information about public health issues related to exposure to chemicals in the environment, and to identify populations for which further health-related actions may be needed. It is not intended to address liability or other non-health issues.

Conclusions:

GDPH has reached six conclusions regarding the public health implications stemming from the under-the-surface pipeline release of a significant amount of gasoline from the Plantation Pipeline Company – Center Pumping Station that occurred in Hull, GA in February 2003.

Conclusion 1

Residents living near the site were not exposed to gasoline-contaminated soil from the block valve release site because the leak occurred underground.

Basis for Decision

Following the subsequent excavation of approximately 900 cubic yards of contaminated soil and treatment by bioremediation, which lasted approximately eight months, residents living near the site would not have been exposed because site security and fencing of the excavation and soil bioremediation areas during the initial cleanup response and monitoring activities would have prevented access to the site from trespassers. Worker related exposure to soil contamination was not evaluated in this public health assessment because the use of PPE by clean up contractors would make exposure to site-related contaminants unlikely.

Conclusion 2

An extensive off-site private well survey and monitoring program showed that all residential wells used for drinking water purposes within ½ mile of the Plantation site have never been impacted by site-related contaminants.

Basis for Decision

The well water samples from potable wells did not show presence of site-related contamination.

Conclusion 3

Exposure to benzene was/is not expected to harm the health of past, current, and future residents living near the Plantation Pipeline – Center Pumping Station.

Basis for Decision

Although benzene exposure to surface water in the on- and off-site stream may have occurred GDPH used a worse case scenario assuming someone received a maximum dose from the highest historical concentration of benzene detected in the stream to determine if adverse health effects were likely from this exposure scenario, as well as a more realistic approach to our exposure evaluation at this site using an exposure scenario where trespassing occurred infrequently and at random periods between 2003 and 2010. From this analysis, significant non-cancer adverse health effects are not likely to occur from exposure to on-site surface water under the exposure assumptions made in this evaluation.

Conclusion 4

Exposure to on-site contaminated groundwater has never occurred.

Basis for Decision

The vertical and horizontal extent of groundwater contamination is well-defined and determined to be localized to Plantation property. Moreover, remediation efforts have shown the contamination plume is shrinking with time.

Conclusion 5

Water treatment system discharge into the on-site stream is not expected to harms one's health if exposure to surface water should occur.

Basis for Decision

Except for one event that occurred in January 2004, water treatment system effluent discharge into the on-/off-site stream has continuously been in compliance with GEPD surface water discharge requirements since July 2003.

Conclusion 6

Discharge from the on-site Soil Vapor Extraction system is not expected to harm the health of residents living near Plantation Pipeline.

Basis for Decision

Plantation is located in a sparsely populated rural area. Although there is one day care center within one-half mile of the site, there are no schools, nursing homes, or any other sensitive population centers within a one-mile radius of the Plantation property. Discharge of VOCs from the SVE system is occurring at emission rates that are significantly lower than GEPD emission limits outside the Atlanta metro non-attainment area. However, being that Plantation is located in a sparsely populated rural area, with populated areas being ¼ mile or greater from the site, and that the SVE system emission discharge rate is significantly less than the GEPD limit, adverse health effects from this discharge are not expected.

BACKGROUND

Site Description

The Plantation Pipe Line Company (Plantation) is one of the largest liquid petroleum product pipelines in the United States. It began operating in 1942, and is currently majority owned by the Kinder Morgan Energy Partners Corporation. Plantation operates a 3,100 mile interstate pipeline network, which originates in Louisiana and serves various metropolitan areas throughout eight states and ends in the Washington, D.C. area. Plantation's pipeline connects to 130 shipper terminals and transports approximately 30 million gallons of gasoline, diesel fuel, jet fuel, kerosene and heating oils each day. The pipeline is buried underground, and line markers are used to show the approximate location. Markers are located at public roads, rail crossings, and many other points along the pipeline route. These line markers list the products transported, the name of the pipeline operator, and a telephone number where someone in authority can be reached at all times [1].

(Source: Kinder Morgan, www.kne.com/business/ products pipelines)

Thirty six pumping stations are located along the pipeline route. As the name implies, the stations pump the product (using electrical energy) along the pipeline. The Plantation Center Pumping Station is located approximately one mile north of Hull, and 10 miles northeast of Athens, Georgia.

Plantation does not permit unauthorized access to the property. The fenced facility has a gated driveway and all equipment and building are surrounded by a barbed wire fence with ample lighting along the site perimeter. Warning signs and pipeline notification signs are posted in numerous locations on the property. Redundant fencing includes the building behind a fence; nearby pipeline equipment is contained within its own fenced area, and all of the above ground pipes/exchanges are in another fenced section. On-site surface water drainage ways and the unnamed creek tributary are located behind the facility perimeter fencing. No public access occurs at the Plantation facility and trespassing is not likely to occur.

Regional topography is gently sloping with a well-defined dendritic drainage pattern [2]. The area surrounding the release location is rural with sparse residential dwellings within one mile of the site. Adjacent properties include a mobile home park to the east, small industry, forest and farm land to the west, and residential properties to the north and south. There is one day care center within one-half mile of the site. There are no schools, nursing homes, or any other sensitive population centers within a one-mile radius of the property.

Site History

A pipeline release was reported on February 22, 2003 when a local resident called 911 to report gasoline odors near the Center Pumping Station site. Plantation confirmed that a release from the pipeline had occurred. The pipeline was shut down and Plantation's pipeline maintenance contractor was mobilized to the site to begin excavating in search of the leak. The release occurred when a block valve flange gasket located on the 26-inch pipeline malfunctioned. The gasoline released from the pipeline, located 3-5 feet below ground surface, migrated to/and entered an unnamed tributary of East Sandy Creek. Approximately 33,000 gallons was released from the pipeline (Figure 1).

The subsequent environmental clean up response to the release occurred between February 22 and March 8, 2003 where Plantation instituted several measures to remedy and minimize potential environmental harm from the release, including:

- Repair of the flange gasket
- Containment of released gasoline
- Excavation and repair of the pipeline
- Installation of interceptor trenches with a total fluids recovery system

In November 2008, a settlement was reached with the U.S. Environmental Protection Agency (EPA). Plantation agreed to pay a $725,000 civil penalty[1] for discharges in three states, including the spill in Madison County. The company also agreed to implement $1.3 million in new spill prevention safeguards, with upgrades to pipelines and excavating buried valves to improve regular inspection capabilities [3].

Demographics

Using 2000 U.S. Census data, the Agency for Toxic Substances and Disease Registry[2] (ATSDR) calculated population information for individuals living within a 1-mile radius of the Plantation facility. The population within one mile of Plantation is approximately 700 people (Figure 2).

Site Hydrogeology

Surface Water

Surface drainage from the block valve area generally flows to the south towards the stream bordering the site. The stream flows south and then west approximately 0.4 mile to a small lake on an unnamed tributary of East Sandy Creek. The tributary joins East Sandy Creek approximately 0.3 mile downstream from the lake. From the confluence with the unnamed tributary, East Sandy Creek flows southwest approximately 5.4 miles until it converges with Sandy Creek, which flows 3.1 miles to the North Oconee River near Athens [4].

Groundwater

The water table typically occurs between 10 and 25 feet below ground surface (bgs) onsite. Groundwater depth generally increases with distance from the steam. The water table is shallowest at the stream, particularly during the winter when groundwater provides base flow for

[1] $715,000 penalty to the federal government's Oil Spill Liability Trust Fund and $10,000 to the North Carolina Department of Environment and Natural Resources.

[2] The Agency for Toxic Substances and Disease Registry, based in Atlanta, Georgia, is a federal public health agency of the U.S. Department of Health and Human Services.

the stream. There is zero flow in parts of the stream during the summer months. The head of the stream is approximately 500 feet downgradient of the block valve involved in the gasket failure [5].

Water-table gradients are toward the west in the northern portion of the site and west-southwest in the southern portion of the site. Site topography appears to have limited influence on the groundwater flow direction, which is generally in the direction of East Sandy Creek [5].

The horizontal hydraulic conductivity of the saprolite (shallow groundwater) was estimated using the groundwater flow rate data from the three collection trenches between February 9 and April 20, 2003. The estimated hydraulic conductivity of 0.3 feet per day is within the range of literature values for Piedmont saprolite [5]. The vertical hydraulic permeability is 1.6×10^{-7} centimeters per second. This is approximately 1000 times lower than the estimated horizontal hydraulic conductivity [5].

Site Remediation

Initial Response and Remedial Actions

When the gasoline leak from a block-valve gasket was discovered in February 2003, the flange was repaired and initial abatement activities included: containment of released gasoline, excavation and repair of the pipeline, soil sampling, groundwater sampling, surface water monitoring, water supply well sampling, and the installation of interceptor trenches with a fluid recovery system [2]. Initially, two interceptor trenches (S-1 and S-2) were installed at the head of the Site stream. The trenches were excavated to about 3 to 4 feet below the static groundwater table. Initially, water pumped from the excavations and trenches were placed into a 21,000-gallon tank that was mobilized to the site. The water from the tank was hauled to Plantation's Bremen, Georgia facility and discharged to the facility treatment system. Beginning in March 2003, total fluids were removed from the trenches with a vacuum truck from March to June 2003 and were transported to the Bremen facility for treatment. A fluids recovery and treatment system was installed by contactors hired by Plantation. This system utilized eductor pumps in the interceptor trenches to recover total fluids. Captured fluids flowed through piping into a 200-gallon above grade tank, then drained into an on-site oil-water separator. Water effluent from the oil-water separator was pumped into a 200 gallon per minute air stripper for treatment. Consent Order EPD-WQ-4169, executed in July 2003 by Plantation and the Georgia Environmental Division (GEPD), allowed for discharge of treated groundwater into the Site stream. Discharge limitations required that the treated groundwater contain less than 71 micrograms per liter (ug/L) benzene and less than 200,000 ug/L toluene [6]. Monitoring requirements consisted of analyzing treated groundwater for benzene, toluene, and xylenes on a bimonthly basis. Pursuant to a GEPD letter dated January 20, 2004, and beginning the first quarter of 2004, the frequency of effluent sampling and analysis was reduced from monthly to quarterly [7].

One additional interceptor trench (S-3) was installed in November 2003, and three more interceptor trenches (S-4, S-5, and S-6) were installed in July 2004 (Figure 3).

Soil

Approximately 900 cubic yards of soil from the pipeline excavation were stockpiled onsite for treatment by ex-situ bioremediation. The soil was placed into windrows and covered with 6-mil plastic sheeting. Biodegradation was promoted by applying hydrocarbon degrading microorganisms, a nutrient mixture, and periodically turning the windrows to facilitate aeration.

Six months after the start of ex-situ bioremediation, the total petroleum hydrocarbons-gasoline range organics (TPH-GRO) concentrations were reduced to 16.2 mg/kg, which is below GEPD cleanup criterion of 100 milligrams TPH-GRO per kilogram (mg/kg) of soil. Subsequent sampling events in October and November 2003 indicated even lower concentrations. The highest TPH-GRO concentration in November was 2.7 mg/kg. Following treatment, the soil was spread onsite, seeded, and fertilized [2, 4].

Door-to-Door Private Well Survey

On May 8, 2003, a door-to-door survey of private wells within an approximately 1500 foot radius from the release location was performed by Plantation and their cleanup contractors. Thirty-four potential private wells were identified within the 1,500 foot radius of the release site [2]. The nearest municipal water supply well is approximately six miles from the release location and has not been impacted.

Five private water wells (WW-1 through WW-5) near the release site were selected for benzene, toluene, ethylbenzene, and xylenes (BTEX) and methyl-tert-butyl-ether (MTBE) monitoring (Figure 4). WW-2 through WW-5 are located within ¼ mile of the block valve. Since March 2003, total BTEX and MTBE have not been detected in any of these five private wells [2, 8, 9, 10].

Water Well	Location	Comment
WW- 1	Near the stream, approximately 2,200 feet west of the block valve	Hand-bored in 1977 to a depth of 40 feet below ground surface.
WW-2	Approximately 1,200 feet south of the block valve.	Private water well
WW-3	Approximately 600 feet southwest of the block valve.	Supplies non-potable water to the Center pumping station
WW-4	Approximately 700 feet northeast of the block valve.	Supplies water to the Neese Mobile Home Park
WW-5	Approximately 700 feet east of the block valve.	Supplies water to the Neese Mobile Home Park.

Corrective Action

In August 2004, Plantation submitted a Corrective Action Plan (CAP) to GEPD that included the following goals of corrective action at this Site: (1) remove light non-aqueous phase liquid (LNAPL) to the extent practical or until there is less than 0.01 foot of LNAPL in existing wells, and; (2) reduce the concentrations of dissolved phase volatile organic compounds (VOCs) to maximum contaminant levels (MCLs) in groundwater monitoring wells [5].

The remedial approach recommended in the CAP was continued operation of the total fluids recovery system, and construction and operation of Air Sparging (AS) and Soil Vapor Extraction (SVE) systems. Construction of the remediation system began in April 2005. Completion of the

remediation system and the operational start-up began on January 19, 2006. The AS and SVE systems have been in operation since the start-up period.

The purpose of the AS system is to treat dissolved phase hydrocarbons by injecting air through sparge well screens located approximately 20 feet bgs. The injected air physically removes hydrocarbons by air stripping and increases dissolved oxygen concentrations in groundwater to promote biological degradation of hydrocarbons. Air sparging is performed in timed cycles to pulse air into the saturated zone.

The purpose of the SVE system is to capture vapors generated by the air sparging process, capture and removed sorbed phase hydrocarbons, and to promote air flow through the unsaturated zone to enhance biodegradation. Vapors from the equipment manifold pass through a knock-out tank (to remove droplets of entrained liquid) prior to entering the SVE blower. The SVE blower provides motive force for the SVE system. Vapors exiting the SVE blower are directed to a thermal oxidizer for thermal destruction of hydrocarbons. Vapors treated by this process are discharged to the atmosphere. In August/September 2007, the GEPD Air Protection Branch reviewed the results of the oxidizer operation following Plantation's request to directly discharge soil vapor to the atmosphere without thermal oxidation. GEPD approved the removal of the thermal oxidation system and allowed direct discharge of soil vapor into the atmosphere in October 2007.

The purpose of the total fluids recovery and treatment system is to capture and remove LNAPL (floating product) from the groundwater surface, capture and remove groundwater with dissolved phase hydrocarbon constituents, and to increase the unsaturated thickness around extraction trenches (through drawdown), which allows for increased air flow to SVE wells. Fluids captured by the system are treated through an oil-water separator followed by air stripping. Permitted discharge of the treated water is piped through a flow meter to the nearby stream. LNAPL floating on the water surface in the oil-water separator is skimmed at a weir and gravity drained to a LNAPL recovery tank. When sufficient quantities accumulate, fluids in the LNAPL storage tank are transported offsite for treatment. Operation of the total fluids recovery system through October 2005 recovered an estimated 11,000 gallons of fuel.

LNAPL has been at thicknesses of up to 6.38 feet near what is now MW-11 in August 2003. This thickness had decreased to 0.33 feet by July 2004. Thickness has steadily decreased and has not been encountered in MW-11 since the April 2007 monitoring event.

Effectiveness of remediation system operations has been evaluated by monitoring groundwater conditions in 21 shallow and four deep monitoring wells, surface water conditions at six locations along the Site stream, and by collecting groundwater samples from 24 private wells located within one mile of the Site. Locations of the monitoring wells and the surface water sampling locations are shown in Figures 3 and 5. Nearby private wells are shown in Figure 4.

DISCUSSION

Environmental Sampling Data

Soil

In February 2003, three test pits were excavated and sampled using a tracked excavator to approximate the horizontal and vertical impact of the gasoline release. Soil samples were collected from each test pit approximately 1 to 2 feet bgs and just above the water table (between 5 to 7 feet bgs). The samples were analyzed for BTEX and MTBE using EPA Method 8021B, and TPH-GRO using EPA Method 8015B[3].

Total BTEX concentrations ranged from 0.009 mg/kg to 621 mg/kg. MTBE concentrations ranged from 0.0035 mg/kg to 126 mg/kg. TPH-GRO concentrations ranged from <10 mg/kg to 3,500 mg/kg [2].

In addition, samples were collected from each of 10 soil borings from the ground surface to the water table and field-screened using a flame ionization detector (FID). Samples were analyzed for BTEX and MTBE using EPA Method 8060B, TPH-GRO and TPH-diesel-range organics (TPH-DRO) using EPA Method 8015C.

The highest BTEX, MTBE, and TPH-GRO concentrations were detected at three sampling locations closest to the release point. The highest total BTEX concentration in this area was detected at 7-8 feet bgs at a concentration of 3,500 mg/kg. Elevated BTEX concentrations of 625 mg/kg and 131 mg/kg were detected 200 feet southwest of the release point and 600 feet southwest of the release site; respectively [2].

Surface Water

Surface water sampling locations were established at six points along the small, spring-fed stream that begins on Plantation property to monitor the impact of the release on surface water quality (Table 1 and Figure 4). The surface water sampling locations have been sampled routinely since February 2003 and analyzed for BTEX and MTBE using EPA Method 8260B.

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[3] Total petroleum hydrocarbon (TPH) is a term used for several hundred chemical compounds that originally come from crude oil. Scientists divide TPH into groups that act alike in soil or water. These groups are called petroleum hydrocarbon fractions. Each fraction contains many individual chemicals. Because there are so many different chemicals in crude oil and in other petroleum products, it is not practical to measure each one separately. However, it is useful to measure the total amount of TPHs at a site.

Some chemicals that may be found in TPH are benzene, toluene, ethylbenzene, and xylenes, as well as other petroleum products and gasoline components. Commonly, one fraction of TPHs is measured by the total amounts of benzene, toluene, ethylbenzene, and xylenes (BTEX), or total BTEX. These are the most soluble of the major gasoline compounds and, therefore, are common indicators of gasoline contamination.

In addition, methyl tertiary butyl ether (MTBE) is a gasoline additive used to oxygenate and to raise the octane number, although its use has declined in response to environmental and health concerns. It has been found to easily pollute large quantities of groundwater when gasoline with MTBE is spilled. MTBE is often measured after spills because it dissolves easily in water, and spreads more easily underground than other gasoline components.

Table 1: Surface Water Sampling Locations Downstream of Gasoline Release

Station ID	Approximate Distance Downstream of Release	Comment
SW-3	600 feet	Located near head of stream
SW-2	925 feet	None
SW-1	1,250 feet	30 feet upstream of Highway 106
SW-4	1,430 feet	Downstream of Highway 106; just upstream of fish pond
SW-5	2,000 feet	Downstream of fish pond
SW-6	3,000 feet	Approximately 975 feet upstream of small lake

Surface water samples were initially collected from SW-1, SW-2, and SW-3 in February and March 2003. In March 2003, BTEX was not detected in SW-2, SW-5, and SW-6. The highest BTEX concentration (124 ug/L) was recorded at SW-3, which is closest to the release site. None of the BTEX constituents exceeded the Georgia instream water quality standards. MTBE ranged from 3.1 ug/L in SW-6 to 3,920 ug/L in SW-3 [2]. Seven more samples were collected from March through June 2003 at SW-1 and SW-3. Three additional samples were collected from SW-2 in March and April 2003. Samples from SW-4, SW-5 and SW-6 were initially collected in March 2003 and sampled once again in April 2003. Samples were collected again from SW-1 through SW-6 in October 2003, and then sampled weekly from November 2003 through August 2004. Beginning in September 2004, samples were collected monthly from SW-1 through SW-6 until November 2005. Quarterly monitoring of SW-1 through SW-6 began in February 2006 through November 2007, when semi-annual monitoring of the surface water sampling locations was implemented [8]. Surface water samples were analyzed for BTEX and MTBE using EPA Method 8260B.

The highest BTEX concentrations have consistently been detected at SW-2, which is approximately 450 feet from the head of the stream and 900 feet downgradient of the release location (Table 2). Total BTEX concentrations have routinely been below the detection limit of 1.0 microgram per liter (ug/L) at SW-5 and SW-6, with the exception of three sampling events (06/13/05, 08/17/05, and 02/08/06) where benzene was detected slightly above the detection limit (1.2, 1.2, and 1.6 ug/L; respectively). MTBE has been detected occasionally at SW-5 and SW-6 at concentrations that have ranged from below the detection limit to19 ug/L on January 8, 2004 at SW-5 [8, 9, 10].

Table 2: Surface water sampling results from February 2003 through April 2010 showing both the highest concentration found and the average concentration over this period.

Sample Location	Benzene ug/L		Toluene ug/L		Ethylbenzene ug/L		Xylenes ug/L		MTBE ug/L	
	High	Mean	High	Mean	High	Mean	High	Mean	High	Mean
SW-1	29	4.2	150	7.0	14	0.75	188	15.4	411	58
No. Samples	74		74		74		74		74	
SW-2	1,800	115	7,200	518	610	52	6,100	617	2,400	258
No. Samples	72		72		72		72		72	
SW-3	160	11.4	1,500	49	110	6.6	1,320	76	3,920	360
No. Samples	74		74		74		74		74	
SW-4	8.1	1.8	16	1.2	2.3	0.355	40	3.1	120	17
No. Samples	60		60		60		60		60	
SW-5	1.6	0.15	ND	ND	ND	ND	ND	ND	19	2.2
No. Samples	26		26		26		26		26	
SW-6	ND	ND	ND	ND	ND	ND	ND	ND	10	1.1
No. Samples	26		26		26		26		26	

ug/L: microgram per liter or part per billion (ppb)
ND: not detected
Note: SW-2 and SW-3 are highlighted to illustrate the two sampling locations that have always had the highest concentrations detected.

Monitoring events show long term trends of decreasing concentrations in BTEX and MTBE from 2003 to 2010. The last monitoring event in April 2010 showed no BTEX detected in any of the surface water sampling locations, while MTBE was detected in one (SW-3) of the six surface water sampling locations at a concentration of 5.1 ug/L. Figure 4 shows the surface water sampling locations.

On-site Groundwater

Initial groundwater samples were collected from test pits dug with a post-hole digger during the initial cleanup response in February and March 2003. BTEX and MTBE were analyzed using EPA Method 8260B. Total BTEX ranged from 24 ug/L to 76,140 ug/L. MTBE ranged from 670 ug/L to 338,000 ug/L. Temporary monitoring wells (TMWs) were installed in the summer of 2003 to determine the relative extent of groundwater contamination. Groundwater samples were collected in August and December 2003. Total BTEX found ranged from non-detect to 61,200 ug/L, while MTBE levels ranged from non-detect to 270,000 ug/L. The highest BTEX and MTBE concentrations were found 85 feet upgradient of the block valve that may have been the result of accumulation (pooling) of LNAPL in the subsurface around the block valve. Where LNAPL was observed in the TMWs, samples were not taken [2, 4].

In May 2004, groundwater samples were collected from all 36 TMWs and two deep wells and analyzed for BTEX and MTBE. Again, the TMWs with measurable LNAPL were not sampled. Because the total BTEX concentrations at eight TMWs were notably different than the results from the August/December 2003 sampling event, the TMWs were re-sampled in July 2004. Total BTEX found ranged from non-detect to 68,000 ug/L, while MTBE levels ranged from non-detect to 930,000 ug/L [4, 8]. The May/July 2004 sampling events showed two migration pathways. The first migration pathway extends from the block valve to the southwest towards the stream generally following surface topography. The second migration pathway extends from the block valve west towards Highway 106 generally following the overall groundwater flow

direction at the site. BTEX was not found east and south of the stream. This suggests that the stream and collection trenches serve as a hydraulic barrier to the plume migration.

Two deep wells were installed in December 2003 and January 2004 to vertically delineate the dissolved-phase BTEX plume and to provide monitoring points between the release and downgradient water wells. Groundwater samples were collected in January and May 2004 and analyzed fro BTEX and MTBE using EPA Method 8260B, and for TPH-GRO and TPH-DRO using EPA Method 8015C. No analytes were detected in the samples collected from the deep wells.

Plantation submitted a groundwater monitoring plan that was approved by GEPD in April 2005. The monitoring program calls for quarterly monitoring events during the first three years of remediation system operation (2005, 2006, and 2007), followed by semi-annual monitoring events until site closure. The highest concentration and average (mean) concentration of each constituent sampled since groundwater monitoring began in August 30, 2005 through April 2010 (the majority of the monitoring wells have been sampled 13 times to date) is summarized in Table 3. Monitoring well locations are shown in Figure 3.

Table 3: Groundwater sampling results from August 2005 through April 2010 showing both the highest concentration found and the average concentration over this period at each monitoring well.

Monitoring Well	Benzene ug/L		Toluene ug/L		Ethylbenzene ug/L		Xylenes ug/L		MTBE ug/L	
	High	Mean	High	Mean	High	Mean	High	Mean	High	Mean
MW-1	ND	ND	ND	ND	ND	ND	ND	ND	3.5	0.27
MW-2	ND	ND	ND	ND	ND	ND	ND	ND	62	10.8
MW-3	8.7	0.88	4.5	0.77	4.6	0.56	22.1	7.55	260	39.5
MW-5	200	22.15	430	33.2	16	1.23	259	32.8	2800	740.8
MW-6	4900	2059.5	8200	3298	210	71	3300	1228	68000	12656
MW-7	11000	3514.5	11000	3490	1100	406.2	11900	4808.2	93000	21180
MW-8	2800	797	11000	2161	740	177	7700	2059	42000	14470
MW-9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-10	ND	ND	ND	ND	ND	ND	ND	ND	63	17.35
MW-11	LNAPL	LNAPL	LNAPL	LNAPL	LNAPL	LNAPL	LNAPL	LNAPL	LNAPL	LNAPL
MW-12	22000	3188	37000	6207	3200	461	16700	2869.55	1400000	119375
MW-13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-14	120	15.4	490	59.5	48	4.8	195	22.3	ND	ND
MW-15	16000	4462	35000	10421	3000	885	14900	4832	230000	51329
MW-16	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-17	35	8.3	160	36	6.9	2.6	149	41.7	2.1	0.27
MW-18	100	21.9	1.6	0.23	9.3	1.67	114	25.6	1900	1107
MW-19	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-20	ND	ND	1.1	0.18	ND	ND	ND	ND	ND	ND
MW-21	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TMW-21	ND	ND	1.4	0.17	ND	ND	ND	ND	320	53.3
TMW-19	ND	ND	1.6	0.12	ND	ND	ND	ND	230	24.6
MW-1D	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW-2D	ND	ND	2.6	0.2	ND	ND	ND	ND	ND	ND
MW-3D	51	11.32	ND	ND	ND	ND	29	5.8	600	186.2
MW-4D	ND	ND	1.2	0.44	ND	ND	ND	ND	ND	ND
MW-5D	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

ug/L: microgram per liter or part per billion (ppb)

ND: not detected
LNAPL: light non-aqueous phase liquid (i.e. floating product)
Note: highlighted monitoring wells illustrate the highest on-site concentrations of contaminants historically detected.

The vertical and horizontal extent of groundwater contamination is well-defined and is localized on Plantation property. Long-term monitoring of on-site groundwater shows trends of reduced dissolved phase benzene concentrations in the defined contaminant plume (Figure 5) as well near the Site stream (SW-2, SW-3, and MW-8) . The last monitoring event in April 2010 showed no BTEX detected in any of the surface water sampling locations, while MTBE was detected in one 89(SW-3) of the six surface water sampling locations at a concentration of 5.1 ug/L.

Off-site Private Well Water

Water supply well locations were identified during a receptor survey performed by Plantation contractors in 2003. Development within 1 mile of the Site is checked during each monitoring event to determine if there are additional or previously un-identified water supply wells in the area or if previously identified wells are no longer in use. To date, twenty-four private water supply wells have been located within ½ mile of the Site. However, one private well located on a property with an abandoned house (>¼ mile from the site) has never been sampled because the pump does not work and the well is not in use.

Beginning in September 2005, all private wells within ¼ mile of the Site (13 in total) were sampled quarterly until April 2008, when semi-annual sampling began. All private wells located between ¼ mile and ½ mile from the Site are sampled annually. This monitoring frequency will continue until Site closure. Samples are analyzed for BTEX (with a detection limit of 2.0 ug/L) and MTBE (with a detection limit of 5.0 ug/L) using EPA Method 8260B.

BTEX and MTBE have never been detected in any of the 13 private wells located within ¼ mile of the Site with the exception of two private wells on one monitoring event each, of 13 monitoring events in total. On April 23, 2008, a shallow, bored well located on Sanders Road was sampled and BTEX was found at a concentration of 22.2 ug/L. Individual BTEX constituent concentrations were: 11 ug/L toluene, 1.8 ug/L ethylbenzene, and 9.4 ug/L xylenes. This well was re-sampled on May 14, 2008 and BTEX was not detected. The second private well where BTEX was detected at a concentration of 7.7 ug/L is located on Willis Glenn Road. This is also a shallow, bored well where 3.8 ug/L toluene and 3.9 ug/L xylenes were detected during the April 23, 2008 monitoring event. This well also was re-sampled on May 14, 2008 and BTEX was not detected. It appears that these samples represent an anomaly of either the sampling or analytical process [9].

BTEX and MTBE have never been detected in any of the 11 private wells located between ¼ mile and ½ mile of the Site with the exception of one private well on one monitoring event, of 9 monitoring events in total. On April 19, 2007, another private well that supplies two houses located on Willis Glenn Road was sampled and BTEX was found at a concentration of 3.0 ug/L. Individual BTEX constituent concentration was: 3.0 ug/L toluene. This well was re-sampled on May 15, 2007 and BTEX was not detected. This well was re-sampled on a quarterly basis two more times until the toluene source was resolved. A new pressure tank was installed at this well on April 4, 2007 and this installation is suspected of being the source of the toluene contamination found at this well on April 19, 2007. It is important to note that Site-related groundwater contamination has never affected off-site private wells.

Water Treatment System Effluent

As of August 2010, operation of the water treatment system continued to be in compliance with discharge permit requirements. Quarterly influent and effluent monitoring events results are provided to GEPD in Discharge Monitoring Reports. Since July 2003, effluent has been monitored for benzene, toluene, and xylenes. Benzene discharge exceeded the discharge permit requirement of 71 ug/L one time since effluent monitoring began in July 2003. This exceedance occurred on January 8, 2004. Sampling results showed that benzene was discharged to the Site stream at a concentration of 100 ug/L, while toluene was discharged at a concentration of 470 ug/L (which is below discharge criteria). There was no detectable benzene in an effluent sample collected two weeks later on (January 21, 2004), or in subsequent effluent samples. The January 8, 2004 sample most likely represents an anomaly of either the sampling process, treatment system process, or analytical process [9, 10]. Other than this one sampling anomaly, benzene has never been detected in any of the effluent samples collected. Analytical detection limits are 1.0 ug/L for benzene and toluene, and 2.0 ug/L for xylenes. Toluene has not been detected in effluent sampling in 95% of the monitoring events, while xylenes have not been detected in 89% of the monitoring events. Toluene discharge requirements of 200,000 ug/L have never been exceeded [8].

VOCs Recovered by the SVE System

On May 6, 2008 and December 16, 2008, vapor sampling was performed on the SVE blower exhaust using EPA Method 25A, air samples were analyzed for total VOCs (TVOCs). The results of the vapor tests indicated that the SVE discharge resulted in a range of approximately 74 to 77 pounds TVOCs per day or 14 tons TVOCs per year from the discharge stack. This emission rate is significantly less than the GEPD limit of 550 pounds TVOCs per day or 100 tons TVOCs per year outside of the Atlanta metro non-attainment area. Air emissions monitoring conducted April 9, 2009 and October 12, 2009 indicated that the SVE discharge emissions included approximately 43 pounds TVOCs per day or 8 tons TVOCs per year from the discharge stack during the April monitoring event and 18 pounds TVOCs per day or 3.3 tons TVOCs per year during the October monitoring events [9, 10].

Evaluation Process

For each environmental medium, GDPH examines the types and concentrations of contaminants of concern (COC), which are then screened with comparison values established by the ATSDR and EPA. Comparison Values (CVs) are concentrations of a contaminant that can reasonably (and conservatively) be regarded as harmless to human health, assuming default conditions of exposure. The CVs include ample safety factors to ensure protection of sensitive populations. Because CVs do not represent thresholds of toxicity, exposure to contaminant concentrations above CVs will not necessarily lead to adverse health effects [11]. GDPH then considers how people may come into contact with the contaminants. Because the level of exposure depends on the route and frequency of exposure and the concentration of the contaminants, this exposure information is essential to determine if a public health hazard exists. CVs and the evaluation process used in this document are described in more detail in Appendix A.

Pathways Analysis

The next step is to determine if people are coming into contact with these COCs. GDPH identifies pathways of human exposure by identifying environmental and human components that might lead to contact with contaminants in environmental media (e.g., air, soil, and groundwater). A pathways analysis considers five principle elements: a source of contamination, transport through an environmental medium, a point of exposure, a route of human exposure, and a receptor population. Completed exposure pathways are those in which all five elements are present, and indicate that exposure to a contaminant has occurred in the past, is presently occurring, or will occur in the future. GDPH regards people who come into contact with contamination as exposed. For example, people who reside in an area with contaminants in air, or who drink water known to be contaminated, or who work or play in contaminated soil are considered to be exposed to contamination. Potential exposure pathways are those for which exposure seems possible, but one or more of the elements is not clearly defined. Potential pathways indicate that exposure to a contaminant could have occurred in the past, could be occurring now, or could occur in the future. However, key information regarding a potential pathway may not be available. It should be noted that the identification of an exposure pathway does not imply that health effects will occur. Exposures may, or may not be substantive. Thus, even if exposure has occurred, human health effects may not necessarily result [11].

GDPH visited the Site in February 2010 to examine site conditions, the integrity of the fencing surrounding the property, and the depth of the stream located on the property. The on-site, spring-fed stream is more of a brook bordered on both sides with a dense growth of trees and underbrush and the brook had four to 12 inches of water depth at the time of our site visit. The brook flows underneath the two-lane state Highway 106 onto private property located across the street from Plantation and feeds the private fishing pond (Figures 1 and 4). Unauthorized access onto plantation property from the location of the brook would be difficult because the busy highway has no shoulder on either side, and a gully runs on both sides of the highway where property fencing is located on each side of the highway. In addition, we spoke with the owner of the private property where the fishing pond is located. He stated that the brook is usually dry in the summer and that since 2003; he has run off three trespassers from his property. He also stated that he and his family are the only ones that fish the pond occasionally and that swimming never occurs.

GDPH also reviewed the site's history and available environmental sampling data. Based on this review, GDPH identified three potential exposure pathways that warrant further evaluation: dermal absorption of BTEX constituents through surface water, incidental ingestion of site-related surface water contaminants, ingestion of site-related contaminants that may be present in fish from the private fishing pond located west of Highway 106, and the inhalation of contaminated air emanating from the SVE system emission stack. Worker related exposure to soil contamination was not evaluated in this public health assessment for two reasons: (1) U.S. Occupational Safety and Health Administration (OSHA) regulations stated in 29 Code of Federal Regulations Part 1910 Section 120 (29CFR1910.120) and Subpart I (29CFR1910Subpart I) stipulate the use of personal protective equipment (PPE) for workers involved with hazardous waste and emergency response operations; and, (2) the initial request for the public health assessment was to determine the potential for community health effects related to exposure from the pipeline release. The use of PPE by clean up contractors would make exposure to site-related contaminants unlikely. Moreover, besides the rural location of the release site that is surrounded

by private property, site security and fencing of the excavation and soil bioremediation areas during the initial cleanup response and monitoring activities would have prevented access to the site from trespassers. The potential pathway from exposure to contaminated soil has been eliminated. Table 4 illustrates the elements of the completed exposure pathways this public health assessment will address.

Table 4: Completed Exposure Pathways

Pathway	Exposure Pathway Elements					Time
	Source	Transport	Point of Exposure	Route of Exposure	Exposed Population	
Surface water	Movement of contaminants from on-site contamination	Groundwater and Surface Water	On and Offsite Stream	Dermal Absorption, Incidental ingestion	Trespassers, guests of landowner	Past
Biota	Movement of contaminants from on-site contamination	Groundwater and Surface Water	Fishing Pond	Ingestion	Pond owner's family and guests	Past
Air	Soil Vapor Extraction system emissions	Air	Ambient Air	Inhalation	Residents, Workers in the area	Past, Current, and Future

Toxicological Evaluation

Evaluating the public health implications of exposure to an environmental medium is a multi-step process. When a contaminant exceeds a CV, the toxicological evaluation requires a comparison of calculated site-specific exposure doses (e.g., amount of the contaminant believed to enter the body at the person's body weight for an estimated duration of time) with an appropriate health guideline for each exposure pathway identified in the exposure assessment. The health guidelines are health-protective values that have incorporated various safety factors to account for varying human susceptibility and the use of animal data to evaluate human exposure. Health guidelines used include ATSDR's Minimal Risk Levels (MRLs) and the EPA's Reference Dose (RfDs). MRLs and RfDs are described in more detail in Appendix A. Usually little or no information is available for a site to know exactly how much exposure is actually occurring, so health assessors assume worse case scenarios where someone received a maximum dose. Actual exposure is likely much less than the assumed exposure. In the event that the calculated, site-specific exposure dose for a chemical is greater than the established health guideline, this exposure dose is evaluated further by comparing to exposure doses from individual studies documented in the scientific literature that have reported health effects. If a COC has been determined to be cancer causing (carcinogenic), a cancer risk is also estimated.

Surface Water

The highest concentrations of BTEX and MTBE found in the on/off-site stream were found between November 11 and December 10, 2003. Table 5 shows the highest concentrations of each constituent found and the respective CV for each constituent. Because health-based

comparison values for dermal absorption of contaminants to surface water do not exist, we can utilize established ATSDR CVs for drinking water. Please note, however, that the derivation of drinking water CVs is based on the assumption that adults drink 2 liters of water per day and weigh 70 kilograms, and that children drink one liter of water per day and weigh 10 kilograms.

Table 5: The highest concentration of site-related contaminants in surface water found in November/December 2003.

Contaminant	Highest Concentration ug/L	Health-Based CV ug/L	Type of CV
Benzene	1,800	20 5 0.5	Chronic $EMEG_{adult}$ Chronic $EMEG_{child}$ CREG
Toluene	7,200	40,000 29,630	$AcuteEMEG_{adult}$ $AcuteEMEG_{child}$
Ethylbenzene	610	700	LTHA, MCL
Xylenes	6,100	50,000 37,037	Acute $EMEG_{adult}$ Acute $EMEG_{child}$
MTBE	3,920	20,000 14,815	$AcuteEMEG_{adult}$ $AcuteEMEG_{child}$

ug/L: microgram per liter (same as part per billion)
EMEG: chronic Environmental Media Evaluation Guide for adults and children (exposures lasting longer than 1 year)
AcuteEMEG: acute Environmental Media Evaluation Guide for adults and children (exposures lasting less than 15 days) derived from the Acute MRL available for toluene, xylenes, and MTBE. The Acute EMEG is calculated by multiplying the Acute MRL by the bodyweight of an adult (70 kg) or a 10 year old male child (32 kg) and dividing by the average daily water intake of an adult (1.4 liters) or a 6-17 year old child (0.864 liters)
CREG: Cancer Risk Evaluation Guide. CREGs are media-specific comparison values that are used to identify concentrations of cancer-causing substances that are unlikely to result in an increase of cancer rates in an exposed population
LTHA: Lifetime Health Advisory
MCL: Maximum Contaminant Level
ATSDR Drinking Water Comparison Values (February 2011)
Note: Highlighted values represent concentrations that are higher than the CVs for this particular constituent, which will be evaluated further.

Based on surface water samples collected from the site stream in 2003, calculated benzene exposure doses were evaluated to determine the likelihood of health effects. Adult and child exposure doses were calculated based on the maximum detected benzene concentration in the site stream (at SW-2). However, because sampling events prior to October 2003 showed no contaminants detected at SW-2, and sampling events after November 2003 (when maximum concentrations were detected) showed gradual declines over the next several months where contaminants were not detected in June 2003 sampling events, exposure doses were also calculated on the mean (average) benzene concentration spanning the entire monitoring period (from 2003 to 2010). For potential adult and children trespassers, a conservative exposure duration of 15 minutes on three separate occasions was incorporated into the calculations (see Appendix A). Dermal absorption is the route of most concern with surface water contaminants. Ingestion of surface water is possible, but the likelihood of drinking stream water in volumes large enough to be of concern is not very great. However, the incidental ingestion of 25 milliliters of surface water was incorporated in the exposure dose calculations. The permeability of the skin to a chemical is influenced by the physicochemical properties of the substance, including its molecular weight (size and shape), electrostatic charge, hydrophobicity, and solubility in aqueous and lipid media. In general, chemicals that demonstrate high skin permeability are low on molecular weight, non-ionized, and lipid soluble. The BTEX and

MTBE components of gasoline meet these criteria. Estimated doses relative to health guidelines are presented in Table 6.

Table 6: Estimated doses obtained by dermal absorption and incidental ingestion from surface water compared to health guidelines.

Contaminant	Estimated Dose Using Mean Concentration mg/kg/day	Highest Estimated Dose mg/kg/day	Health Guideline mg/kg/day	Numeric Cancer Risk**
Benzene (Dermal Absorption)	Adult: 0.0000003	Adult: 0.000004	MRL: 0.0005	High: 2.5×10^{-8}
	Child: 0.0000004	Child: 0.000006		Mean: 1.9×10^{-9}
Benzene (Incidental Ingestion)*	Adult: 0.0000003	Adult: 0.000005	MRL: 0.0005	High: 3.1×10^{-8}
	Child: 0.0000007	Child: 0.00001		Mean: 1.9×10^{-9}
Benzene (Total Dose: dermal + ingestion)	Adult: 0.0000006	Adult: 0.000009	MRL: 0.0005	High: 5.6×10^{-8}
	Child: 0.000001	Child: 0.00002		Mean: 3.8×10^{-9}

mg/kg/day: milligrams per kilogram per day
MRL: minimal risk level from chronic exposure greater than one year (ATSDR Health Guidelines, February 2011)
* This exposure dose calculation assumes an incidental ingestion of 25 ml of water per exposure event.
** Based on EPA's cancer slope factor [Benzene: 0.055 $(mg/kg/day)^{-1}$] for adults only. This is a lifetime cancer risk associated with benzene exposure at the highest concentration found over an 8 year (8÷70) period (High), and from benzene exposure to the average concentration found over a seven year period (Mean).

For dermal exposure to occur, a contaminant must be permeable and absorbed by the skin, which is composed of two layers, the stratum corneum (dead skin cell barrier) and the viable epidermis. Although permeability coefficients (distance traveled by a chemical through skin in one hour) have been measured in the laboratory, different interlaboratory experimental conditions (e.g. skin sample characteristics, temperature, flow-through or static diffusion cells, and concentration of chemical in solution) influence the value of the resulting permeability coefficient. Predicted permeability coefficients of approximately 90 compounds, benzene included, have also been derived [13]. The U. S. Environmental Protection Agency (EPA) has identified both the measured and predicted permeability coefficients as one of the major contributors to uncertainty in the assessment of dermal exposures to contaminants in aqueous media. However, since the variability between the predicted and measured permeability coefficients is no greater than the variability in interlaboratory replicated measurements, EPA recommends the use of the predicted permeability coefficient for all organic chemicals [13]. The predicted permeability coefficient for benzene was used to calculate dermal exposure doses in this public health assessment.

The calculated exposure doses presented in Table 6 incorporate a percentage (10%) of default total skin surface area of adult males and females recommended by ATSDR [11]. The total skin surface area of adult males and females were averaged for the purpose of calculating an exposure dose. For children, the average male and female total skin surface area for 9 to 12 year olds was used for exposure dose calculations. The child exposure dose calculation assumes that a 10 year male weighing 32 kilograms was exposed to contaminated surface water [12]. The total exposure dose calculations include the combined dermal absorption and incidental ingestion of benzene found in the surface water. The parameters used in the calculation of dermal exposure doses can be found in Appendix A.

Non-cancer Health Effects

Benzene

Many factors determine individual responses to chemical exposures. These factors include the duration of dose, and individual factors such as age, gender, diet, family traits, lifestyle, and state of health. For these reasons, this evaluation cannot determine the actual health risk to any one particular individual. For this evaluation, the exposure doses for dermal absorption and incidental ingestion were combined to produce a total estimated dose from infrequent events of trespassing onto Plantation property and crossing the brook on foot. Our evaluation of exposure doses determined that an exposure scenario using the maximum detected benzene concentration found in the on-site brook would be approximately 55 times lower than the MRL for an adult and 2.5 times lower than the MRL for a 10 year old boy. This exposure scenario is unlikely because of the short period (less than 6 months) that higher benzene concentrations were found in the brook coupled with the unlikelihood of trespassing strictly occurring during this particular period since 2003. A more realistic approach to our exposure evaluation at this site uses an exposure scenario where trespassing occurred infrequently and at random periods between 2003 and 2010. In this scenario, using the average concentration of benzene found over this period, the estimated adult exposure does is approximately 833 times lower than the MRL and for a 10 year old boy, the estimated exposure dose is approximately 500 times lower than the MRL. From this analysis, significant non-cancer adverse health effects are not likely to occur from exposure to on-site surface water under the exposure assumptions made in this evaluation.

Cancer Risk

Long-term exposure to high levels of benzene in the air can cause leukemia, particularly acute myelogenous leukemia, often referred to as AML. This is a cancer of the blood forming organs. The Department of Health and Human Services (DHHS) has determined that benzene is a known carcinogen. The International Agency for Research on Cancer (IARC) and the EPA have determined that benzene is carcinogenic to humans [18]. The estimated theoretical risk for cancer from exposure to the contaminants usually is calculated by multiplying the exposure dose by EPA's corresponding cancer slope factor 0.055 $(mg/kg/day)^{-1}$ for benzene. For more information, see Appendix A.

Assuming that trespassing onto Plantation property did occur three times during the period where benzene concentrations were at the maximum concentration detected (1800 ug/L); the predicted theoretical risk for cancer from exposure to benzene for an adult would be (approximately 6 cancer cases per 100,000,000 people exposed, or 5.6×10^{-8}. Under the same conditions, if an adult trespasser was exposed to benzene in the stream around sample location SW-2 for 15 minutes, three times over the entire monitoring period of seven years, the predicted theoretical risk for cancer for this person would again be (approximately 4 cancer cases per 1,000,000,000 people exposed, or 3.8×10^{-9}). This theoretical risk to increased cancer from exposure to benzene is surface water under the assumed exposure scenario is well below an acceptable cancer risk of one in a million (1×10^{-6}).

Biota

A private fishing pond is located approximately 3000 feet southwest of the block valve release location, and the stream where site-related contaminants have been detected feeds into that private fishing pond. One surface water monitoring location (SW-4) at the stream's inlet into the pond has been sampled numerous times since March 2003. BTEX and MTBE samples analyzed from the inlet sampling location have never exceeded and adult CV. Benzene has exceeded a child CV (between 5.1 to 8.1 ug/L) eight times during weekly sampling events between January 8 to April 1, 2004. None of the other BTEX constituents or MTBE have ever exceeded a CV at this sampling location. Samples collected from and analyzed near the pond outlet (SW-5) have shown benzene detected three times at concentrations ranging between 1.2 and 1.6 ug/L. Other BTEX constituents have never been found at this sampling location. MTBE has been detected at SW-5 above the detection limit six times at concentrations ranging from 5 to 19 ug/L.

The pond itself has never been sampled but given that dilution of the concentration if BTEX constituents and MTBE that may be found in the stream is occurring, and given that benzene concentrations sampled at SW-5 have been detected only three times since monitoring began in 2003, any BTEX constituents that may be in the pond would likely not exceed a CV. Therefore, GDPH did not further evaluate consumption of biota from this pond. Also, this is a private fishing pond used by the owner of this property and it is unlikely that fishing would occur at this pond from anyone except invited guests of the property owner unless trespassing is occurring. The owner of the pond verified that trespassers have been chased off three times since 2003. The pond owner also stated that no one besides his family fishes this pond, which occurs occasionally in a given year. Therefore, GDPH concludes that exposure to site-related contaminants from consuming fish that may be caught in this pond is not likely to lead to adverse health effects.

Air

Discharge from the Soil Vapor Extraction system is measured in pounds per day of total VOCs (TVOCs) discharged into the atmosphere. The analysis of individual BTEX constituents and MTBE is not made. We know that in 2008, approximately 14 tons per year of TVOCs were discharged into the atmosphere and in 2009, approximately 8 tons per year of TVOCs was discharged into the atmosphere through the SVE discharge stack. We also know that this emission rate is significantly less than the GEPD limit of 100 tons TVOCs per year outside of the Atlanta metro non-attainment area. However, without knowing the concentrations of individual VOCs being emitted, we cannot determine whether populations downwind of the discharge stack might be affected by the discharge. Being that Plantation is located in a sparsely populated rural area, with the nearest resident being 1000 to 1500 feet from the SVE system, and that the emission rate is significantly less than the GEPD limit, adverse health effects from this discharge are not expected.

Health Outcome Data

Health outcome data, such as morbidity and mortality data, disease information from community members, and health statistics from community health studies can provide information on various aspects of the health of people living on or near a contaminated site. It may reveal whether people living or working near a site are experiencing adverse health effects at a rate higher than would be expected to occur.

GDPH did not evaluate health outcome data because a quantified exposed population at sufficient exposure levels did not exist at this Site as a result of the fuel leak and subsequent remediation that occurred at this site in 2003. Moreover, GDPH has never received any health concerns or complaints from residents living near the Plantation site.

CHILD HEALTH CONSIDERATIONS

To protect the health of the nation's children, ATSDR has implemented an initiative to protect children from exposure to hazardous substances. In communities faced with contamination of the water, soil, air, or food, ATSDR and GDPH recognize that the unique vulnerabilities of infants and children demand special emphasis. Due to their immature and developing organs, infants and children are usually more susceptible to toxic substances than are adults. Children are more likely to be exposed because they play outdoors and they often bring food into contaminated areas. They are also more likely to encounter dust, soil, and contaminated vapors close to the ground. Children are generally smaller than adults, which results in higher doses of chemical exposure because of their lower body weights relative to adults. In addition, the developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages.

Based on the 2000 U.S. Census, less than 50 children (age 6 and younger) live within one mile of the Plantation site. Because of the distance of the homes from the Site, and because the area where the Plantation site is located is largely composed of rural, private property, it is unlikely that children will have in the past or present come into contact with surface water containing site-related contaminants at levels that would lead to adverse health effects.

CONCLUSIONS

The purpose of this public health assessment is to determine the nature and extent of exposure to hazardous chemicals in the environment and whether exposure might result in adverse health effects. Based on the results of extensive environmental sampling data, GDPH has categorized the Plantation Pipeline Company – Center Pumping Station Block Valve Release Site is not expected to harm the health of residents living near the site, and nearby private industry employees. A description of public health hazard categories is provided in Appendix B. Specifically:

1. Residents living near the site were not exposed to gasoline-contaminated soil from the block valve release site because the leak occurred underground. Following the subsequent excavation of approximately 900 cubic yards of contaminated soil and treatment by bioremediation, which lasted approximately eight months, residents living near the site would not have been exposed because site security and fencing of the excavation and soil bioremediation areas during the initial cleanup response and monitoring activities would have prevented access to the site from trespassers. Worker related exposure to soil contamination was not evaluated in this public health assessment because the use of PPE by clean up contractors would make exposure to site-related contaminants unlikely.
2. An extensive off-site private well survey and monitoring program showed that all residential wells used for drinking water purposes within ½ mile of the Plantation site have never been impacted by site-related contaminants.

3. Although benzene exposure to surface water in the on- and off-site stream may have occurred GDPH used a worse case scenario assuming someone received a maximum dose from the highest historical concentration of benzene detected in the stream to determine if adverse health effects were likely from this exposure scenario, as well as a more realistic approach to our exposure evaluation at this site using an exposure scenario where trespassing occurred infrequently and at random periods between 2003 and 2010. From this analysis, significant non-cancer adverse health effects are not likely to occur from exposure to on-site surface water under the exposure assumptions made in this evaluation.
4. The vertical and horizontal extent of groundwater contamination is well-defined and determined to be localized to Plantation property. Moreover, remediation efforts have shown the contamination plume is shrinking with time. Exposure to on-site contaminated groundwater has never occurred.
5. Except for one event that occurred in January 2004, water treatment system effluent discharge into the on-/off-site stream has continuously been in compliance with GEPD surface water discharge requirements since July 2003.
6. Plantation is located in a sparsely populated rural area where nearby properties include a mobile home park to the east (approximately ¼ mile from the Site), small industry, forest and farm land to the west, and residential properties to the north and south (approximately ¼ to ½ mile from the Site). Although there is one day care center within one-half mile of the site, there are no schools, nursing homes, or any other sensitive population centers within a one-mile radius of the Plantation property. Discharge of VOCs from the SVE system is occurring at emission rates that are significantly lower than GEPD emission limits outside the Atlanta metro non-attainment area. However, without knowing the concentrations of individual VOCs being emitted, we cannot determine whether populations downwind of the discharge stack might be affected by the discharge. However, being that Plantation is located in a sparsely populated rural area, with populated areas being ¼ mile or greater from the site, and that the SVE system emission discharge rate is significantly less than the GEPD limit, adverse health effects from this discharge are not expected.

RECOMMENDATIONS

There are no recommendations at this time.

PUBLIC HEALTH ACTION PLAN

Actions Completed

- An extensive private well survey has been conducted on all residential wells within ½ mile of the site
- All private wells have been monitored in an on-going basis since the block-valve gasket leak was discovered in 2003 to ensure that nearby residents have not been exposed to site-related groundwater contamination
- Under GEPD oversight, the plantation site has undergone extensive remediation to mitigate the effects of the gasoline release that occurred in 2003

Actions Planned

- All private wells within ¼ mile of the Plantation site will continue to be monitored on a semi-annual basis until the site has been remediated to requirements set by GEPD
- All private wells within ½ mile of the Plantation site will continue to be monitored on an annual basis until the site has been remediated to requirements set by GEPD
- On-site remediation will continue under GEPD oversight until Site closure
- As additional data become available, GDPH will review the information and take appropriate actions.
- GDPH will respond to all requests for information regarding health issues raised regarding the Plantation site.

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FIGURE 1: AERIAL IMAGE OF THE CENTER PUMPING STATION SITE

FIGURE 2: SITE LOCATION AND DEMOGRAPHIC MAP

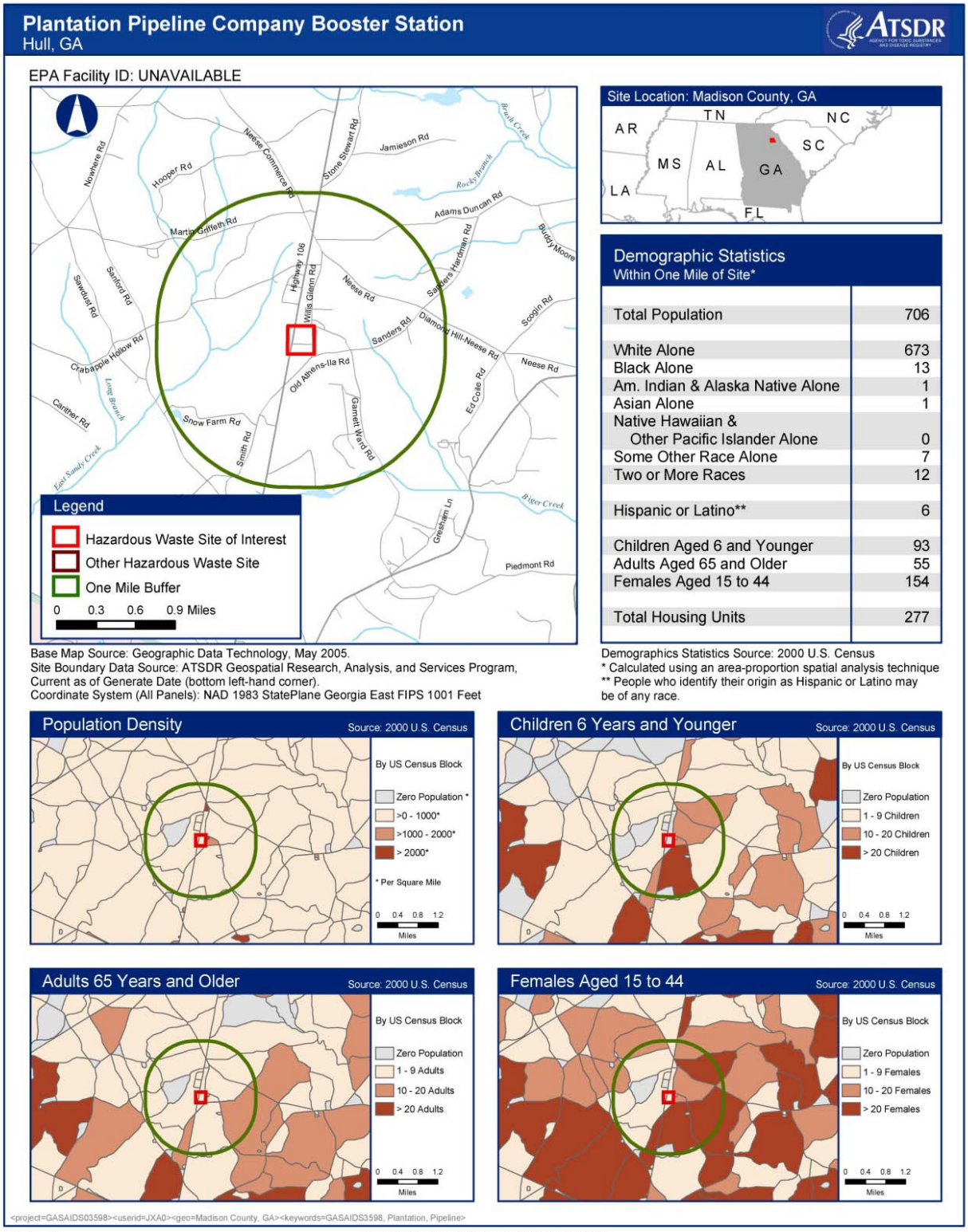


FIGURE 3: SITE BASE MAP

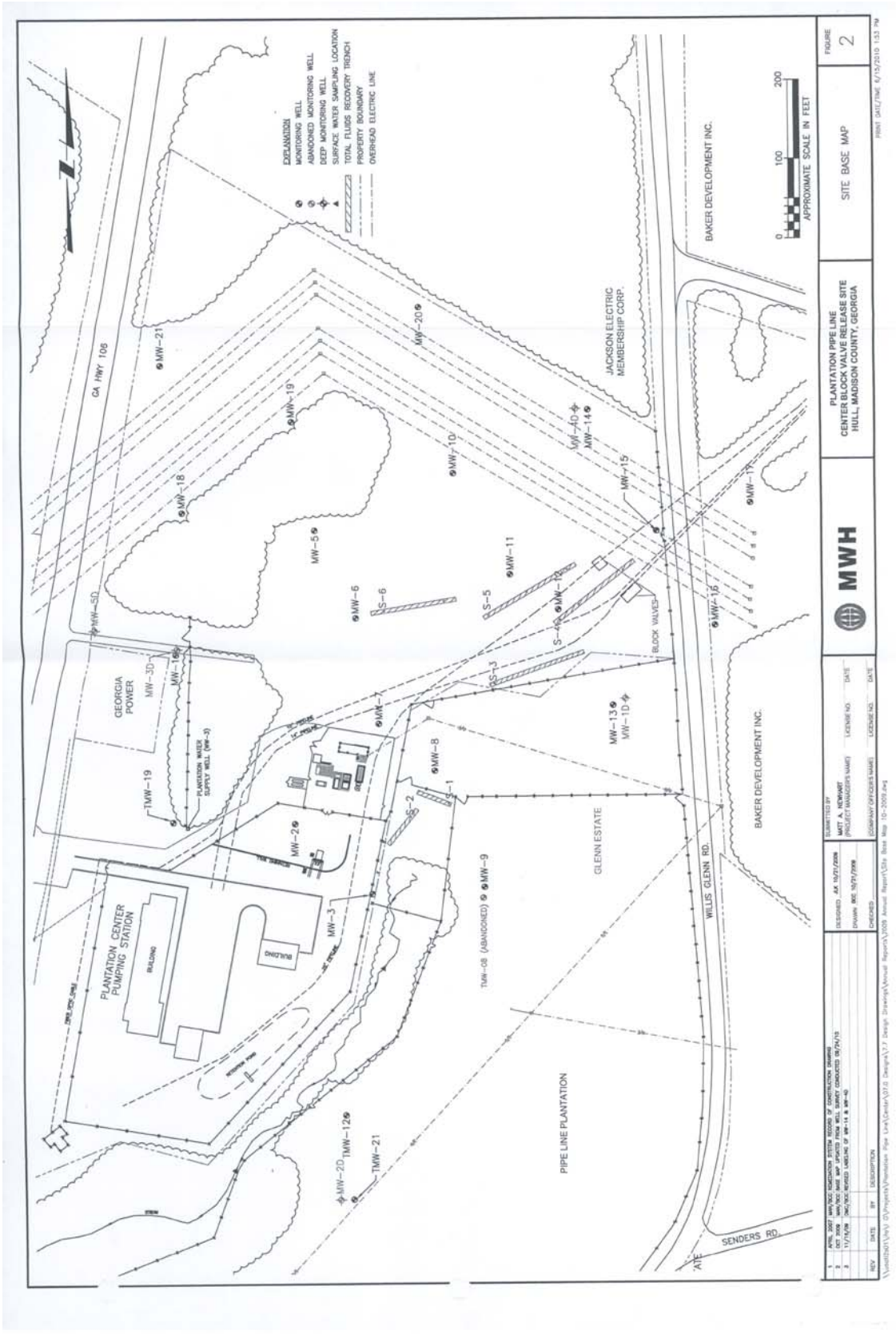


FIGURE 4: PRIVATE WELL AND SURFACE WATER SAMPLING LOCATIONS

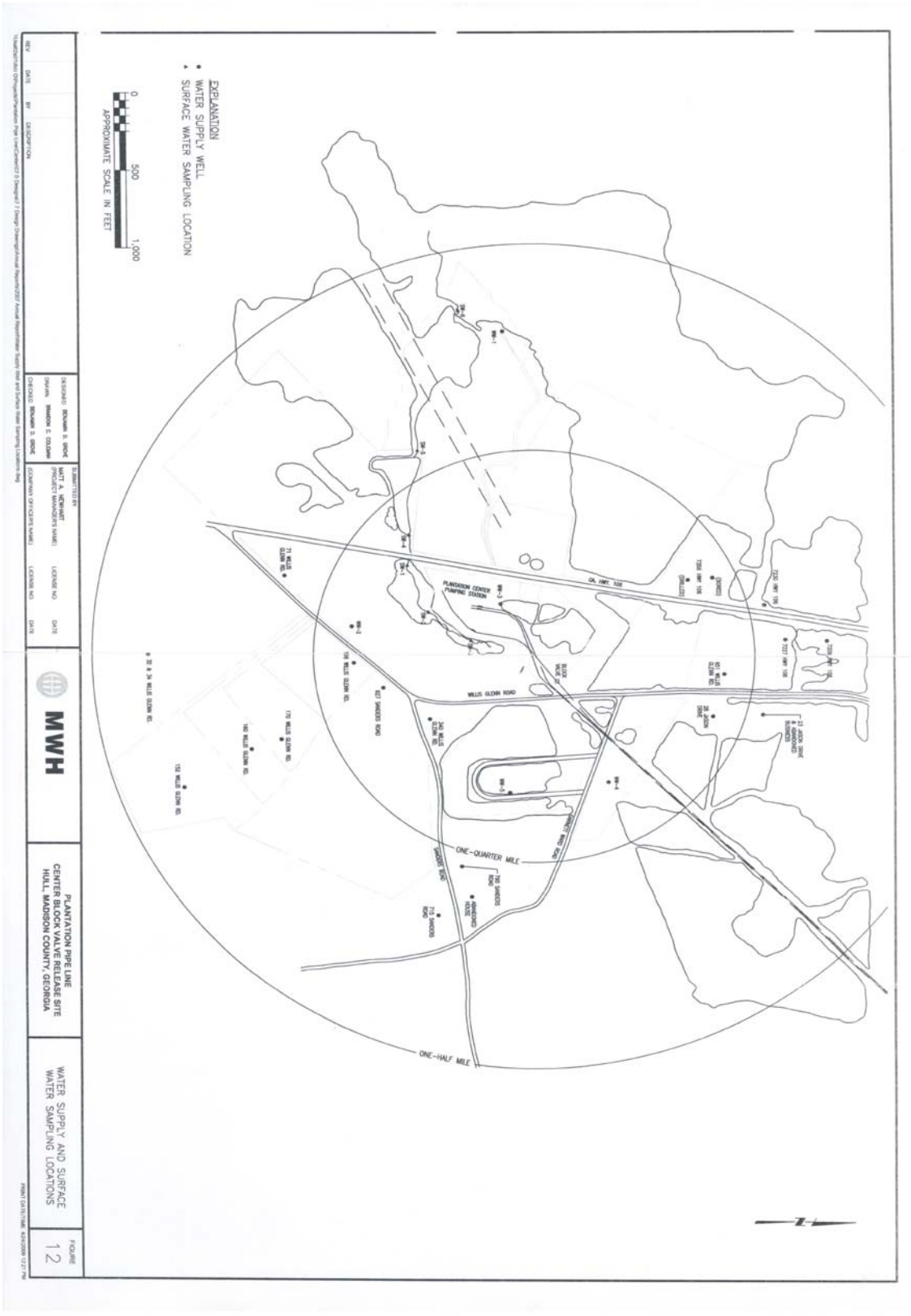
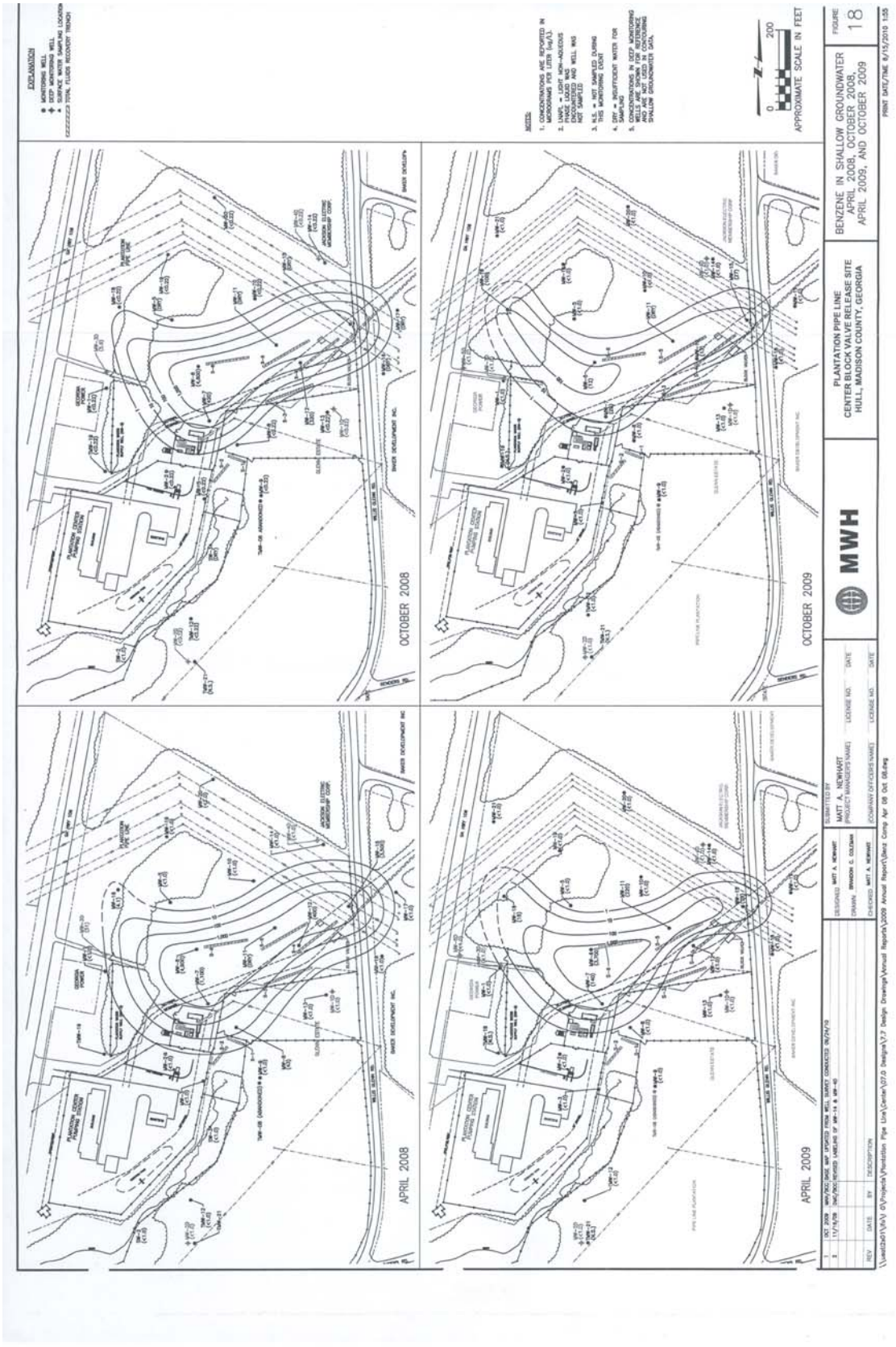


FIGURE 5: BENZENE IN SHALLOW GROUNDWATER



APPENDICES

Appendix A: Explanation of Evaluation Process

Step 1--The Screening Process

In order to evaluate the available data, GDPH used comparison values (CVs) to determine which chemicals to examine more closely. CVs are contaminant concentrations found in a specific environmental media (for example; air, soil, water) and are used to select contaminants for further evaluation. CVs incorporate assumptions of daily exposure to the chemical and a standard amount of air, soil, or water that someone may inhale or ingest each day. CVs are generated to be conservative and non-site specific. The CV is used as a screening level during the public health assessment process where substances found in amounts greater than their CVs might be selected for further evaluation. CVs are not intended to be environmental clean-up levels or to indicate that health effects occur at concentrations that exceed these values.

CVs can be based on either carcinogenic (cancer-causing) or non-carcinogenic effects. Cancer-based CVs are calculated from the U.S. Environmental Protection Agency's (EPA) oral cancer slope factors for ingestion exposure, or inhalation risk units for inhalation exposure. Non-cancer CVs are calculated from the Agency for Toxic Substances and Disease Registry's (ATSDR) minimal risk levels, EPA's reference doses, or EPA's reference concentrations for ingestion and inhalation exposure. When a cancer and non-cancer CV exist for the same chemical, the lower of these values is used as a conservative measure. The chemical and media-specific CVs used in the preparation of this public health assessment are listed below:

Step 2--Evaluation of Public Health Implications

The next step in the evaluation process is to take those contaminants that are above their respective CVs and further identify which chemicals and exposure situations are likely to be a health hazard. Separate child and adult exposure doses (or the amount of a contaminant that gets into a person's body) are calculated for site-specific scenarios, using assumptions regarding an individual's likelihood of accessing the site and contacting contamination.

Direct Skin (Dermal) Contact with Contaminants Present in Surface Water

Exposure doses from dermal absorption of contaminants present in surface water were calculated using the maximum concentration and average concentrations of benzene from the surface water sample data, in milligrams/kilogram (mg/L), and the default permeability coefficient value for benzene [13]. The exposure dose calculations used in this evaluation are presented in Table 6 of the document body. Use the equations below and the values presented above in Tables A1-A3 to reproduce the output in Table 6 of the document body. The following equation is used to estimate the exposure doses resulting from dermal absorption of contaminated water:

Dermal Absorbed Dose

DA event (mg/cm^2-event) = 2 FA * K_p * C_w $\sqrt{(6\tau ev * tev \div \pi)}$ (EPA 2004, Equation 3-2)

where:

Parameter		Definition (units)
DA_{event}	=	Absorbed dose per event (mg/cm-event)
FA	=	Fraction absorbed (dimensionless)
K_p	=	Dermal permeability coefficient of compound in water (cm/hr)
C_w	=	Chemical concentration in water (mg/cm^3)
τ_{event}	=	Lag time per event (hr/event)
t_{event}	=	Event duration (hr/event)
t^*	=	Time to reach steady-state (hr) = 2.4 τ_{event}

DAD (mg/kg-day) = $\frac{DAev * EF * ED * SA}{BW * AT_{NC}}$ (EPA 2004, Equation 3-1)

where:

Parameter		Definition (units)
DAD	=	Dermally Absorbed Dose (mg/kg-day)
DA_{event}	=	Absorbed dose per event (mg/cm^2-event)
SA	=	Skin surface area available for contact (cm^2)
EV	=	Event frequency (events/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (days): noncarcinogenic effects AT = ED x 365 d/yr

Example: Non-cancer 10 year old male child dermal absorbed dose for maximum level benzene found in the surface water =

C_w = *1,800 µg/L * (10^{-3} mg/µg) * (1L/1000cm^3) = 1.8 x10^{-3} mg/cm^3*

DA_{ev} *= 2 * 1 * (1.5 x10^{-2}cm/hr) *1.8 x10^{-3}* $\sqrt{(6 * 0.91 * 1 \div \pi)}$ ***= 2.0 x10^{-5} mg/cm^2-event***

DAD *= (2.0 x10^{-5} mg/cm^2-event * 3 days/year * 8 years * 1160cm^2)/ (32kg * 2920 days)=* ***6.0 x 10^{-6} mg/kg-day***

Table A1. Dermal Exposure Factors

Receptor	Body Weight (BW)	Exposure Frequency (EF)	Exposure Duration (ED)	Incidental Water Ingestion Rate (IRW)	Skin Surface Area* (SA)	Time per Event (t_{ev})	Non-cancer Averaging Time (AT_{NC})
10 Year Old Male Residents	32 kg (CDC Clinical Growth Charts)	3 days per year (professional judgment)	8 years (EPA 1997)	25 ml per event (professional judgment)	1160 cm^2 (EPA RAGS, Part E 2004)	0.25 hour (professional judgment)	2920days (EPA RAGS A, 1989)
Adult Residents	70 kg (EPA 1997)	3 days per year (professional judgment)	8 years (non-cancer) (EPA 1997)	25 ml per event (professional judgment)	1815 cm^2 (EPA RAGS, Part E 2004)	0.25 hour (professional judgment)	2920 days (EPA RAGS A, 1989)

Notes:
* Exposed body surface area (cm^2). Default values used include 10% of 18,150 cm^2 for adults (50th percentile average value of adult men and women (ages 17-70) total body surface areas), and 10% of 11,600 cm^2 for 9-12 year old children (50th percentile total body surface area).
$cm.^2$ = square centimeters
kg. = kilogram
mg. = milligram
µg. = microgram
EPA (1997) = Exposure Factor Handbook

Table A2. Chemical-Specific Dermal Exposure Factors (EPA RAGS, Part E 2004)

Chemical of Concern	Fraction Absorbed FA (dimensionless)	Dermal Permeability Coefficient of Compound in Water K_p (cm/hr)	Lag Time per event τ_{event} (hour/event)	Time to reach steady-state t^* (in hours)
Benzene	1.0	1.5E-02	0.287	0.689

Table A3. Dermal Absorbed Dose Per Event (DA_{ev})

Environmental Medium	Exposure Level	Benzene (mg/cm^2- event)
Surface Water	High Concentration	2.0E-05
	Average Concentration	1.28E-06

Incidental Ingestion of Contaminants Present in Surface Water

Exposure doses from incidental ingestion of contaminants present in surface water were calculated using the maximum concentration and average concentrations of benzene from the sample data, in milligrams/kilogram (mg/kg), and the default permeability coefficient value for benzene [13]. The following equation is used to estimate the exposure doses resulting from ingestion of contaminated water:

Non-Cancer Exposure Dose = **(C_w * IRW * CF * EF * ED) / (BW * AT_{NC})**

where:

Parameter		Definition (units)
Exposure Dose	=	(mg/kg-day)
IRW	=	Incidental water ingestion rate (ml per event)
C_w		Contaminant concentration in water (µg/L)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (days): AT = ED x 365 d/yr

Example: 10 year old male child incidental ingestion dose for maximum level benzene in surface water =

*(1800 ug/L * 0.025L * 10^{-3} mg/ug * 3 days * 8 years)/(32kg * 2920 days)= 1.15x 10^{-5} mg/kg-day*

Non-cancer Health Risks

The doses calculated for exposure to individual chemicals are then compared to an established health guideline, such as an ATSDR minimal risk level (MRL) or an EPA reference dose (RfD), in order to assess whether adverse health impacts from exposure are expected. Health guidelines are chemical-specific values that are based on available scientific literature and are considered protective of human health. Non-carcinogenic effects, unlike carcinogenic effects, are believed to have a threshold, that is, a dose below which adverse health effects will not occur. As a result, the current practice to derive health guidelines is to identify, usually from animal toxicology experiments, a no observed adverse effect level (NOAEL), which indicates that no effects are observed at a particular exposure level. This is the experimental exposure level in animals (and sometimes humans) at which no adverse toxic effect is observed. The known toxicological values are doses derived from human and animal studies that are summarized in ATSDR's *Toxicological Profiles (www.atsdr.cdc.gov/toxpro2.html).* The NOAEL is modified with an uncertainty (or safety) factor, which reflects the degree of uncertainty that exists when experimental animal data are extrapolated to the human population. The magnitude of the uncertainty factor considers various factors such as sensitive subpopulations (e.g., children, pregnant women, the elderly), extrapolation from animals to humans, and the completeness of the available data. Thus, exposure doses at or below the established health guideline are not expected to cause adverse health effects because these values are much lower (and more human health protective) than doses, which do not cause adverse health effects in laboratory animal studies.

Minimal Risk Levels (MRLs) are developed by ATSDR for contaminants commonly found at hazardous waste sites. The MRL is developed for ingestion and inhalation exposure, and for lengths of exposures: acute (less than 14 days); intermediate (between 15-364 days), and chronic (365 days or greater). ATSDR has not developed MRLs for dermal exposure (absorption through skin).

Reference Doses (RfDs) EPA developed chronic RfDs for ingestion and RfCs for inhalation as estimates of daily exposures to a substance that are likely to be without a discernable risk of deleterious effects to the general human population (including sensitive subgroups) during a lifetime of exposure.

If the estimated exposure dose to an individual is less than the health guideline value, the exposure is unlikely to result in non-cancer health effects. If the calculated exposure dose is greater than the health guideline, the exposure dose is compared to known toxicological values for the particular chemical and is

discussed in more detail in the text of the public health assessment. A direct comparison of site-specific exposures and doses to study-derived exposures and doses found to cause adverse health effects is the basis for deciding whether health effects are likely to occur.

It is important to consider that the methodology used to develop health guidelines does not provide any information on the presence, absence, or level of cancer risk. Therefore, a separate cancer risk evaluation is necessary for potentially cancer-causing contaminants detected at this site.

Cancer Risks

Exposure to a cancer-causing chemical, even at low concentrations, is assumed to be associated with some increased risk for evaluation purposes. The estimated risk for developing cancer from exposure to contaminants associated with the site was calculated by multiplying the site-specific doses by EPA's chemical-specific cancer slope factors (CSFs) available at *www.epa.gov/iris*. This calculation estimates a theoretical excess cancer risk expressed as a proportion of the population that may be affected by a carcinogen during a lifetime of exposure. For example, an estimated risk of 1×10^{-6} predicts the probability of one additional cancer over background in a population of 1 million. An increased lifetime cancer risk is not a specified estimate of expected cancers. Rather, it is an estimate of the increase in the probability that a person may develop cancer sometime in his or her lifetime following exposure to a particular contaminant under specific exposure scenarios. For children, the theoretical excess cancer risk is not calculated for a lifetime of exposure, but from a fraction of lifetime; based on known or suspected length of exposure, or years of childhood.

Because of conservative models used to derive CSFs, using this approach provides a theoretical estimate of risk; the true or actual risk is unknown and could be as low as zero. Numerical risk estimates are generated using mathematical models applied to epidemiologic or experimental data for carcinogenic effects. The mathematical models extrapolate from higher experimental doses to lower experimental doses. Often, the experimental data represent exposures to chemicals at concentrations orders of magnitude higher than concentrations found in the environment. In addition, these models often assume that there are no thresholds to carcinogenic effects--a single molecule of a carcinogen is assumed to be able to cause cancer. The doses associated with these estimated hypothetical risks might be orders of magnitude lower that doses reported in toxicology literature to cause carcinogenic effects. As such, a low cancer risk estimate of 1×10^{-6} and below may indicate that the toxicology literature supports a finding that no excess cancer risk is likely. A cancer risk estimate greater than 1×10^{-6}, however, indicates that a careful review of toxicology literature before making conclusions about cancer risks is in order.

Appendix B: Overarching Category Statements

Category 1

Chemical Hazard:

ATSDR concludes that [SUBSTANCE/PATHWAY. Describe the pathway – drinking, breathing, eating, etc.] for [TIME PERIOD. List the time period – less than a year, less than two weeks, or two weeks or less] at/in [PLACE] could harm people's health. This is an urgent public health hazard.

Physical Hazard:

ATSDR concludes that [PHYSICAL HAZARD. Describe physical hazard] at/in [PLACE] could harm people's health. This physical hazard is an urgent public health hazard.

Category 2

Chemical Hazard:

ATSDR concludes that [SUBSTANCE/PATHWAY. Describe the pathway – drinking, breathing, eating, etc.] for [TIME PERIOD. List the time period **–** a year or longer] at/in [PLACE] could harm people's health. The following optional statement may be added for this category: "This is a public health hazard."

Physical Hazard:

ATSDR concludes that [PHYSICAL HAZARD. Describe physical hazard] at/in [PLACE] could harm people's health. The following optional statement may be added for this category: "This physical hazard is a public health hazard."

Category 3

ATSDR cannot currently conclude whether [SUBSTANCE/PATHWAY. Describe the pathway – drinking, breathing, eating, etc.] at/in [PLACE] could harm people's health. The following optional statements may be added for this category: (1) "The reason for this is [add information why data will never be available]" or (2) "The information we need to make a decision is not available. We are working with [specify agencies] to gather the needed information."

Category 4

ATSDR concludes that [SUBSTANCE/PATHWAY. Describe the pathway – drinking, breathing, eating, etc.] at/in [PLACE] is not expected to harm people's health. The following optional phrase may be added to the end of the sentence for this category: "because [state reason]." Or, the following optional statement may be added for this category: "The reason for this is [state reason]."

Note: There are two options for Category 4 – exposure with further action or without further action.

Category 5

ATSDR concludes that the [SUBSTANCE/PATHWAY] will not harm people's health. The following optional phrase may be added to the end of the sentence for this category: "because people have not been [describe the pathway – drinking, breathing, eating, etc.]" Or, the following optional statement may be added for this category: "The reason for this is that people have not been [describe the pathway – drinking, breathing, eating etc.]"

APPENDIX C: GDPH Glossary of Terms

This glossary defines words used by GDPH in communications with the public. It is not a complete dictionary of environmental health terms.

General Terms

Absorption
The process of taking in. For a person or an animal, absorption is the process of a substance getting into the body through the eyes, skin, stomach, intestines, or lungs.

Acute
Occurring over a short time [compare with chronic].

Acute exposure
Contact with a substance that occurs once or for only a short time (up to 14 days) [compare with intermediate duration exposure and chronic exposure].

Additive effect
A biologic response to exposure to multiple substances that equals the sum of responses of all the individual substances added together [compare with antagonistic effect and synergistic effect].

Adverse health effect
A change in body function or cell structure that might lead to disease or health problems

Aerobic
Requiring oxygen [compare with anaerobic].

Ambient
Surrounding (for example, ambient air).

Anaerobic
Requiring the absence of oxygen [compare with aerobic].

Analyte
A substance measured in the laboratory. A chemical for which a sample (such as water, air, or blood) is tested in a laboratory. For example, if the analyte is mercury, the laboratory test will determine the amount of mercury in the sample.

Analytic epidemiologic study
A study that evaluates the association between exposure to hazardous substances and disease by testing scientific hypotheses.

Antagonistic effect
A biologic response to exposure to multiple substances that is less than would be expected if the known effects of the individual substances were added together [compare with additive effect and synergistic effect].

Background level
An average or expected amount of a substance or radioactive material in a specific environment, or typical amounts of substances that occur naturally in an environment.

Biodegradation
Decomposition or breakdown of a substance through the action of microorganisms (such as bacteria or fungi) or other natural physical processes (such as sunlight).

Biologic monitoring
Measuring hazardous substances in biologic materials (such as blood, hair, urine, or breath) to determine whether exposure has occurred. A blood test for lead is an example of biologic monitoring.

Biologic uptake
The transfer of substances from the environment to plants, animals, and humans.

Biomedical testing
Testing of persons to find out whether a change in a body function might have occurred because of exposure to a hazardous substance.
Biota
Plants and animals in an environment. Some of these plants and animals might be sources of food, clothing, or medicines for people.
Body burden
The total amount of a substance in the body. Some substances build up in the body because they are stored in fat or bone or because they leave the body very slowly.
CAP [see Community Assistance Panel.]
Cancer
Any one of a group of diseases that occur when cells in the body become abnormal and grow or multiply out of control.
Cancer risk
A theoretical risk for getting cancer if exposed to a substance every day for 70 years (a lifetime exposure). The true risk might be lower.
Carcinogen
A substance that causes cancer.
Case study
A medical or epidemiologic evaluation of one person or a small group of people to gather information about specific health conditions and past exposures.
Case-control study
A study that compares exposures of people who have a disease or condition (cases) with people who do not have the disease or condition (controls). Exposures that are more common among the cases may be considered as possible risk factors for the disease.
CAS registry number
A unique number assigned to a substance or mixture by the American Chemical Society Abstracts Service.
Central nervous system
The part of the nervous system that consists of the brain and the spinal cord.
CERCLA [see Comprehensive Environmental Response, Compensation, and Liability Act of 1980]
Chronic
Occurring over a long time [compare with acute].
Chronic exposure
Contact with a substance that occurs over a long time (more than 1 year) [compare with acute exposure and intermediate duration exposure]
Cluster investigation
A review of an unusual number, real or perceived, of health events (for example, reports of cancer) grouped together in time and location. Cluster investigations are designed to confirm case reports; determine whether they represent an unusual disease occurrence; and, if possible, explore possible causes and contributing environmental factors.
Community Assistance Panel (CAP)
A group of people from a community and from health and environmental agencies who work with ATSDR to resolve issues and problems related to hazardous substances in the community. CAP members work with ATSDR to gather and review community health concerns, provide information on how people might have been or might now be exposed to hazardous substances, and inform ATSDR on ways to involve the community in its activities.

Comparison value (CV)
Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. The CV is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.
Completed exposure pathway [see exposure pathway].
Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)
CERCLA, also known as Superfund, is the federal law that concerns the removal or cleanup of hazardous substances in the environment and at hazardous waste sites. ATSDR, which was created by CERCLA, is responsible for assessing health issues and supporting public health activities related to hazardous waste sites or other environmental releases of hazardous substances. This law was later amended by the Superfund Amendments and Reauthorization Act (SARA).
Concentration
The amount of a substance present in a certain amount of soil, water, air, food, blood, hair, urine, breath, or any other media.
Contaminant
A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.
Delayed health effect
A disease or an injury that happens as a result of exposures that might have occurred in the past.
Dermal
Referring to the skin. For example, dermal absorption means passing through the skin.
Dermal contact
Contact with (touching) the skin [see route of exposure].
Descriptive epidemiology
The study of the amount and distribution of a disease in a specified population by person, place, and time.
Detection limit
The lowest concentration of a chemical that can reliably be distinguished from a zero concentration.
Disease prevention
Measures used to prevent a disease or reduce its severity.
Disease registry
A system of ongoing registration of all cases of a particular disease or health condition in a defined population.
DOD
United States Department of Defense.
DOE
United States Department of Energy.
Dose (for chemicals that are not radioactive)
The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An "exposure dose" is how much of a substance is encountered in the environment. An "absorbed

dose" is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.

Dose (for radioactive chemicals)
The radiation dose is the amount of energy from radiation that is actually absorbed by the body. This is not the same as measurements of the amount of radiation in the environment.

Dose-response relationship
The relationship between the amount of exposure [dose] to a substance and the resulting changes in body function or health (response).

Environmental media
Soil, water, air, biota (plants and animals), or any other parts of the environment that can contain contaminants.

Environmental media and transport mechanism
Environmental media include water, air, soil, and biota (plants and animals). Transport mechanisms move contaminants from the source to points where human exposure can occur. The environmental media and transport mechanism is the second part of an exposure pathway.

EPA
United States Environmental Protection Agency.

Epidemiologic surveillance [see Public health surveillance].

Epidemiology
The study of the distribution and determinants of disease or health status in a population; the study of the occurrence and causes of health effects in humans.

Exposure
Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [acute exposure], of intermediate duration, or long-term [chronic exposure].

Exposure assessment
The process of finding out how people come into contact with a hazardous substance, how often and for how long they are in contact with the substance, and how much of the substance they are in contact with.

Exposure-dose reconstruction
A method of estimating the amount of people's past exposure to hazardous substances. Computer and approximation methods are used when past information is limited, not available, or missing.

Exposure investigation
The collection and analysis of site-specific information and biologic tests (when appropriate) to determine whether people have been exposed to hazardous substances.

Exposure pathway
The route a substance takes from its source (where it began) to its end point (where it ends), and how people can come into contact with (or get exposed to) it. An exposure pathway has five parts: a source of contamination (such as an abandoned business); an environmental media and transport mechanism (such as movement through groundwater); a point of exposure (such as a private well); a route of exposure (eating, drinking, breathing, or touching), and a receptor population (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a completed exposure pathway.

Exposure registry
A system of ongoing follow-up of people who have had documented environmental exposures.

Feasibility study
A study by EPA to determine the best way to clean up environmental contamination. A number of factors are considered, including health risk, costs, and what methods will work well.

Geographic information system (GIS)
A mapping system that uses computers to collect, store, manipulate, analyze, and display data. For example, GIS can show the concentration of a contaminant within a community in relation to points of reference such as streets and homes.

Grand rounds
Training sessions for physicians and other health care providers about health topics.

Groundwater
Water beneath the earth's surface in the spaces between soil particles and between rock surfaces [compare with surface water].

Half-life (t½)
The time it takes for half the original amount of a substance to disappear. In the environment, the half-life is the time it takes for half the original amount of a substance to disappear when it is changed to another chemical by bacteria, fungi, sunlight, or other chemical processes. In the human body, the half-life is the time it takes for half the original amount of the substance to disappear, either by being changed to another substance or by leaving the body. In the case of radioactive material, the half life is the amount of time necessary for one half the initial number of radioactive atoms to change or transform into another atom (that is normally not radioactive). After two half lives, 25% of the original number of radioactive atoms remain.

Hazard
A source of potential harm from past, current, or future exposures.

Hazardous Substance Release and Health Effects Database (HazDat)
The scientific and administrative database system developed by ATSDR to manage data collection, retrieval, and analysis of site-specific information on hazardous substances, community health concerns, and public health activities.

Hazardous waste
Potentially harmful substances that have been released or discarded into the environment.

Health consultation
A review of available information or collection of new data to respond to a specific health question or request for information about a potential environmental hazard. Health consultations are focused on a specific exposure issue. Health consultations are therefore more limited than a public health assessment, which reviews the exposure potential of each pathway and chemical [compare with public health assessment].

Health education
Programs designed with a community to help it know about health risks and how to reduce these risks.

Health investigation
The collection and evaluation of information about the health of community residents. This information is used to describe or count the occurrence of a disease, symptom, or clinical measure and to evaluate the possible association between the occurrence and exposure to hazardous substances.

Health promotion
The process of enabling people to increase control over, and to improve, their health.

Health statistics review
The analysis of existing health information (i.e., from death certificates, birth defects registries, and cancer registries) to determine if there is excess disease in a specific population, geographic area, and time period. A health statistics review is a descriptive epidemiologic study.

Indeterminate public health hazard
The category used in ATSDR's public health assessment documents when a professional

judgment about the level of health hazard cannot be made because information critical to such a decision is lacking.

Incidence

The number of new cases of disease in a defined population over a specific time period [contrast with prevalence].

Ingestion

The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way [see route of exposure].

Inhalation

The act of breathing. A hazardous substance can enter the body this way [see route of exposure].

Intermediate duration exposure

Contact with a substance that occurs for more than 14 days and less than a year [compare with acute exposure and chronic exposure].

In vitro

In an artificial environment outside a living organism or body. For example, some toxicity testing is done on cell cultures or slices of tissue grown in the laboratory, rather than on a living animal [compare with in vivo].

In vivo

Within a living organism or body. For example, some toxicity testing is done on whole animals, such as rats or mice [compare with in vitro].

Lowest-observed-adverse-effect level (LOAEL)

The lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals.

Medical monitoring

A set of medical tests and physical exams specifically designed to evaluate whether an individual's exposure could negatively affect that person's health.

Metabolism

The conversion or breakdown of a substance from one form to another by a living organism.

Metabolite

Any product of metabolism.

mg/kg

Milligram per kilogram.

mg/cm2

Milligram per square centimeter (of a surface).

mg/m3

Milligram per cubic meter; a measure of the concentration of a chemical in a known volume (a cubic meter) of air, soil, or water.

Migration

Moving from one location to another.

Minimal risk level (MRL)

An ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), noncancerous effects. MRLs are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic). MRLs should not be used as predictors of harmful (adverse) health effects [see reference dose].

Morbidity

State of being ill or diseased. Morbidity is the occurrence of a disease or condition that alters health and quality of life.

Mortality
Death. Usually the cause (a specific disease, a condition, or an injury) is stated.
Mutagen
A substance that causes mutations (genetic damage).
Mutation
A change (damage) to the DNA, genes, or chromosomes of living organisms.
National Priorities List for Uncontrolled Hazardous Waste Sites (National Priorities List or NPL)
EPA's list of the most serious uncontrolled or abandoned hazardous waste sites in the United States. The NPL is updated on a regular basis.
National Toxicology Program (NTP)
Part of the Department of Health and Human Services. NTP develops and carries out tests to predict whether a chemical will cause harm to humans.
No apparent public health hazard
A category used in ATSDR's public health assessments for sites where human exposure to contaminated media might be occurring, might have occurred in the past, or might occur in the future, but where the exposure is not expected to cause any harmful health effects.
No-observed-adverse-effect level (NOAEL)
The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals.
No public health hazard
A category used in ATSDR's public health assessment documents for sites where people have never and will never come into contact with harmful amounts of site-related substances.
NPL [see National Priorities List for Uncontrolled Hazardous Waste Sites]
Physiologically based pharmacokinetic model (PBPK model)
A computer model that describes what happens to a chemical in the body. This model describes how the chemical gets into the body, where it goes in the body, how it is changed by the body, and how it leaves the body.
Pica
A craving to eat nonfood items, such as dirt, paint chips, and clay. Some children exhibit pica-related behavior.
Plume
A volume of a substance that moves from its source to places farther away from the source. Plumes can be described by the volume of air or water they occupy and the direction they move. For example, a plume can be a column of smoke from a chimney or a substance moving with groundwater.
Point of exposure
The place where someone can come into contact with a substance present in the environment [see exposure pathway].
Population
A group or number of people living within a specified area or sharing similar characteristics (such as occupation or age).
Potentially responsible party (PRP)
A company, government, or person legally responsible for cleaning up the pollution at a hazardous waste site under Superfund. There may be more than one PRP for a particular site.
ppb
Parts per billion.

ppm
Parts per million.
Prevalence
The number of existing disease cases in a defined population during a specific time period [contrast with incidence].
Prevalence survey
The measure of the current level of disease(s) or symptoms and exposures through a questionnaire that collects self-reported information from a defined population.
Prevention
Actions that reduce exposure or other risks, keep people from getting sick, or keep disease from getting worse.
Public availability session
An informal, drop-by meeting at which community members can meet one-on-one with ATSDR staff members to discuss health and site-related concerns.
Public comment period
An opportunity for the public to comment on agency findings or proposed activities contained in draft reports or documents. The public comment period is a limited time period during which comments will be accepted.
Public health action
A list of steps to protect public health.
Public health advisory
A statement made by ATSDR to EPA or a state regulatory agency that a release of hazardous substances poses an immediate threat to human health. The advisory includes recommended measures to reduce exposure and reduce the threat to human health.
Public health assessment (PHA)
An ATSDR document that examines hazardous substances, health outcomes, and community concerns at a hazardous waste site to determine whether people could be harmed from coming into contact with those substances. The PHA also lists actions that need to be taken to protect public health [compare with health consultation].
Public health hazard
A category used in ATSDR's public health assessments for sites that pose a public health hazard because of long-term exposures (greater than 1 year) to sufficiently high levels of hazardous substances or radionuclides that could result in harmful health effects.
Public health hazard categories
Public health hazard categories are statements about whether people could be harmed by conditions present at the site in the past, present, or future. One or more hazard categories might be appropriate for each site. The five public health hazard categories are no public health hazard, no apparent public health hazard, indeterminate public health hazard, public health hazard, and urgent public health hazard.
Public health statement
The first chapter of an ATSDR toxicological profile. The public health statement is a summary written in words that are easy to understand. The public health statement explains how people might be exposed to a specific substance and describes the known health effects of that substance.
Public health surveillance
The ongoing, systematic collection, analysis, and interpretation of health data. This activity also involves timely dissemination of the data and use for public health programs.

Public meeting
A public forum with community members for communication about a site.
Radioisotope
An unstable or radioactive isotope (form) of an element that can change into another element by giving off radiation.
Radionuclide
Any radioactive isotope (form) of any element.
RCRA [see Resource Conservation and Recovery Act (1976, 1984)]
Receptor population
People who could come into contact with hazardous substances [see exposure pathway].
Reference dose (RfD)
An EPA estimate, with uncertainty or safety factors built in, of the daily lifetime dose of a substance that is unlikely to cause harm in humans.
Registry
A systematic collection of information on persons exposed to a specific substance or having specific diseases [see exposure registry and disease registry].
Remedial investigation
The CERCLA process of determining the type and extent of hazardous material contamination at a site.
Resource Conservation and Recovery Act (1976, 1984) (RCRA)
This Act regulates management and disposal of hazardous wastes currently generated, treated, stored, disposed of, or distributed.
RFA
RCRA Facility Assessment. An assessment required by RCRA to identify potential and actual releases of hazardous chemicals.
RfD [see reference dose]
Risk
The probability that something will cause injury or harm.
Risk reduction
Actions that can decrease the likelihood that individuals, groups, or communities will experience disease or other health conditions.
Risk communication
The exchange of information to increase understanding of health risks.
Route of exposure
The way people come into contact with a hazardous substance. Three routes of exposure are breathing [inhalation], eating or drinking [ingestion], or contact with the skin [dermal contact].
Safety factor [see uncertainty factor]
SARA [see Superfund Amendments and Reauthorization Act]
Sample
A portion or piece of a whole. A selected subset of a population or subset of whatever is being studied. For example, in a study of people the sample is a number of people chosen from a larger population [see population]. An environmental sample (for example, a small amount of soil or water) might be collected to measure contamination in the environment at a specific location.
Sample size
The number of units chosen from a population or an environment.
Solvent
A liquid capable of dissolving or dispersing another substance (for example, acetone or mineral spirits).

Source of contamination
The place where a hazardous substance comes from, such as a landfill, waste pond, incinerator, storage tank, or drum. A source of contamination is the first part of an exposure pathway.
Special populations
People who might be more sensitive or susceptible to exposure to hazardous substances because of factors such as age, occupation, sex, or behaviors (for example, cigarette smoking). Children, pregnant women, and older people are often considered special populations.
Stakeholder
A person, group, or community who has an interest in activities at a hazardous waste site.
Statistics
A branch of mathematics that deals with collecting, reviewing, summarizing, and interpreting data or information. Statistics are used to determine whether differences between study groups are meaningful.
Substance
A chemical.
Substance-specific applied research
A program of research designed to fill important data needs for specific hazardous substances identified in ATSDR's toxicological profiles. Filling these data needs would allow more accurate assessment of human risks from specific substances contaminating the environment. This research might include human studies or laboratory experiments to determine health effects resulting from exposure to a given hazardous substance.
Superfund [see Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and Superfund Amendments and Reauthorization Act (SARA)
Superfund Amendments and Reauthorization Act (SARA)
In 1986, SARA amended the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and expanded the health-related responsibilities of ATSDR. CERCLA and SARA direct ATSDR to look into the health effects from substance exposures at hazardous waste sites and to perform activities including health education, health studies, surveillance, health consultations, and toxicological profiles.
Surface water
Water on the surface of the earth, such as in lakes, rivers, streams, ponds, and springs [compare with groundwater].
Surveillance [see public health surveillance]
Survey
A systematic collection of information or data. A survey can be conducted to collect information from a group of people or from the environment. Surveys of a group of people can be conducted by telephone, by mail, or in person. Some surveys are done by interviewing a group of people [see prevalence survey].
Synergistic effect
A biologic response to multiple substances where one substance worsens the effect of another substance. The combined effect of the substances acting together is greater than the sum of the effects of the substances acting by themselves [see additive effect and antagonistic effect].
Teratogen
A substance that causes defects in development between conception and birth. A teratogen is a substance that causes a structural or functional birth defect.
Toxic agent
Chemical or physical (for example, radiation, heat, cold, microwaves) agents that, under certain circumstances of exposure, can cause harmful effects to living organisms.

Toxicological profile
An ATSDR document that examines, summarizes, and interprets information about a hazardous substance to determine harmful levels of exposure and associated health effects. A toxicological profile also identifies significant gaps in knowledge on the substance and describes areas where further research is needed.

Toxicology
The study of the harmful effects of substances on humans or animals.

Tumor
An abnormal mass of tissue that results from excessive cell division that is uncontrolled and progressive. Tumors perform no useful body function. Tumors can be either benign (not cancer) or malignant (cancer).

Uncertainty factor
Mathematical adjustments for reasons of safety when knowledge is incomplete. For example, factors used in the calculation of doses that are not harmful (adverse) to people. These factors are applied to the lowest-observed-adverse-effect-level (LOAEL) or the no-observed-adverse-effect-level (NOAEL) to derive a minimal risk level (MRL). Uncertainty factors are used to account for variations in people's sensitivity, for differences between animals and humans, and for differences between a LOAEL and a NOAEL. Scientists use uncertainty factors when they have some, but not all, the information from animal or human studies to decide whether an exposure will cause harm to people [also sometimes called a safety factor].

Urgent public health hazard
A category used in ATSDR's public health assessments for sites where short-term exposures (less than 1 year) to hazardous substances or conditions could result in harmful health effects that require rapid intervention.

Volatile organic compounds (VOCs)
Organic compounds that evaporate readily into the air. VOCs include substances such as benzene, toluene, methylene chloride, and methyl chloroform.