# The San Jacinto River Waste Pits Superfund Site: An Assessment of Remedial Options for Sites with Dioxin-contaminated Sediments with Implications for Remedy Selection at the San Jacinto Site

By

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**Abstract**

A survey of seven Superfund sites which share location and contaminant characteristics with the San Jacinto River Waste Pit Superfund site shows that EPA required removal of the most highly contaminated materials as a part of the chosen remedy anywhere such a removal did not irreversibly damage the surrounding waterway. Areas of lesser contamination were capped to prevent further exposure and dispersion of these contaminants into the ecosystem. The practice of removing highly contaminated materials and containing those less contaminated falls in line with EPA's stated policies concerning sites where contaminants include extremely toxic materials such as the ones at the SJRWPs. In light of these findings, EPA's National Remedy Review Board should consider complete removal of both the residual wastes in the pits and the most highly contaminated sediments outside the original waste lagoon structures, with a containment strategy to address sediments contaminated above recommended site cleanup goals within the site perimeter, as the remedy which best conforms to both past agency practice and stated agency policy for sites contaminated with PCBs, mercury, and dioxin.

## Executive Summary

The following report was completed on behalf of Texans Together for the San Jacinto River Coalition, an organization representing the communities of Highlands and Channelview, Harris Co., Texas. These communities abut the San Jacinto River Waste Pits (SJRWP) Superfund Site and are concerned about the past, current, and future health and environmental impacts of the site. The citizens are especially interested in the final disposition of this site, and that whatever remedial solution is selected be the most protective of long-term human and environmental health in the area.

This report was completed by Dr. Kathleen A. Garland under contract to Texans Together. Dr. Garland is a faculty member at the University of Houston Clear Lake in the Environmental Management Program (vita attached). This report represents Dr. Garland's professional research and findings as an independent consultant, and in no way reflects the opinions or viewpoints of the University of Houston Clear Lake or the University of Houston System.

This report summarizes the past and current site conditions at the SJRWP site and the health and environmental impacts of the Contaminants of Concern (COCs) found at the site. It then discusses the seven case studies available in EPA's Superfund Information database where similar COCs exist under similar site conditions. These discussions focus on any emergency removal actions conducted at the sites, and on the final remedial actions chosen to address contamination at these sites. The report then compares the removal actions and remedies chosen at the studied sites to the proposed remedy at the SJRWP site. In addition, the report highlights EPA's stated policies and guidance with respect to the COCs and conditions such as those found at SJRWP site, and reviews the proposed remedy in light of those policies and guidance. The report concludes with recommendations for the final disposition of the SJRWP site.

The SJRWP site lies adjacent to and partially submerged in the San Jacinto River, Harris Co., TX. The waste pits were owned by McGinnis Industrial Services Co. (acquired by Waste Management, Inc.) and received about 200,000 cubic yards of concentrated paper mill wastes from the Champion Paper Mill (acquired by International Paper, Inc.) from 1965-1966. Over time, and to some extent due to human activity, the San Jacinto River encroached upon the abandoned pits, eroding part of the containment structure and releasing the wastes into the San Jacinto River. The COCs at the site consist of dioxins, PCBs, and mercury, all of which are proven to be highly toxic to both humans and to aquatic ecosystems. Seafood consumption advisories for these COCs exist in the river adjacent to the site as well as upstream and downstream in the river system, the Houston Ship Channel, and parts of Galveston Bay. Following discovery of the site in 2006, a Time-critical Removal Action (TCRA) took place to reduce the emergency conditions posed by on-going release of the site's highly concentrated wastes. A Human Health Risk Assessment was not deemed necessary to confirm the risks associated with the COCs prior to implementing the TCRA, as the risks of exposure to extreme levels of dioxin are well-documented. The TCRA took the form of an armored cap, which was constructed over the northern part of the site in 2011. The ensuing Draft Remedial Investigation/Feasibility Study (RI/FS), released in 2013 by the Potentially Responsible Parties, proposes that the final remedy for this site be reinforcement of the existing cap along with administrative controls to limit access to and activities at and around the site.

The seven cases summarized for this report share four characteristics with the SJRWPs which allows them to be compared:

1. COCs include dioxins, PCBs, and mercury; and,

2. COCs are present in riverine, estuarine, or shallow marine sediments; and,

3. Environmental conditions at the site include subaerial and subaqueous exposure of contaminants in a tidally-influenced, estuarine or shallow marine environment; and,

4. Consumption advisories for fish and/or shellfish based on the increased risk of cancer and/or developmental defects for individuals consuming the contaminated seafood have been implemented in adjacent waters.

Analysis of these cases leads to the following conclusions:

A. In all cases, remedy selection for dioxin-contamined sediments included physical removal of the most highly contaminated sediments unless such removal would cause channel or bank instability.

***Implications for the SJRWP***: Such a removal appears to be feasible at the SJRWP site.

B. In all cases, selection of sediment removal as a remedy was based on a Human Health Risk Assessment which demonstrated that the site posed an elevated cancer risk to humans through the consumption of contaminated fish and shellfish. The Human Health Risk Assessments at these sites were conducted **PRIOR TO** any removal actions taken to reduce the immediate threat of exposure from the principal threat wastes at the site.

***Implications for the SJRWP*:** Such a pre-existing risk assessment does not exist for the SJRWP site, but extreme risk can be inferred from EPA's requirement that emergency action to protect human and environmental health be taken at the site in 2009.

C. In all cases, areas of lower-concentration, dispersed contamination were capped.

***Implications for the SJRPW***: The SJRWP site includes areas of such dispersed contamination that should be considered for capping to prevent further dispersion into the San Jacinto River and Galveston Bay systems.

D. Remedy selection in all the cases studied conformed to EPA's policy on management of principal threat wastes as stated in the National Contingency Plan (40 CFR 300.430(a)(1)(ii)).). That policy can be summarized as:

"EPA expects to use treatment to address the principal threats posed by a site, wherever practicable…," including "…liquids, areas contaminated with high concentrations of toxic compounds and highly mobile materials.

EPA expects to use engineering controls, such as containment (*n.b. which includes capping*), for waste that poses a relatively low long-term threat or where treatment is impracticable.

EPA expects to use a combination of methods, as appropriate, to achieve protection of human health and the environment…" (40 CFR 300.430(a)(1)(ii)).

In addition, EPA has recently released guidance on calculating cleanup levels at dioxin contaminated sites which states, "…preliminary site cleanup goals for dioxin-contaminated soils should consider 50 ppt (parts per trillion) for residential soils and 664

ppt for industrial/commercial soils as recommended values to be used in order to be protective of human health and the environment." (USEPA February 2012)

***Implications for the SJRWP***: The preferred remedy for the site as proposed in the RI/FS by the PRPs does not conform to this policy, as it specifies reinforcement of the current cap and added institutional controls as the remedy. Caps do not qualify as "treatment" for principal threat wastes under the National Contingency Plan criteria; such containment strategies are only acceptable for areas of lower-threat wastes. According to the NCP, the existing impoundments and surrounding highly contaminated wastes should be "treated" in order to permanently reduce toxicity at the site, and surrounding lower-level wastes should be contained to prevent further dispersion. Because of the nature of the contaminants at this site, the chosen treatment must be removal, as no other options exist to reduce the toxicity of these COCs to the levels recently proposed in EPA's guidance for cleanup levels at dioxin-contaminated sites.

# The San Jacinto River Waste Pits Superfund Site: An Assessment of Remedial Options for Sites with Dioxin-contaminated Sediments with Implications for Remedy Selection at the San Jacinto Site

## 1 SITE HISTORY

The San Jacinto River Waste Pits Superfund site, sometimes referred to as the McGinnis Pits, originated in 1965 as a series of unlined waste lagoons constructed in low-lying marshland on the western bank of the San Jacinto River east of Channelview and southwest of Highlands, TX. Paper mill wastes containing highly toxic and persistent dioxins and furans were transported by barge to these pits and deposited there from 1965-1966. The draft Feasibility Study conducted on this site as part of the Superfund process indicates that approximately 200,000 cubic yards of paper mill waste material was disposed in the pits during this period (Integral Consulting Inc, and Anchor QEA, LLC. May 2013).

Subsequent to disposal of wastes in these pits, regional subsidence and local sand removal caused the disposal area to sink and become partially submerged in the river. River processes and storm events eroded the pits and dispersed some of the contaminants into local sediments upstream and downstream of the site. Sediment sampling by the Texas Commission on Environmental Quality (TCEQ) and the US Environmental Protection agency (EPA) in the early 2000's identified elevated levels of dioxins and furans in river sediments adjacent to the pits. These chemicals were determined to have the same chemical signature as those found in the paper mill wastes disposed in the McGinnis pits in the 1960s, leading to listing of the pits and surrounding contaminated sediments on the National Priorities List, and paving the way for investigation and eventual remediation of the contaminated site (Integral Consulting Inc, and Anchor QEA, LLC. May 2013).

The Remedial Investigation/Feasibility Study (RI/FS) recently released in draft by the EPA identifies the San Jacinto River Waste Pits site as including the sites of the original McGinnis Pits as well as areas of river sediments impacted as these pits eroded and pit wastes migrated into the surrounding aquatic systems. It is important to recognize that sampling and analysis conducted as part of the RI identifies several distinct areas of contamination: the pits themselves, which contain high levels of dioxins and furans (> 50,000 ppt, or > 50 ppb), PCBs, and mercury in those concentrated paper mill wastes still contained within the original lagoon structures; an area of the surrounding river bottom where highly-contaminated wastes eroded from the lagoons into the waterway; and a larger area of the river bottom where the eroded wastes dispersed and mixed with uncontaminated sediments, resulting in lower levels of contaminants. All these sediments continue to be reworked by currents in the river system, and are constantly mixed with, and to some extent buried by new sediments as they are transported and deposited by the river. Daily tidal fluctuations, river currents, shipping traffic, and periodic flood events further dispersed the contaminated sediments both upstream and downstream of the waste pits.

# 2 FATE AND TRANSPORT OF THE CHEMICALS OF CONCERN

The chemicals of concern (COCs) at this site, which pose a risk to both human and ecological health, are PCBs, mercury, and dioxins and furans. PCBs, when found in paper mill waste, generally resulted from the recycling of carbonless copy paper, which was manufactured from the mid-1950s until early 1970s (Carr et al. 1977). Mercury contamination resulted primarily from its use as a biocide in the paper-making process (Clean Water Action Council of NE Wisconsin 2014). The dioxins and furans found in paper mill waste are unwanted by-products which were formed during the process of chlorine bleaching of paper pulp (Hill 2010, p. 90). All these chemicals are known human and animal carcinogens, as well as developmental toxins (i.e. capable of causing damage to developing foetuses and immature individuals in both humans and animals). PCBs, mercury, and dioxins and furans are extremely stable in the environment. They do not thermally, biologically, or chemically degrade over time. They have extremely low solubility in water, and preferentially adhere to organic particles in soil or sediment (Hill 2010, Chapter 14). For this reason, the remedial alternatives under consideration for the site focus on removal or isolation of the remaining pit wastes and some of the surrounding sediments, rather than addressing mobility of contaminants in water or air.

## 2.1 BIOACCUMULATION AND SEAFOOD CONSUMPTION

Although the COCs found at this site do not readily dissolve in water or evaporate into the air, they can be consumed by benthic (bottom-dwelling) invertebrates in the aquatic environment. Such organisms ingest the sediment, metabolize the organic matter contained in the sediment, and excrete the residual mineral matter. Their bodies cannot metabolize PCBs, mercury, or dioxins, so these COCs concentrate in the fatty tissues in the bodies of the organisms. This process is known as “bioaccumulation.”

Human exposure to the COCs from the SJRWP site currently comes primarily from the consumption of contaminated finfish, crabs, oysters, and clams. However, concerns remain about the potential for direct exposure to actual waste materials should the temporary cap deteriorate, reexposing the wastes in the pits. Exposure to these chemicals over time, either through direct contact or consumption of contaminated seafood, increases the likelihood of certain types of cancer in adults. Developmental effects are of concern for children, as they have lower body mass than adults, and are undergoing rapid development of key physiological systems (USEPA February 2012). Studies have shown that dioxins and furans may be concentrated in breast milk, thus posing a health hazard to nursing infants whose mothers consume contaminated fish or shellfish (Texas Dept. of State Health Services 2013). The presence of these COCs in river and bay seafood has led to fish consumption advisories, which have been issued by the Texas Dept. of Health in the San Jacinto River adjacent to the site as well as in the greater Galveston Bay estuary. These advisories recommend that adults consume no more than one 8-ounce fish meal of either catfish or spotted sea trout per month, and that children under twelve and pregnant or nursing mothers avoid consuming catfish and seatrout caught in these waters (Texas Dept. of State Health Services 2013). The harvesting of shellfish has been completely banned in the area immediately surrounding the waste pits.

# 3 ACTIONS COMPLETED TO DATE AT THE SJRWP SITE

The following sections of the report focus on the remedial activities which have taken place at the SJRWP site to date and those proposed in the RI/FS, and compares them to the types of actions which have been completed at Superfund sites contaminated with similar COCs in similar geographic and hydrologic settings.

## 3.1 TIME-CRITICAL REMOVAL ACTION

In July, 2010, EPA and the PRPs entered into an Administrative Order on Consent (AOC), which required the PRPs to install a protective cap designed to prevent further release of site contaminants into the environment, and to install protective fencing and other measures to prevent public access to the site and the surrounding waters (USEPA April 2, 2010). The EPA's order required that any cap be engineered to " …withstand forces sustained by the river including any future erosion and be structurally sound for a number of years until a final remedy is designed and implemented. Also, the Houston area is visited by seasonal severe weather events (i.e. strong force winds or flooding) and the physical protective barrier must be structurally secure to withstand any potential future extreme weather events (i.e. Hurricane Ike of 2008)" (USEPA April 2, 2010). In its decision document dated July 28, 2010, EPA Region 6 approved Alternative 3 of the PRP's proposed remedial design for a protective cap on the site, with the modification that the installed cap meet the requirements for withstanding a storm of 100-year recurrence frequency (the 100-yr storm)(USEPA October 18, 2010). The PRPs disputed the EPA's order and requested that they be allowed to install a cap engineered to withstand the 10-year storm. After two rounds of dispute resolution on this issue, EPA eventually rejected the PRPs' arguments as to the sufficiency of a 10-yr storm resistant cap, and insisted that the final design meet the requirements for withstanding a 100-yr flood event (USEPA October 18, 2010).

Construction of this cap took place from February through July of 2011. EPA conducted the final inspection of this cap in August of 2011. It should be noted that the PRPs were issued a number of letters of noncompliance during the cap emplacement process for failure to meet the timing requirements of the AOC.

In July of 2012, one year after placement of the 100-yr flood resistant cap, EPA was notified by the PRPs that the cap had undergone erosion on the western side, necessitating repair and placement of additional rock armor. This repair took place in late summer to early fall of 2012. (USEPA August 8, 2012)

## 3.2 PROPOSED REMEDY FOR THE SJRWP SITE: ALTERNATIVE 3—PERMANENT CAP, INSTITUTIONAL CONTROLS, AND MONITORED NATURAL RECOVERY

As part of their report, the PRPs described their preferred remedial alternative, which would enhance the existing armored cap over the pits and adjacent contaminated sediments and implement institutional controls regarding site access to protect the armor and reduce the opportunity for exposure to recreational visitors. The proposed institutional controls include restrictions on dredging and anchoring in the area, deed restrictions on properties south of I-10, deed notices on affected properties

to alert potential buyers, and public notices and perimeter signage (Integral Consulting Inc., and Anchor QEA, LLC. May 2013).

# 4 EPA'S REGULATORY STANCE ON SELECTION OF REMEDIES AT SUPERFUND SITES

40 CFR 300 is the Code of Federal Regulations citation for the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). Subpart E of this plan addresses Hazardous Substance Response. This plan makes it clear that EPA, not the site PRPs, has the responsibility for selecting the appropriate remedy at Superfund sites. EPA's priorities in selection of remedies for Superfund sites is expressly addressed at 40 CFR 300.430(a)(1)(ii) and is quoted here:

> "***Expectations.*** *EPA generally shall consider the following expectations in developing appropriate remedial alternatives:*
>
> ***(A)*** *EPA expects to use treatment to address the principal threats posed by a site, wherever practicable. Principal threats for which treatment is most likely to be appropriate include liquids, areas contaminated with high concentrations of toxic compounds (emphasis added), and highly mobile materials.*
>
> ***(B)*** *EPA expects to use engineering controls, such as containment, for waste that poses a relatively low long-term threat or where treatment is impracticable.*
>
> ***(C)*** *EPA expects to use a combination of methods, as appropriate, to achieve protection of human health and the environment. In appropriate site situations, treatment of the principal threats posed by a site, with priority placed on treating waste that is liquid, highly toxic or highly mobile, will be combined with engineering controls (such as containment) and institutional controls, as appropriate, for treatment of residuals and untreated waste."* (40 CFR 300.430(a)(1)(ii))

# 5 SUPERFUND REMOVAL ACTIONS AND REMEDY SELECTION AT SITES WITH SIMILAR COCS IN SIMILAR SURROUNDINGS

In order to determine how EPA has implemented the NCP on the ground, the author undertook a survey of EPA's Superfund Site Information database to determine what types of remedies have actually been selected for sites such as the SJRWPs. The following section provides a series of case studies of Superfund sites having similar geographic conditions and COCs as the SJRWP site, and serves to illustrate how EPA has implemented the policy expressed above at sites which share key features with the SJRWP.

*NOTE: Data for the following section was taken from the EPA's Superfund Site Information System database. While the database includes all active and archived Superfund sites, including those removed from the NPL, it does not include up-to-date technical information on all sites. (The SJRWP site, for example, has no searchable technical data available in the database, and can only be located using the*

*site name.) There may be information on other sites which has not yet been included in the database, and therefore has not been included in this report.*

## 5.1 CALCASIEU ESTUARY, LOUISIANA: EPA REGION 6

The Calcasieu Estuary is located in southwestern Louisiana, in an ecological and climatic area similar to that of the SJRWP Superfund site. Ecological values associated with the estuary include important nursery habitat for numerous species of shellfish and finfish, including Gulf Shrimp (USEPA August 2014).

### 5.1.1 Bayou Verdine

The Calcasieu Estuary Area of Investigation includes the Bayou Verdine Area of Concern, for which both Time-Critical and Non-Time Critical Removal actions have been implemented (Figure 1)

The Time Critical Removal Action at this site consisted of the removal of all contaminated sediment and capping of the underlying clays in an area where a layer of free ethylene dichloride (EDC) was found in sediments (NOAA et al. 2010). This removal took place in 2002-2003. EDC is a dense, non-aqueous phase liquid (DNAPL) used in the manufacture of petrochemicals. It affects the liver, kidneys, and central nervous system in humans, and is characterized as a B2 probable human carcinogen by the EPA (ATSDR September 2001). Discovery of this highly concentrated area of contamination led to EPA's implementation of this Time-Critical Removal Action.

A Non-time Critical Removal Action has been implemented in order to remove another source of contaminants which threaten "human health and the environment" in the Calcasieu Estuary. (USEPA August 2014). The source which is the subject of this removal action is the 4.8 mile Bayou Verdine, a tidally-influenced, highly industrialized bayou which has been receiving industrial effluent both legally and through accidental releases for many years. The removal action consists of the removal and offsite disposal of approximately 13,300 cubic yards from a hotspot of highly contaminated sediment in the Bayou channel. COCs at this site include Poly-aromatic Hydrocarbons (PAHs), ethylene dichloride (EDC), other petrochemicals, and heavy metals including hexavalent chromium. All COCs are either known or suspected human carcinogens, and several are known to have both immediate and developmental adverse effects on aquatic organisms (URS Nov. 30, 2011). This removal action took place in 2012-2013.

#### *5.1.1.1 Bayou D'Inde*

Bayou D'Inde, a second Area of Concern in the Calcasieu Estuary, is located north of Bayou Verdine, and has a similar history of industrial development (Figure 2). COCs in this area include PCBs, dioxins/furans, and mercury, similar to COCs at the SJRWP site. The Louisiana Department of Environmental Quality (LDEQ) is managing Bayou D'Inde under Louisiana state law. The revised Corrective Action Study (CAS) report provided to LDEQ by the responsible parties and LDEQ's Decision Document specify various strategies for various reaches of Bayou D'Inde, as this waterway includes open water, fringe marshes, and the Lockport Marsh. The recommended alternative for the area of highest dioxin/furan concentrations, which occurs in the open water channel portion of the bayou, is full dredging of that area back to an earlier channel configuration, and removal of approximately 100,000 cubic yards of

contaminated sediment. This alternative is recommended in order to reduce cancer risk in humans due to exposure through consumption of contaminated fish and shellfish (Bayou D'inde Group 2009; LDEQ 2011). The final remedy also includes installation of an articulated block mat in the upper reaches of the Bayou to permanently isolate contaminated sediments. COCs in this part of the Bayou include PCBs, but these are present only locally in high concentrations, and not present at all throughout most of this reach of the Bayou. The articulated block mat option was selected due to the technical infeasibility of completely removing the contaminated sediments without destabilizing the bayou banks in this narrow reach of the waterway (Bayou D'Inde Group 2009)

## 5.2 ATLANTIC WOOD INDUSTRIES INC, PORTSMOUTH, VA

The Atlantic Wood Industries site (AWI) forms part of a complex of Superfund sites located on the Southern Branch of the Elizabeth River, southwest of Norfolk, VA (Figure 3). This highly industrialized part of the Elizabeth River is a northward-flowing tidal estuary, which eventually joins the James River to the north. The James River empties into Chesapeake Bay about two miles east of its confluence with the Elizabeth River, and about 20 miles from the mouth of the Chesapeake.

AWI was listed on the National Priorities List in 1990. A Remedial Investigation was completed in 1992, and a Feasibility Study in 1995, and EPA issued a Record of Decision (ROD) specifying a remedial option in 1995. EPA eventually added two additional operating units (OU) to OU1, which was addressed by the original RI/FS, and eventually completed RI/FS reports for OU2 and OU3 as well as Human Health Risk Assessments for all operating units and Ecological Risk Assessments for OU1 and OU3. Operable Unit 3, which is discussed here, includes an area where the environmental conditions most resemble those present at the SJRWPs.

Dioxin contamination at this site occurs in surface soils, aquifers, river sediments, and in the tissues of shellfish and finfish. The Human Health Risk Assessment identified two exposure scenarios in the northeast portion of the site which correspond to conditions at the SJRWPs: exposure of workers or casual visitors/trespassers to contaminated sediments, and recreational consumers of contaminated shellfish, particularly crabs, from waters adjacent to the site. The risk assessment determined that the lifetime cancer risks associated with exposure to the COCs via direct contact or crab consumption were elevated above the EPA acceptable risk level of E-5 (1 in 100,000), and in some cases were as high as E-2 (1 in 100). Children consuming crabmeat from the site were especially at risk.

The final approved remedy at the Atlantic Wood Industries Superfund site includes excavation of 157,000 cubic yards of contaminated sediment from OU3. The most contaminated materials would be consolidated behind an offshore sheet pile wall, which is to be driven into a subsurface clay confining layer. The top three feet of this consolidated material would undergo a solidification/stabilization process to harden the surface, as would the five feet of sediment immediately against the sheet pile wall. Under this scenario, the final filled area behind the sheet pile wall will become new land, and will not be subject to further inundation (USEPA December 2007)

## 5.3 MCCORMICK AND BAXTER CREOSOTING COMPANY, PORTLAND, OR

The McCormick and Baxter Creosoting Company, located on the Willamette River in Portland, Oregon (Figure 4), is included here because it is a site which has a similar geographic/hydrologic position and contamination profile with the San Jacinto River Waste Pits, but which has not undergone excavation and removal of dioxin contaminated sediments. An important difference in site characteristics is that the McCormick and Baxter site sediments contain significant levels of PAHs, with local areas of Non-aqueous Phase Liquids (NAPL), and the remedy is designed to isolate both contaminated sediments and potentially mobilized NAPL. A Human Health Risk Assessment determined that there was significant increased risk of cancer due to concentrations of PAHs and dioxins in shellfish and crayfish caught near the site, and that the final remedy had to reduce the risk of exposure to recreational and subsistence fishers from consuming local shellfish and crayfish.

In the McCormick and Baxter case, the contaminated sediments were located over a large area in the Willamette River, and appeared to extend at least 80 feet into the subsurface, which was considered too deep for excavation as a remedy. The final site remedy included excavation, removal, treatment, and replacement with clean fill of the top four feet of highly contaminated subaerial surface soils, and a NAPL extraction and groundwater treatment system. The final sediment remedy was a 22-acre sediment cap which consists of sand, organoclays, and rock armoring over most of the submerged areas of the site, with articulated block mats along the side slopes of the river. The purpose of the organoclays in this cap was to interact with and biodegrade any NAPLs that might migrate upward from the underlying sediments. The 5-year site review issued in 2006 indicated that some erosion of the cap armoring took place shortly after installation, and was addressed by the PRPs. In addition, organic sheens were visible on the surface of the water above the cap, and bubbling (ebullition) had been noted coming through the cap. (Oregon DEQ and USEPA 2006)

Extensive sampling and monitoring of the site took place from 2005-2011 in order to determine whether or not the cap was achieving its purpose of isolating contaminated sediments, and to identify the causes of the observed bubbling and sheen. Testing indicated that the bubbles consisted of either almost pure methane, or methane, $CO_2$, and other gases, and were an indication that the organoclays were effectively facilitating the microbial breakdown of PAHs migrating upward from the underlying sediments along gas pathways. Additional testing of the organoclays indicated that, while some degradation of the clays was occurring, it was insignificant in comparison to the total volume of active clays, and that the cap structure was functioning as designed.

Finally, additional testing at this site included bioassays of crayfish from areas adjacent to the site. These crayfish have been under a “do not consume” health advisory since 1991 due to elevated levels of dioxins in crayfish tissue samples. Crayfish were sampled in 2003, before the cap was installed, and again in 2006 and 2008. Based on these results, which showed significant reductions in both dioxin and PAH concentrations from pre-cap to post-cap sampling events, the crayfish consumption advisory was removed in 2010 (Oregon DEQ and USEPA 2011).

## 5.4 Pacific Sound Resources, Seattle, WA

Pacific Sound Resources Superfund Site consists of two areas of concern, an upland area and a marine sediment units (MSU). The MSU exists in an area somewhat comparable to the SJRWP site, although it is in a shallow, fully-marine environment on Elliott Bay in Puget Sound, WA (Figure 5). COCs at the site

include PAHs, PCBs, and dioxins, and exposure pathways of concern include consumption of contaminated shellfish by subsistence fishers with a resulting increased risk of cancer.

The final remedy at this site included a 58-acre engineered, subaqueous sediment cap in waters ranging from 0-300' in depth, and the dredging and removal of 10,000 cubic yards of contaminated sediment to maintain navigational depths near the site. EPA has not issued a protectiveness certification for this site due to inadequate data collection for monitoring contaminants at and above the deeper portions of the cap. (USEPA Region 10 2009)

## 5.5 The Welch Creek Area of The Domtar (formerly Weyerhauser) Site, Plymouth, NC

This former Weyerhauser wood-treating facility has a location on the Roanoke River adjacent to Chesapeake Bay, and includes the tidally influenced Welch Creek area, which was contaminated with wood-treating wastes during operations of the Weyerhauser facilities (Figure 6). Contaminants of concern at this site include PAHs and dioxins; however, dioxin concentrations in the most highly contaminated upper reaches of Welch Creek pose a cancer risk to humans of less than E-4 with low possibility of exposure, and also pose only modest ecological risk to exposed organisms. This exposure assessment is borne out by documented decreases in the dioxin content of both fish tissues and bird eggs over the past decade. An Army Corp of Engineers erosion assessment of the creek under hypothetical storms, nor'easters, and hurricanes demonstrated that the upper reach of the creek was unlikely to undergo erosion. For this reason, dioxins in the Welch Creek are not considered to be a principal threat waste requiring treatment.

The selected remedy for this site is a thin layer sand cap over 18 acres of the upper, most contaminated reach of Welch Creek to reduce bioavailability of contaminants. The midreach of the creek, which has lower dioxin concentrations, would undergo mobility monitoring to assure that sediments do not move out of the creek into the Roanoke River (USEPA 2007).

## 5.6 Wyckoff Co./Eagle Harbor Site, Kitsap Co., WA

The Wyckoff Co./ Eagle Harbor Site, located on Bainbridge Island in Puget Sound (Figure 7), is yet another former wood treating facility where on-site wood treatment processes generated wastes which have contaminated soils and groundwater at the facility, as well as extensively contaminating the sediments of Eagle Harbor. COCs in the sediments at this site include PAHs, mercury and other heavy metals, and pentachlorophenol (PCP). Dioxin contamination occurs in the soils and groundwater beneath the former facility, as well as in seeps on adjacent beaches. A seafood consumption advisory for the harbor has been in place since the early 1980s due to the presence of PAHs in sediments, fish and shellfish, with particular concern for the local clam population which is used extensively by the Squamish tribe for subsistence fishing (USEPA Wyckoff Co./Eagle Harbor Site Details).

The Wyckoff Co. site consists of three operable units (OUs): the Soil and Groundwater Remediation OU, the East Harbor OU, and the West Harbor OU. Remedies currently in place at this site include an

extensive groundwater pump and treat system to remove both NAPL and dissolved phase contaminants from the former facility. A 54-acre sediment "hot spot" in the harbor was dredged to remove the most highly contaminated sediments, and then capped. Various other capping and monitoring programs address PAHs and hydrocarbon contamination. A TCRA was conducted from 1992-1994 on the Wyckoff treatment facility to remove creosote sludges and contaminated oils, dispose of asbestos, install a sheet-pile wall to prevent contaminated groundwater from seeping into the harbor, and remove and recycle various metal equipment and debris from the site. 30,000 cubic yards of contaminated soils have been removed from the former facility site either during the construction of sheet pile walls or as a remedial measure. The site continues to be monitored and reviewed for additional treatment options in those areas where natural attenuation is not achieving the expected reductions in hydrocarbon contamination. (USEPA Sept. 27, 2012)

# 6 DECISION CRITERIA FOR REMOVAL ACTIONS AT STUDIED SITES

The sites discussed above are those where EPA addressed similar COCs in similar geographic and hydrologic settings to the SJRWPs. After reviewing the RODs, AOCs, and/or Five-year Reviews for these sites, the following criteria appear to drive EPA's decisions as to using treatment or containment for dioxin-contaminated sediments.

1. Sediments contaminated at levels significantly above 1 ppb dioxin, and occurring in a discrete and geographically limited area which can feasibly be excavated or dredged without causing stability issues in the removal area (such as bank erosion or instability, slope failures, etc.), will be removed to achieve a site-specific cleanup goal.

   Note: As of February 17, 2012, EPA released its final, non-cancer dioxin reassessment, including a reference dose (RfD), in EPA's Integrated Risk Information System (IRIS). Based on this value, preliminary site cleanup goals for dioxin-contaminated soils should consider 50 ppt (parts per trillion) for residential soils and 664 ppt for industrial/commercial soils as recommended values to be used in order to be protective of human health and the environment. (USEPA February 2012) According to EPA's Office of Solid Waste and Emergency Response (OSWER) guidance on this topic, the new RfD will be used to formulate site-specific cleanup goals for CERCLA (Superfund) and RCRA sites. EPA Region 6 would be expected to apply this reference dose in determining cleanup goals at the SJRWP site.

2. A human exposure scenario exists where human cancer risk due to ingestion of contaminated seafood exceeds E-5, or the 1 additional cancer per 100,000 exposed persons, based on a Human Health Risk Assessment that took place **before** any removal actions or remedy implementation. In these cases, source removal has been selected as the treatment for highly contaminated areas.

3. Benthic fauna studies demonstrate that sediments are toxic to benthic organisms and have significant potential for biomagnification up the food web with adverse impacts at higher trophic levels. In these cases, dredging and capping, or capping only, have been chosen as the remedy.

4. In addition to meeting one or more of these criteria, sites which have been addressed since EPA developed its National Contingency Plan also address the issue of "principal threat" wastes, as discussed in Section 4 above. Such wastes must be treated except in cases such as McCormick and Baxter, where sediments are highly contaminated to a depth of 80 feet over an area of 22 acres. A removal action under such conditions is considered technically infeasible, as it would significantly impact the riverbed morphology and benthic ecosystem, and would change current and sedimentation patterns in the Willamette River for a significant period of time.

## 6.1 Application of EPA's Decision Criteria at the SJRWP Site

The dioxin-bearing waste materials at the SJRWPs clearly meet the criterion 1 listed above: the highly contaminated wastes (> 50,000 ppt, or > 50 ppb) occur within and adjacent to the footprint of the original waste lagoons, and extend to a depth of 15 feet or less. Some areas of the site are currently subaerial, and those areas which are submerged are located in areas which could safely be excavated without causing bank or channel instability.

In terms of criterion 2, the Baseline Human Health Risk Assessment at the SJRWPs took place **after** the TCRA installation of the temporary cap. The fact that EPA ordered the PRPs to implement a Time Critical Removal Action at this site prior to any Human Health Risk Assessment indicates that EPA determined that the contaminants at this site posed an immediate and serious risk to human health and the environment based on the sampling conducted at that time (USEPA April 2010). Sampling and analysis of the in-situ wastes as reported in the RI/FS indicate that extremely high concentrations (> 50,000 ppt, or > 50 ppb) of dioxins are present beneath the cap, a value far above the suggested RfD for dioxins found in the new OSWER guidance on target cleanup goals for the non-cancer toxicity of dioxin (Integral Consulting Inc, and Anchor QEA, LLC. May, 2013). If a site cleanup goal were determined by OSWER's recommendations for either residential or industrial/commercial soils, it would still require a long-term site treatment that would reduce dioxin concentrations at the site by two to three orders of magnitude in the highly contaminated wastes remaining in and adjacent to the lagoon structures. Given the persistent nature of the COCs at this site, complete removal is the only treatment which would sufficiently reduce the toxicity of the site to the recommended levels.

A recent study completed by Texas A&M (Center for Texas Beaches and Shores 2014) demonstrates through surge modeling as well as community analysis that this site is susceptible to storm surge and attendant wave action, and that vulnerable facilities and communities, including the Lynchburg Reservoir, could be significantly exposed if the current cap fails. This study indicates that a cap designed for the 100-yr storm will not be sufficient to withstand the forces associated with either storm surge, riverine flooding, or a combination of these, as commonly occurs under coastal storm conditions. In the wake of this study, EPA has contracted with the Army Corp of Engineers' Engineering Research and Development Center to model the currents and erosional forces which would likely affect the site under different storm, surge, and flooding scenarios. Pending the ACOE's report, the best indication of the insufficiency of the current cap is its need for ongoing maintenance during a period when the site has

not undergone a significant coastal storm or a riverine flood, and has been subjected to only the erosive forces consistent with ordinary rainstorms, river levels, tides, and transportation activity.

In terms of criterion 3, a baseline ecological risk assessment completed for the SJRWP site in 2012 and revised in 2013 indicates that the health risk of site sediments to benthics, fish and shellfish, birds, and mammals is low to negligible for most species. Individual birds and mammals, including the spotted sandpiper, killdeer, and marsh rice rat, may experience reproductive effects if exposed to the pre-TCRA sediment concentrations of dioxins and furans at the site of the original pits, but there is negligible expected effect on populations of these organisms (Integral Consulting, Inc. and Anchor QEA, LLC., 2012).

In terms of criterion 4, the NCP's concept of principal threat wastes, the "principal threats" at the SJRWP site are those areas of extremely high dioxin concentrations, which are located within and adjacent to the former waste lagoons. According to the expectations outlined in the NCP, this area of the site would be expected to be addressed using a treatment option, rather than "engineering controls, such as containment, " as proposed by the PRPs. The National Contingency Plan makes it clear that containment methods such as capping are not considered to be treatment, and are insufficient to address principal threats for the purposes of remedy selection. Such methods should be reserved for areas of lower-level threat, as represented at the SJRWP site by the areas of dispersed sediment outside the original lagoons. The PRPs have argued that the current cap sufficiently contains the highly contaminated waste, and is basing their comparison of remedial alternatives on post–TCRA conditions at the site. Their recommendation does not meet EPA's NCP policy, which requires treatment, rather than engineering controls, for principal threat wastes. The NCP makes no policy exceptions for areas where engineering controls have been used for a TCRA, as at the SJRWP site.

# 7 Summary of Criteria for Site Remedy Selection at Dioxin-contaminated Sites, and Implications for the Future of the SJRWP

The case studies presented above include all sites contained in EPA's Superfund Site Information database that share three primary characteristics with the SJRWP site:

1. COCs include dioxins, PCBs, and mercury, and
2. COCs are present in riverine or estuarine sediments, and
3. Environmental conditions at the site include subaerial and subaqueous exposure of contaminants in a tidally-influenced, estuarine environment (with the exception of Pacific Sound Resources and Wyckoff Co./Eagle Harbor, where the environment is fully marine).
4. Although sites were not selected for study based on this criterion, all these cases have resulted in consumption advisories for fish and/or shellfish in the affected waters surrounding the sites. These advisories are based on the increased risk of cancer and/or development effects for individuals consuming the contaminated seafood.

Analysis of these cases leads to the following conclusions:

A. In all cases, remedy selection for dioxin-contamined sediments included physical removal of the most highly contaminated sediments unless such removal would cause channel or bank instability. In the only case where sediments were not removed, the McCormack & Baxter site, the contaminants were present to a depth of 80 feet over 22 acres, and physical removal would have dramatically altered the benthic ecosystem as well as the morphology of the contaminated area. EPA has allowed this exception with the added protection of extensive and ongoing monitoring to ensure that the active capping remedy is achieving its goals of protecting the ecosystem and residents of the area.

B. In all cases, selection of sediment removal as a remedy was based on a Human Health Risk Assessment which demonstrated that the site posed an elevated cancer risk to humans through the consumption of contaminated fish and shellfish. The Human Health Risk Assessments at these sites were conducted **PRIOR TO** any removal actions taken to reduce the immediate threat of exposure from the principal threat wastes at the site.

C. In all cases, areas of lower-level, dispersed contamination were either dredged and capped, or capped. The capping material ranged from articulated block mats to a layer of sand or clean sediment. The choice of capping strategy depended on a number of factors, including water depth, erosive potential of the surface to be capped, navigational considerations, and benthic ecology and toxicity issues.

D. Remedy selection in all the cases studied conformed to EPA's policy on management of principal threat wastes as stated in the National Contingency Plan described in Section 4 above.

These studied sites, however, differ significantly from the SJRWP site in certain aspects that should be noted when drawing conclusions from them relative to the SJRWP.

Conditions at the The Calcasieu Estuary Areas of Concern most closely parallel the conditions at the SJRWP site. This site has geographic, climatic, industrial, and ecological conditions very similar to the San Jacinto River and Galveston Bay Estuary. Both Bayou Verdine and Bayou D'Inde were used as natural disposal sites for industrial effluents, which now threaten the health of the larger Calcasieu Estuary. These sites also have similar environmental justice issues involving nearby communities, particularly the community of Moss Point. Part of this site falls under the jurisdiction of EPA Region 6, as does the SJRWP site. In contrast to the SJRWP site, The Calcasieu Estuary Areas of Concern are much larger, and host a much broader range of COCs. Non-aqueous Phase Liquids (NAPL) are present at some locations, and were the subject of a TCRA in Bayou Verdine. Groundwater and air pollution are of concern at these sites in addition to soil and sediment contamination. The State of Louisiana is managing the cleanup of part of this site under state law.

All other cases studied involve former wood treating sites. Contamination at these sites resulted from past practices used in wood treatment, including directly applying chemicals to wood products on the ground surface and allowing the waste chemicals to infiltrate into the ground or run off into adjacent waters. These practices resulted in widespread, dispersed contamination in native soils and sediments, and in most cases also in shallow groundwater. A number of the sites described above have zones or horizons of free NAPL which must be removed or controled, in addition to handling the contaminated soils and sediments. As a rule, the sites studied involve a great deal more acreage than the SJRWP site, a wider array of COCs, and significantly wider dispersion of the COCs across all media (air, water, soil, and sediment).

In comparison, the SJRWP site involved the direct disposal of COCs produced elsewhere into constructed waste lagoons with clearly-defined physical boundaries. The physical site is small in comparison to the others studied. The waste came from a paper mill, rather than from wood treatment facilities or an industrial complex, so the array of COCs found at the SJRWP is smaller compared to the other studied sites. The site was not originally part of a larger industrial complex, so the high-concentration COCs are present in a well-defined area of the site. NAPL is not present at the site. These differences make the SJRWP site amenable to a physical removal remedy that could be completed fairly rapidly compared to the other sites studied, and would result in the complete elimination of the principal threat waste for all time. The other sites studied are not so lucky; full remediation is not possible at those sites, and the process of cleaning up or controlling the contaminants at those sites is likely to continue for decades.

# 8 CONCLUSIONS ON THE RI/FS PROPOSED REMEDY FOR THE SJRWP

The RI/FS for the SJRWP proposes that the final remedy for the site be the fortification of the existing armored cap. The PRPs argue that this remedy is sufficient because the Human Health Risk Assessment indicates that the cap has contained the COCs and that the concentrations of those COCs at the surface no longer pose a hazard to human health and the environment.

EPA and the PRPs at the SJRWP site entered into an AOC in 2010 for a Time Critical Removal Action in order to reduce an immediate threat of imminent harm to human and ecological health from the release of waste at this site (USEPA June 6, 2012). At the time of the AOC, the Human Health Risk Assessment had not yet been completed, so there was no baseline toxicity or cancer risk assessment on the untreated conditions at the site on which to base the final remedy selection. However, after reviewing the other cases of dioxin-contaminated sediments in the EPA database as well as the provisions of the NCP and the details of EPA's Action Memorandum for this site, it is clear that EPA only requires a TCRA in cases where humans and ecosystems are being directly exposed to these COCs at levels that require emergency action. Although there is no risk data on the wastes exposed at that time, the levels measured by the EPA warranted immediate action. EPA's requirement that a TCRA be completed at this site indicates that the concentrations of the COCs in the waste at this site constitute a principal threat waste.

EPA's stance on the handling of principal threat wastes is clearly defined in their policy described above in Section 4. Principal threat wastes are to be treated; engineering controls such as containment caps are not considered treatment unless other forms of treatment are impracticable. The current TCRA at the SJRWP site is an engineered cap. The AOC for the SJRWP site states that the TCRA remedy selected (the cap) was to be designed to contain the waste "until a final remedy is designed and implemented." The TCRA was never intended to be a final solution, and EPA's practices at other sites of much greater size and complexity demonstrate that containment of a principal threat waste containing dioxin, PCBs, and mercury is not an acceptable alternative to treatment or removal of that waste.

In conclusion, the RI/FS proposed remedy for the SJRWP site does not meet EPA's National Contingency Plan policies on management of principal threat wastes, nor does it conform to EPA's past practices at sites in similar conditions with similar COCs. EPA should consider these issues as it evaluates the remedy selection for this site. EPA's National Remedy Review Board should consider complete removal of both the residual wastes in the pits and the most highly contaminated sediments outside the original waste lagoon structures, with a containment

strategy to address sediments contaminated above recommended site cleanup goals within the site perimeter, as the remedy which best conforms to both past agency practice and stated agency policy for sites contaminated with PCBs, mercury, and dioxin. A combined strategy that removes the principal threat wastes and contains the dispersed contaminants would be the remedy most in keeping with both the National Contingency Plan and past practices for similar sites with similar contaminants.

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**Figures**

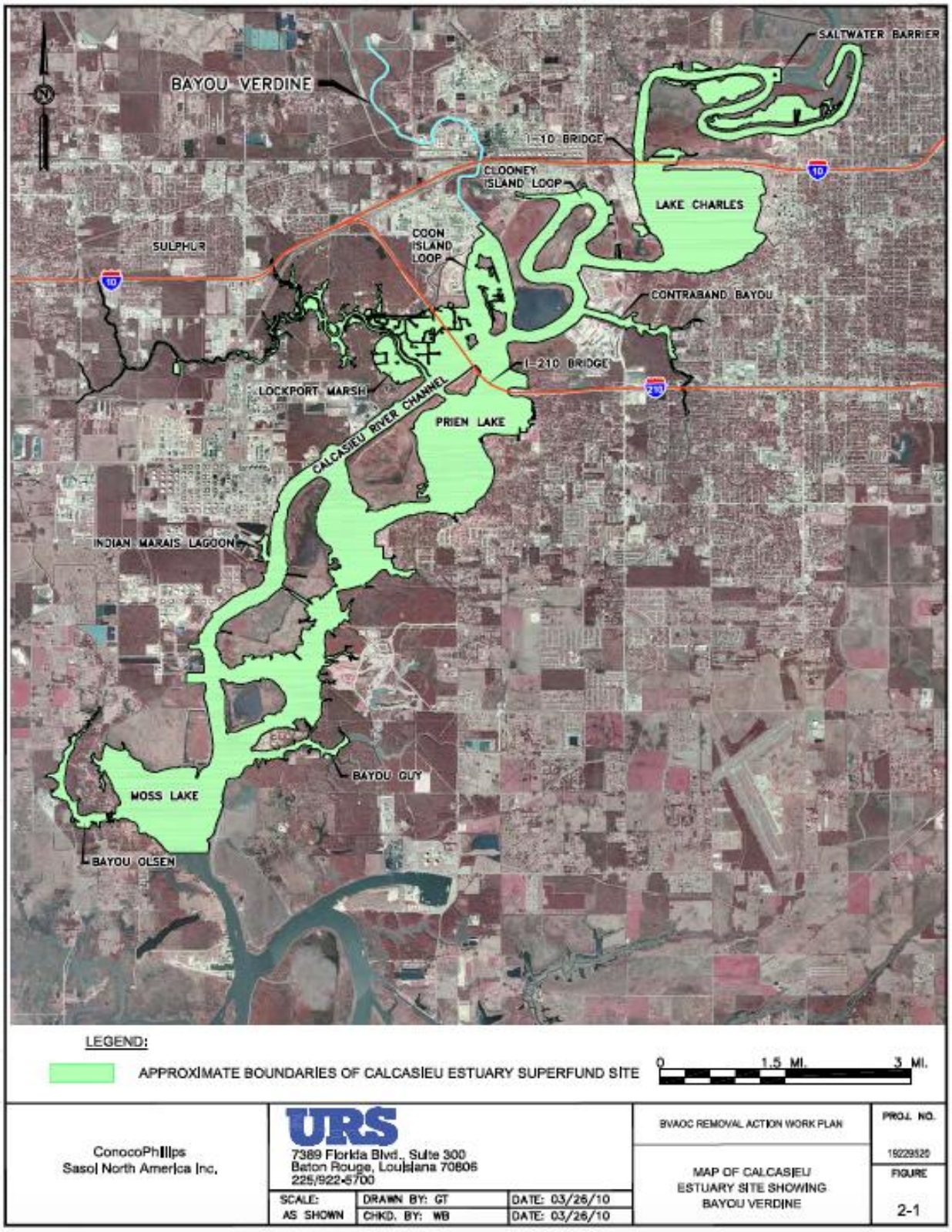


Figure 1: Location Map: Bayou Verdine, Calcasieu Parish, LA (URS 2011)

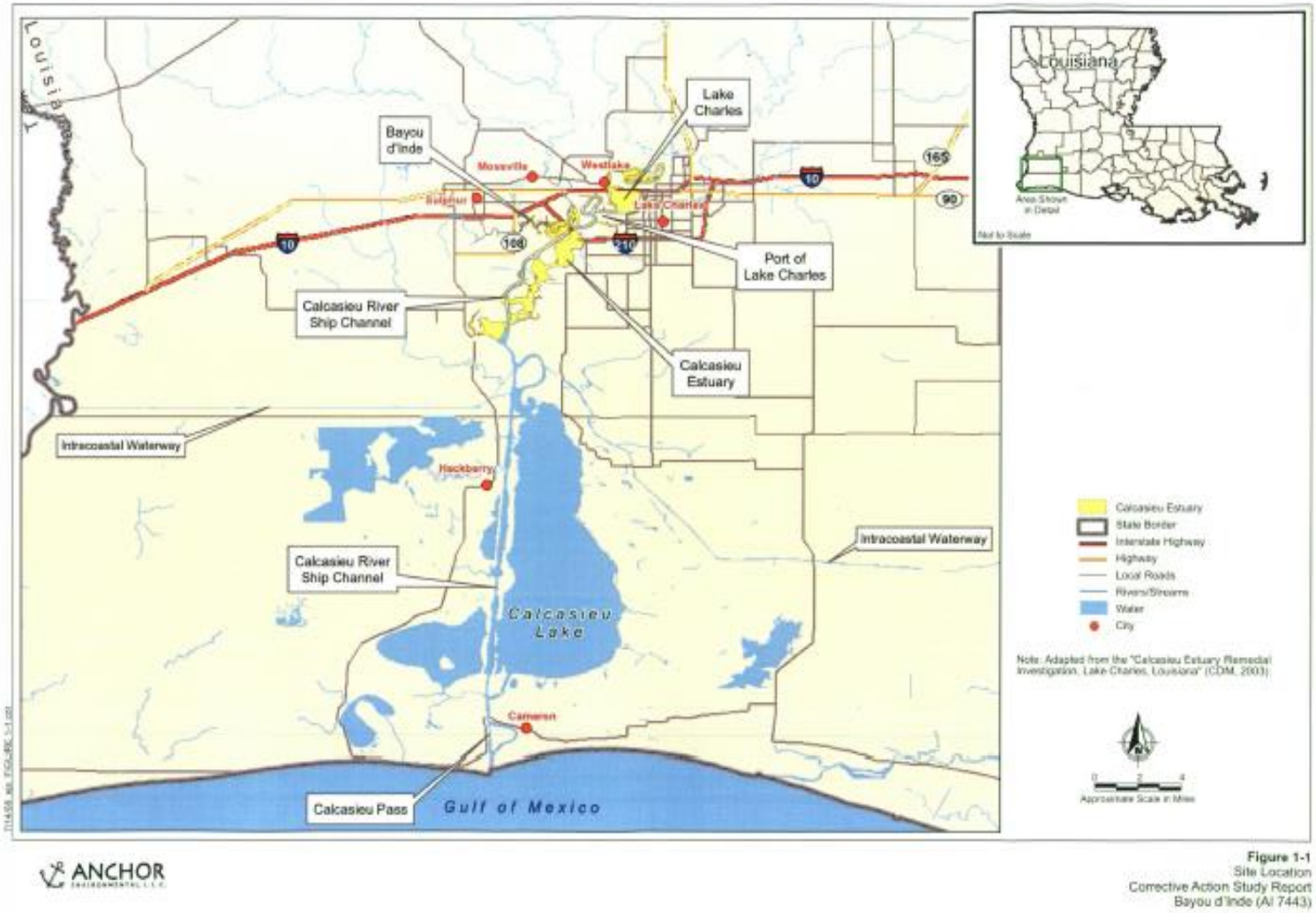


Figure 2: Location Map: Bayou D'Inde, Calcasieu Parish, LA (Bayou D'Inde Group 2009)

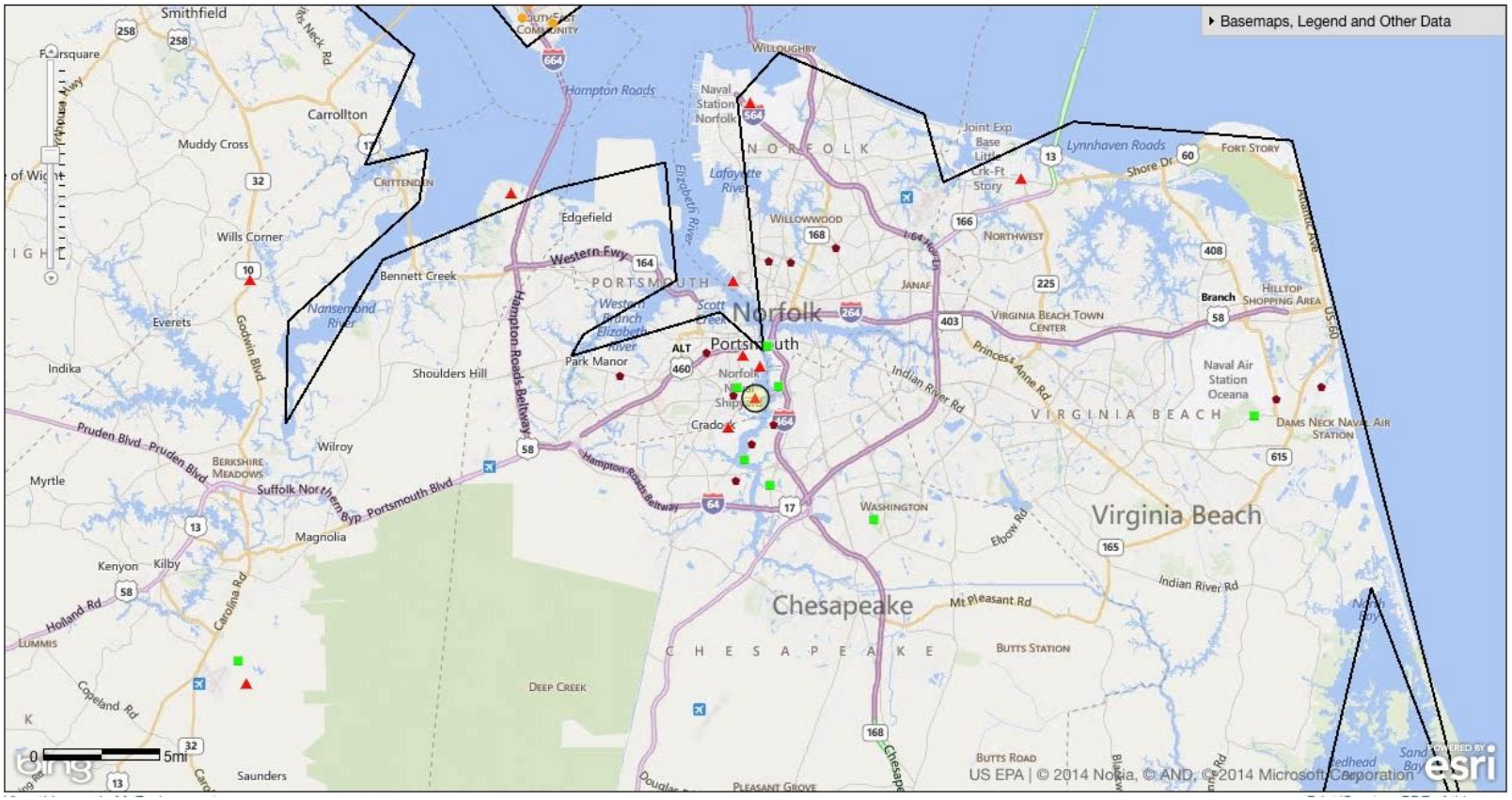


Figure 3: Location Map: Atlantic Wood Industries, Norfolk, VA (USEPA Superfund Site Progress Profile ATLANTIC WOOD INDUSTRIES, INC. (EPA ID: VAD990710410)

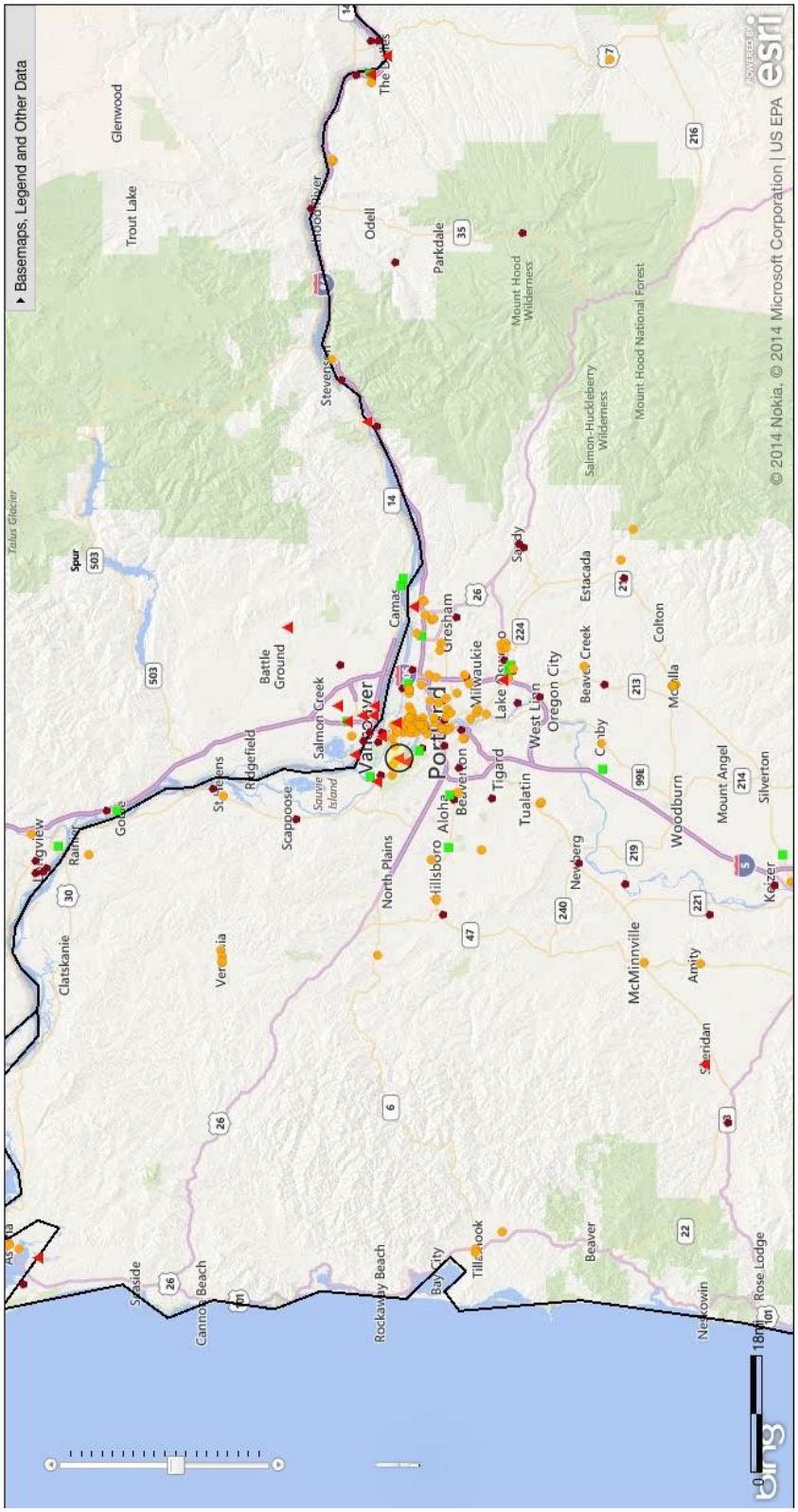


Figure 4: Location Map: McCormick & Baxter Creosoting, Portland, OR (USEPA Superfund Site Progress Profile MCCORMICK & BAXTER CREOSOTING CO. (PORTLAND PLANT)
(EPA ID: ORD009020603)

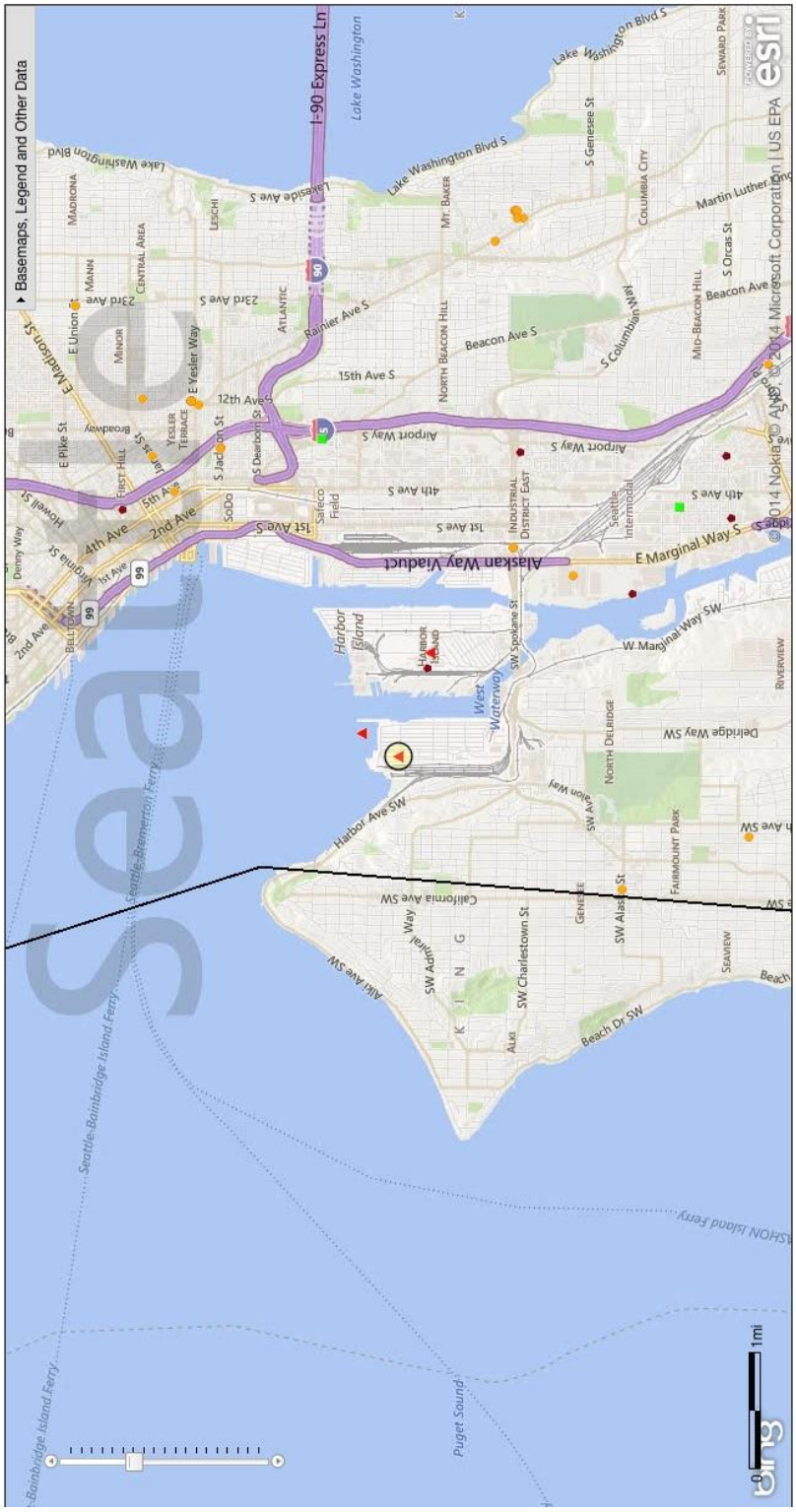


Figure 5: Location Map: Pacific Sound Resources, Seattle, WA (USEPA Superfund Site Progress Profile PACIFIC SOUND RESOURCES (EPA ID: WAD009248287))

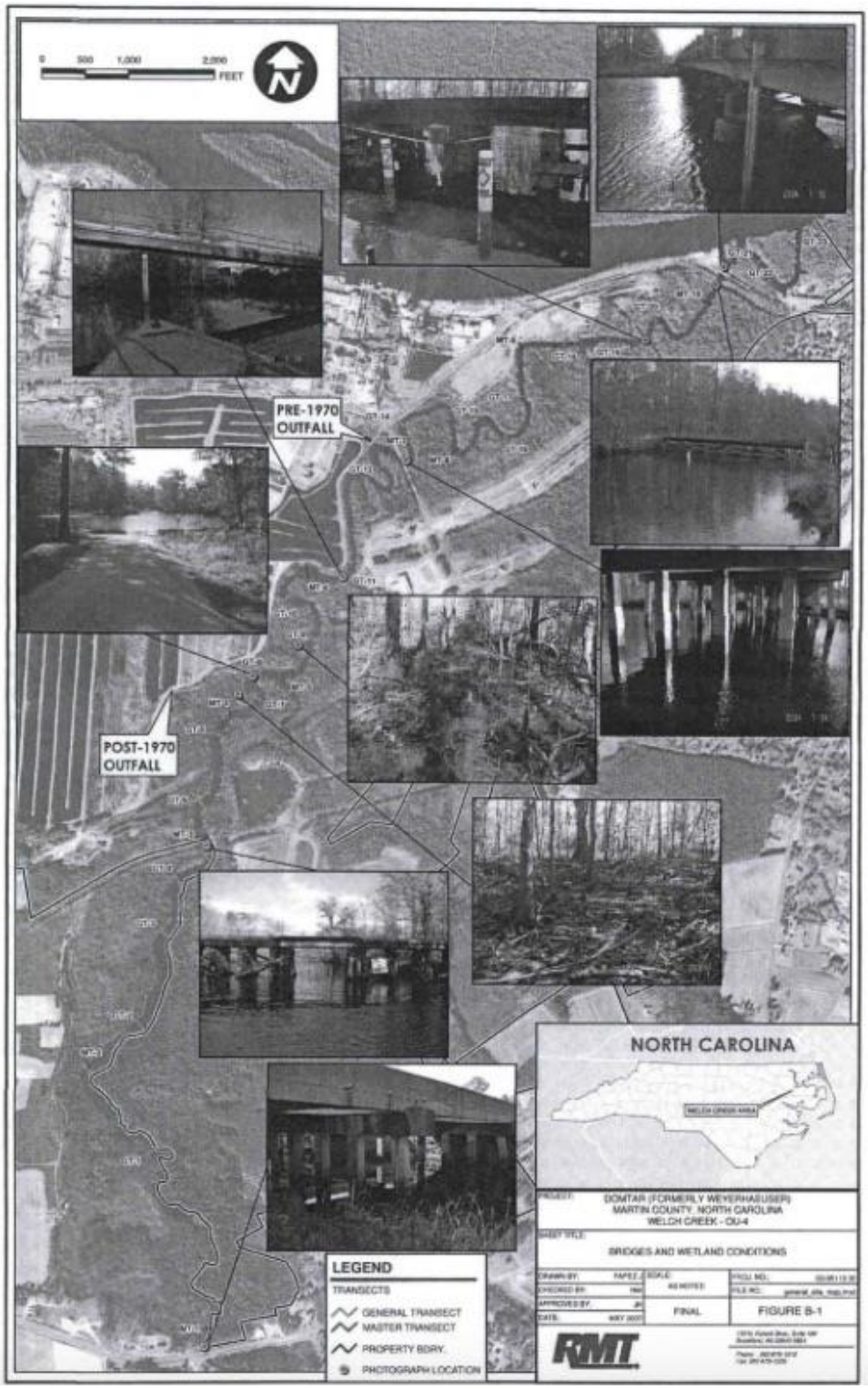


Figure 6: Location Map: Welch Creek Area of the Domtar (former Weyerhauser) Site, Plymouth, NC (USEPA September 2007)

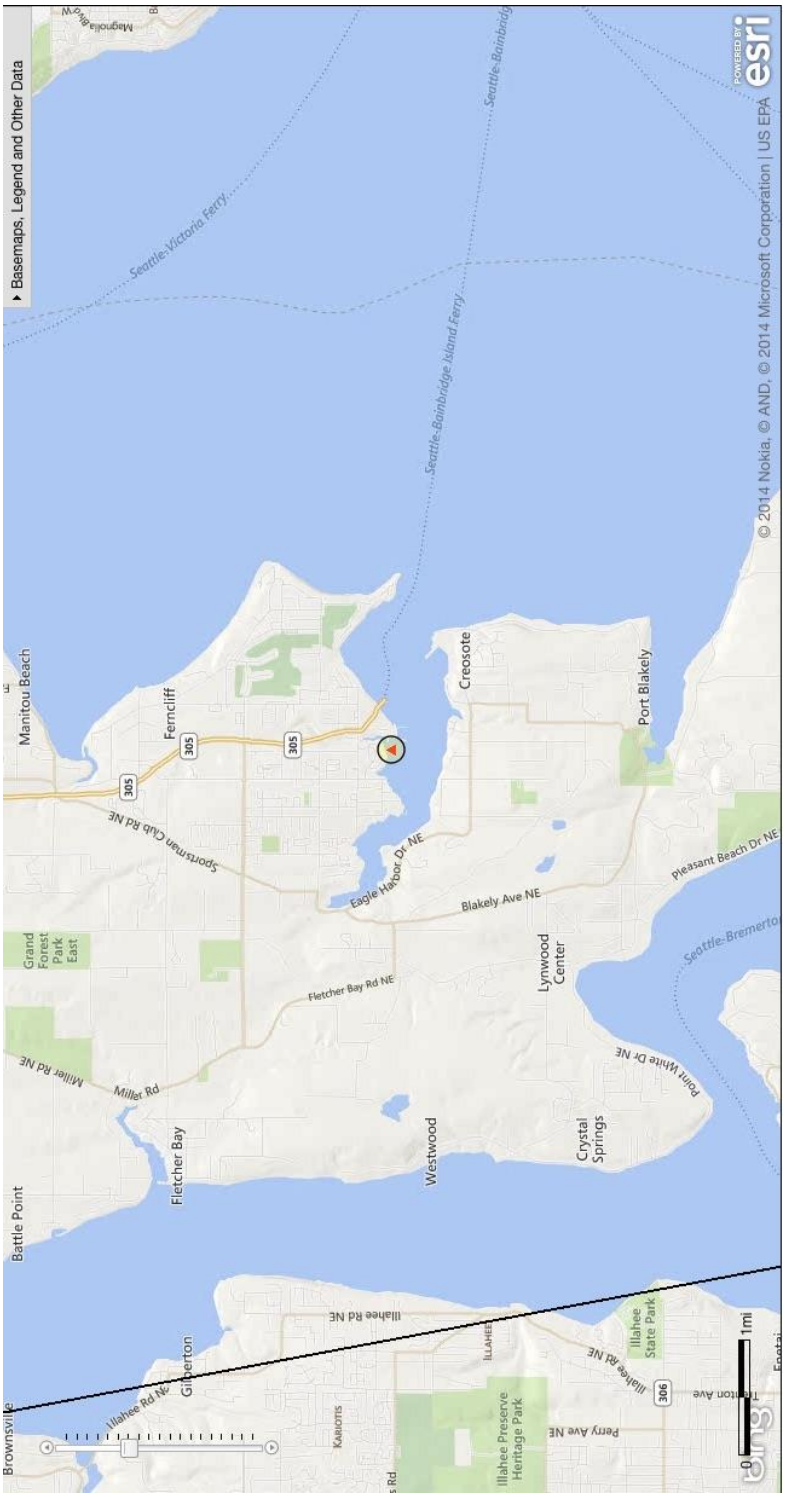


Figure 7: Location Map: Wyckoff Co./Eagle Harbor, Bainbridge Is., WA
(USEPA Superfund Site Progress Profile WYCKOFF CO./EAGLE HARBOR (EPA ID: WAD009248295))

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## EDUCATION

Penn State University
**Ph.D. Geology** **1989**
The Origin, Emplacement, and Deformation of the Crete de la Taillante Oceanic Complex, Queyras, Western French Alps.

L'Université de Bretagne Occidentale
**Diplôme des Etudes Approfondies Océanologie et Géodynamique** **1984**
Preliminary Geological Map of the Crete de la Taillante, Queyras, Western French Alps
Mention: très bien

Penn State University
**B.A. General Arts and Sciences/B.S. Earth Science, summa cum laude** **1982**
Bachelor's Thesis: The Origin of the Spring Line on Tussey Ridge, Centre County, PA

## AWARDS

Two-time Graduate School Fellow, Bourse Chateaubriand (French Gov. Fellowship), and graduate teaching awards. **1982 – 1989**
Phi Beta Kappa, Phi Kappa Phi, National Merit Scholarship, Gulf Scholarship, Penn State Alumni Memorial Scholarship **1977 – 1982**

## TEACHING EXPERIENCE

University of Houston-Clear Lake
**Lecturer, Environmental Management Program, School of Business** **2009-present**
Courses taught include: environmental assessment, environmental risk management, managing contaminated sites, graduate seminar in environmental management practices, undergraduate foundations course, and pollution control technology for undergraduates.
Service: Academic Honesty Council, Sustainability Club Sponsor, Faculty Representative to the Student Conference for Research and the Creative Arts

**Participating Adjunct, Environmental Management Program, School of Business** **2005-2009**
Developed new syllabi and course materials, both face-to-face and online, for topics including: US and international environmental assessment statutes and processes, social and cultural issues in environmental management, risk assessment, case studies in large-scale environmental problems, analyzing and solving multidisciplinary environmental problems, quantitative methods in environmental management.

PROFESSIONAL EXPERIENCE

Syntactics

**Sole proprietor** **2000 – 2003**

Established consulting practice in language arts, communication strategies, and special environmental projects. Projects include: litigation support and preparation of jury presentations; communications management for engineering firm; design of inventory control system for remedial equipment at State of NM; business development consulting and production of publications for small businesses; economic development assistance for City of Espanola; Storm Water compliance for smaller cities; environmental compliance for schools; and others

Environet, Inc.

**Senior Environmental Project Manager** **1998 – 2000**

Permit team leader for several mining projects in Arizona, New Mexico, and Texas, working with NEPA, Endangered Species, NHPA, Clean Water Act, Clean Air Act, RCRA, CERCLA, and TNRCC regulations; project leader and report author for multi-contractor team on USAID project on mining in the Andes; regulatory liaison with TNRCC, USFS, BLM, USFW, and EPA; Acid Rock Drainage Specialist

NM Energy, Minerals and Nat. Resources Dept.

**Director, Mining and Minerals Division** **1995-1998**

Led division of state government that regulates mining and mine reclamation. Oversaw four programs, 38 staff, $3.7 million budget. Implemented newly developed state mining regulations; presiding officer at numerous evidentiary and public hearings on permit matters; department lobbyist to State legislature on mining issues; trained as mediator for employee and community conflicts

NM Environment Department

**Manager, UST Reimbursement Program** **1993-1995**

Created new program to manage and process reimbursement claims for remediation of contamination from leaking underground storage tanks. Hired and trained 7 staff. Reduced paperwork by 70%. Conducted internal audit of claims, resulting in $80,000 in reclaimed costs.

**Project Manager, UST Bureau** **1992-1993**

Case manager for 36 contamination sites regulated under state-delegated RCRA program. Provided technical and regulatory advice and assistance to landowners with contaminated sites. Reviewed and responded to consultant reports on investigation and

remediation of sites. Advised legal and inspection sections on enforcement actions, site conditions, and preferred courses of action.

Chevron, USA
**Development Geologist** **1988-1992**
Developed new prospects for increasing production in existing oil fields, including new wells and workovers of existing wells. Conducted offshore well logging oversight. Assisted with information gathering and organization for sale of fields. Conducted research into log responses in unusual sedimentation conditions.

## SELECTED SPECIALIZED TRAINING

Basic Conflict Resolution (40-hr): NM Energy and Minerals, 1996
Advanced Mediation (40-hr): NM Energy and Minerals, 1997
Family Mediation (20-hr): Center for Dispute Resolution, Santa Fe, NM, 1997
Language of Mediation (8-hr): Bernalillo Co. Metro Court, 1998
Reconciliation and Peacemaking (8-hr): Bernalillo Co. Metro Court, 1998
EPA Storm Water Compliance for Small Communities (20hr), New Orleans, 1999
Professional Geologist Nonresident License, British Columbia, 1999-2001
Coastal Community Resilience Index Facilitator Certification Training, Biloxi, MS, Feb. 2011
Introduction to Green Engineering for NASA (20-hr); Stennis Space Center, MS, January 2012

## RESEARCH GRANTS

**2012** Faculty Research Support Award for continued resilience research on the Upper Texas Coast. Grant supported one RA.
**2011** Faculty Support Research Award for continued resilience research on the Upper Texas Coast. Grant supported one RA.
**2010-11** Co-PI on research grant from Environmental Institute of Houston (EIH) to create a Community Resilience Handbook for the Upper TX Gulf Coast. Grant supported one RA.
**2007-8** Co-PI on research grant from Environmental Institute of Houston (EIH) to research and review TX and US certification structures for professional geologists. Grant supported one RA.
**2005-6** Co-PI on grant from EIH to conducted research in the area of public participation in the NEPA process in Southeast Texas. Grant supported one RA.

## PUBLICATIONS

*Schmidt, Deanna, and Garland, K.A. "Bone Dry in Texas: Resilience to Drought on the Upper Texas Gulf Coast."* Journal of Planning Literature, 2012 27(4), p. 434-435.

## THESIS COMMITTEES

*Liliya Kasatkina Quebedeaux: Planning for Disaster Recovery and Resilient Communities with Faith-based and Secular Nonprofit Organizations. Submitted December, 2013. K. Garland, Chair*

*Henry Busch Hodde, III: The Damage Assessment Process: Evaluating Coastal Damage Assessments in Texas after Hurricane Ike. Submitted December, 2012. K. Garland, Chair.*

## PRESENTATIONS

*Garland*, Kathleen. A., Schmidt, D., and Quebedeaux, L. K. "Planning for Disaster Recovery and Resilient Communities with Faith-based and Secular Nonprofit Organizations."* Galveston Historical Foundation Resilience Conference, Galveston, TX, October 8-9, 2014.

*Garland*, Kathleen A., Schmidt, D., and Hodde, H. B. "The Rapid Damage Assessment Process: Putting Together the Numbers after a Coastal Storm."* Bays and Bayous Symposium 2012, Biloxi, MS, Nov. 14-16, 2012.

*Garland*, Kathleen A., Schmidt, D., and Hodde, H. B. "The Social and Natural Sciences: Necessary Partners for Creating Resilient Coastal Communities."* Western Social Sciences Assoc. 54th Annual Conference, Houston, TX, April 11-14, 2012.

*Schmidt*, Deanna, and Garland, K. A. "Resilience on the Upper Texas Gulf Coast: Coping with Insecure Water Supplies*." Western Social Sciences Assoc. 54th Annual Conference, Houston, TX, April 11-14, 2012.

*Hodde*, Henry B., Garland, K. A., and Schmidt, D. "Creating Resilient Coastal Communities."* Western Social Sciences Assoc. 54th Annual Conference, Houston, TX, April 11-14, 2012.
*Resilience Issues on the Upper Texas Coast.* Panel Discussion, CZ 2011, Chicago, IL, July 2011. Convener: K. Garland

*Garland, K. A., Gossett*, L. B. "Professional Geoscientist and Environmental Professional Licensing: Professionalism or Opportunism?"*
In Proceedings of the 2008 Annual NAEP/AEP Conference, San Diego, CA, March 2008.

*Garland, K. A., Gossett, L. B., Hazur*, H. "Public Participation in the NEPA Process in Southeast Texas."*
In Proceedings of the 31st Annual Conference of the National Assoc. of Environmental Professionals, Albuquerque, NM, April 2006

*indicates presenter

## LANGUAGES

English – Native language
French – Native speaker fluency

## SELECTED MEMBERSHIPS AND LEADERSHIP POSITIONS

Texas Association of Environmental Professionals, Houston, TX (Board Member, 2007-2009)
Board Member, Northern New Mexico Citizens Advisory Board (CAB) to Los Alamos Nat'l Lab, Los Alamos, NM 2001-2002
State-wide Camp Director, Rotary Youth Leadership Award Program (Girls), New Mexico, 2000-2001