United States Environmental Protection Agency

Environmental Protection Agency Region 6 Announces Proposed Plan

San Jacinto River Waste Pits Site
Harris County, Texas
September 2016

The Purpose of this Proposed Plan is to:

- Identify the United States Environmental Protection Agency's preferred remedial alternative to address risks associated with contaminants in fish, impounded paper mill waste, sediment, and soil at the San Jacinto River Waste Pits Site;
- Provide the Environmental Protection Agency's analysis of the results of the Remedial Investigation and Risk Assessments;
- Describe the remedial alternatives evaluated in the Feasibility Study Report;
- Solicit public review and comment on the remedial alternatives and information contained in the Administrative Record file; and
- Provide information on how the public can be involved in the remedy selection process.

The Preferred Remedy for cleaning up the Site is Alternative 6N (Removal of Materials Exceeding Cleanup Levels, Monitored Natural Recovery, and Institutional Controls) for the northern impoundments and aquatic area, and Alternative 4S (Removal and Offsite Disposal with Institutional Controls) for the southern impoundment. The institutional controls will be developed, implemented, and maintained in accordance with the Environmental Protection Agency's Institutional Controls guidance (OSWER Directive 9355.0-89).

The Site, located in Harris County, Texas (Figure 1), consists of a set of impoundments built in the mid-1960s for the disposal of solid and liquid pulp and paper mill wastes, and the surrounding areas containing sediments and soils impacted by waste materials disposed in the impoundments. The northern set of impoundments, approximately 14 acres in size, are located on the western bank of the San Jacinto River, north of the Interstate-10 (I-10) Bridge over the San Jacinto River (Figure 2). These northern impoundments are partially submerged in the river. The southern impoundment, less than 20 acres in size, is located on a small peninsula that extends south of I-10. The wastes that were deposited in the impoundments are contaminated with polychlorinated dibenzo-p-dioxins (dioxins) and polychlorinated dibenzofurans (furans). Dioxins persist in the environment for a long time because their structure is resistant to chemical or biological degradation.

The Environmental Protection Agency is issuing this Proposed Plan to solicit public comment on the remedial alternatives. This Proposed Plan is being issued in accordance with and as part of its public participation

responsibilities under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) §117(a), 42 U.S.C. § 9617(a) and the Code of Federal Regulations (CFR) § 40 Code of Federal Regulations §300.430(f)(2).

The recommendations and alternatives set forth in this Proposed Plan are based on information and documents contained in the Administrative Record file for the Site. The Environmental Protection Agency will select a final remedy for the Site after the public comment period has ended and the comments have been reviewed and considered, and the Environmental Protection Agency has responded to the comments received. The Environmental Protection Agency may select a different alternative or a modified version of the Preferred Remedy based on new information or public comments.

The Environmental Protection Agency Region 6 office is the lead agency for this Site. The Texas Commission on Environmental Quality is the support agency. As the support agency, the State reviews and comments on the remedial investigation and feasibility study, the proposed plan, the Record of Decision, and the remedial design. As part of the Public Comment Period, the state's position and key concerns related to the preferred alternative and other alternatives will be assessed prior to the Environmental Protection Agency making a final remedy selection.

How to Submit Public Comment

EPA will accept comments on the Proposed Plan during the public comment period. Initially, the EPA planned a 30-day public comment period, however, in response to requests from the community, an additional 30-day comment period was added resulting in 60-days for the comment period. The 60-day public comment period on this Proposed Plan and the information contained in the Administrative Record file begins on September 29, 2016, and closes on November 28, 2016. Comments may be submitted in one of four ways. Written comments postmarked no later than November 28, 2016, should be sent to:

EPA Remedial Project Manager
EPA Region 6 (6SF-RA)
1445 Ross Avenue, Suite 1200
Dallas, Texas 75202

Comments also may be submitted no later than November 28, 2016 either by e-mail:

R6_San_Jacinto_Waste_Pits_Comments@epa.gov

or Online:

www.epa.gov/tx/forms/sjrwp-comments

In addition, oral comments may be made on the record at the public meeting on October 20, 2016

EPA will include responses to all comments that are received during the official public comment period in a responsiveness summary that will accompany the final cleanup plan (also called the Record of Decision).

Scope and Role of Response Action

The purpose of this response action is to implement a site wide strategy that addresses the contaminated material at the Site with the primary objectives of preventing human and ecological exposure to contaminants, and preventing further migration of contaminants. This response action will:

- Prevent releases of dioxins from the former waste impoundments;
- Reduce human exposure to dioxins from consumption of fish;
- Reduce human exposure to dioxins from contact with contaminated materials; and
- Reduce exposures of benthic macroinvertebrates (clams, crabs, etc.) to dioxin.

The Preferred Alternative, 6N and 4S, consisting of removal of waste materials that exceed the Preliminary Remediation Goals, Monitored Natural Recovery, and Institutional Controls, is intended to address the threats to human health and environment. The Preferred Alternative is the only one that will reliably result in no catastrophic future release of waste material upon completion of construction. The San Jacinto River

has been subject to severe flooding in the past and future flooding may even be more severe. The river has also experienced significant changes over the last 50 to 60 years as a result of subsidence and flooding cutting new channels. This is expected to continue in the future.

Dioxin in the environment is very persistent, and is expected to remain toxic for hundreds of years. Therefore, any cleanup approach involving containment would have to reliably achieve containment for hundreds of years. The methods that can be used to predict the long-term performance of the river and the stability of a containment remedy have a high degree of uncertainty, as well as not being able to predict future changes in the river channels and riverbanks. The containment alternatives, while costing less, cannot be shown to reliably contain the waste material long-term. The benefit of removal of the dioxin waste material is that it will eliminate the possibility of a catastrophic release that could result in a much more severe impact to the environment.

Community Participation

This Proposed Plan highlights information contained in the Administrative Record for the Site. The Administrative Record includes the Remedial Investigation Report, risk assessment reports, the Evaluation of the San Jacinto Waste Pits Feasibility Study Remediation Alternatives report prepared by the U.S. Army Corps of Engineers, the Feasibility Study Report, and other documents and reports used in the preparation of this Proposed Plan.

The Environmental Protection Agency encourages the public to review these documents to obtain more information about the Superfund activities that have been conducted. The Environmental Protection Agency also encourages the public to participate in the decision-making process for the Site. The Administrative Record file is available on the internet at the following website:

https://www.epa.gov/tx/sjrwp

The Administrative Record file is also available at the following information repository locations:

Highlands Public Library Stratford Branch Library 509 Stratford Street Highlands, Texas 77562 281-426-3521	U.S. Environmental Protection Agency, Region 6 1445 Ross Avenue, Suite 700 Dallas, Texas 75202 800-533-3508	Texas Commission on Environmental Quality Central File Room 12100 Park 35 Circle, Building E Austin, Texas 78753 512-239-2900

The Environmental Protection Agency will hold a public meeting to inform residents of the proposed remedy and obtain comments on the Proposed Plan. The public meeting is being held in a fully accessible facility. Should you have questions about this facility's compliance with the Americans with Disabilities Act, please contact the Environmental Protection Agency Community Involvement Coordinator (contact information provided below). For specific information about the Texas Commission on Environmental Quality's participation in the Superfund process, please contact the Texas Commission on Environmental Quality Project Manager (contact information provided below).

EPA Community Involvement Coordinator Donn Walters EPA Region 6 (6SF) 1445 Ross Avenue, Suite 1200 Dallas, Texas 75202 214-665-6483; walters.donn@epa.gov	TCEQ Project Manager Satya Dwivedula MC-136 Texas Commission on Environmental Quality PO Box 13087 Austin, Texas 78711-3087 512-239-3548; satya.dwivedula@tceq.texas.gov

Site History

In the 1960s, McGinnes Industrial Management Corporation transported liquid and solid pulp and paper mill wastes by barge from the Champion Papers, Inc. paper mill in Pasadena, Texas to impoundments located north of I-10, adjacent to the San Jacinto River, where the waste was stabilized and disposed. Champion Papers, Inc. business records indicate the paper mill produced pulp and paper using chlorine as a bleaching agent. The pulp bleaching process forms dioxins and furans as by-products.

The northern impoundments were used for waste disposal from September 1965 to May 1966. Details regarding the southern impoundment are less well known; however, the southern impoundment was used by Ole Peterson Construction Company prior to construction of the northern impoundments for disposal of the same type wastes generated by Champion Papers, Inc.

Sand mining also occurred in the vicinity of the Site; sand mining operations contributed to the release of waste from the pits, specifically by the creation of an area of elevated dioxin contamination in the sand separation area. In August 2016, the EPA notified MegaSand Enterprises, Inc., of its potential liability as a result of its sand mining operations.

Temporary Armored Cap

Since its completion in July 2011, the armored cap has generally isolated the waste, but has required many repairs and extensive maintenance. The following instances of erosion or missing armor stone have occurred since the time of armored cap installation:

- July 2012: Approximately 200 square feet (ft^2) of stone eroded and geotextile exposed (armor materials had moved down slope). Following EPA approval of the repair plan, additional stone was added to achieve the required cap thickness. Repairs were completed August 3, 2012.
- January 2013: Five areas missing part or all of armor stone with exposed geotextile in some areas of the Eastern Cell. Following EPA approval of a repair plan, additional stone was added to achieve the required cap thickness. Repairs were completed January 30, 2013.
- January 2014: The U.S. Army Corps of Engineers evaluated the design & construction of the cap and found that improvements were needed, including flatter slopes and larger rock in some areas. Following EPA approval of a repair plan, additional rock was added with construction completed on January 13, 2014.
- December 2015: Following an inspection by the EPA Dive Team, approximately 500 ft^2 of cap was missing or deficient in cover (no geotextile, paper mill waste exposed to the river, sediment concentration measured at 43,700 ng/kg dioxin exposed to river). The EPA ordered repair of this area, and following EPA approval of a repair plan, geotextile & new rock was added to repair the area with construction completed on January 4, 2016.
- February 2016: Missing rock in portions of eastern cell (five areas up to 6 ft^2 each with some exposed geotextile). The EPA ordered repair of this area, and after EPA approval of the repair plan, new rock was added to repair the area with construction completed on March 15, 2016.
- March 2016: Approximately 500 locations in the Eastern Cell were probed to check for cap thickness and eight additional areas of missing rock were found. During repairs, additional areas of missing rock and exposed geotextile were found. Following EPA approval of the repair plan, new rock was added over a total area of 170 ft^2 with construction completed on March 31, 2016.
- June 2016: Following an inspection by the EPA Dive Team, ten areas of missing rock were found in the Western Cell up to 300 ft^2. Following EPA approval of the repair plan, new rock was added to repair the areas with construction completed on June 17, 2016.

The cap was designed to withstand a hundred year storm, yet the above cases of eroded or missing armor stone all occurred with flooding less than less that the design 100-year storm.

Early Investigations

Between 1993 and 1995, the City of Houston conducted a toxicity study of the Houston Ship Channel that included the San Jacinto River. Sediment, fish, and crab samples collected near the Site indicated elevated dioxin and furan levels.

Between 2002 and 2004, the Texas Commission on Environmental Quality conducted a study of total maximum daily loads (TMDL) for dioxins and furans in the Houston Ship Channel. Sediment, fish, and crab samples indicated the presence of dioxin and furan contamination in the San Jacinto River surrounding the Site. In April 2005, the Texas Parks and Wildlife Department sent a letter notifying the Texas Commission on Environmental Quality of the existence of former waste pits in a sandbar in the San Jacinto River north of I-10. The letter included: 1) discussion of anecdotal evidence, that indicated the pits were likely used from the mid-1960's to mid-1970's for disposal of paper mill waste; 2) data collected during the Houston Ship Channel Toxicity Study and TMDL study, discussed in the paragraph above; 3) documentation of U.S. Army Corps of Engineers dredge and fill permits in the area; and 4) requested that the Texas Commission on Environmental Quality further investigate the Site.

Contamination

Improper disposal of paper mill wastes has resulted in contaminated sediment, soil, and fish. The paper mill waste is considered Principal Threat Waste.

National Priorities Listing

The site was proposed for listing on the National Priorities List on 19 September 2007, and was placed on the list effective 19 March 2008 (73 FR 14723).

A preliminary assessment and screening site inspection was completed in 2006 to determine if the Site was eligible for proposal to the National Priorities List. Sediment sample results indicated elevated concentrations of dioxin congeners. The former surface impoundments were identified as the source of hazardous substances at the Site. Following this assessment and inspection, the site was proposed for listing on the National Priorities List on September 19, 2007, and was placed on the list effective March 19, 2008.

Unilateral Administrative Order for Remedial Investigation/Feasibility Study

In July 2009, the Environmental Protection Agency provided International Paper Company and McGinnes Industrial Maintenance Corporation an opportunity to negotiate an agreement to perform the Remedial Investigation and Feasibility Study for the San Jacinto River Waste Pits Site. They failed to submit a good faith offer to negotiate an Administrative Order on Consent for the Remedial Investigation and Feasibility Study, and, because of the ongoing release of hazardous substances at the Site, the Environmental Protection Agency concluded that work at the Site could no longer be delayed. Therefore, on November 20, 2009, the Environmental Protection Agency issued a Unilateral Administrative Order to International Paper Company and McGinnes Industrial Management Corporation. International Paper Company is the successor to Champion Papers, Inc. Champion Papers, Inc. had arranged for the disposal of the paper mill waste materials containing dioxin that were disposed of at the Site.

The paper mill waste contains Comprehensive Environmental Response, Compensation, and Liability Act hazardous substances. McGinnes Industrial Maintenance Corporation operated the waste disposal facility at the time of disposal of the waste. The Unilateral Administrative Order directed International Paper Company and McGinnes Industrial Management Corporation to conduct a Remedial Investigation and Feasibility Study in accordance with provisions of the order; the Comprehensive Environmental Response, Compensation, and Liability Act; the National Oil and Hazardous Substances Pollution Contingency Plan; and Environmental Protection Agency guidance.

Between 2010 and 2013, site-specific data were collected for the remedial investigation. The remedial investigation included the collection of paper mill waste, sediment, tissue (i.e., hardhead catfish, Gulf killifish, rangia clam, and blue crabs), soil, and groundwater samples for analyses including dioxins and furans, polychlorinated biphenyls (PCBs) as Aroclors, metals, semivolatile organic compounds, volatile organic compounds, and pesticides. Physical data collected during the remedial investigation included: a bathymetric survey, current velocity, material, geotechnical, riverbed properties, sediment loading, erosion rates of cohesive sediment, and net sedimentation rates.

The Potentially Responsible Parties prepared a draft Feasibility Study report under Environmental Protection Agency oversight. Following review and comment by the Environmental Protection Agency and other Site stakeholders on the draft, a revised draft Feasibility Study was submitted to the Environmental Protection Agency. Following review of the Potentially Responsible Parties' second draft, the Environmental Protection Agency decided to revise and complete the Feasibility Study report. The Environmental Protection Agency entered into an agreement with the U.S. Army Corps of Engineers to review the Feasibility Study and to provide additional information and modelling analysis.

Administrative Settlement Agreement and Order on Consent for Removal Action

In 2010, the Environmental Protection Agency decided that it was necessary to stabilize the site, temporarily abating the release of dioxins until the Site was fully characterized and a remedy could be implemented. On May 11, 2010, the Environmental Protection Agency filed the Administrative Settlement Agreement and Order on Consent for Removal Action, which was entered into voluntarily by the Environmental Protection Agency, International Paper Company, and McGinnes Industrial Management Corporation. The Administrative Settlement Agreement and Order on Consent for Removal Action provided for the performance of a Time Critical Removal Action.

The Environmental Protection Agency Administrative Order required the Potentially Responsible Parties to construct the temporary armored cap to stabilize the northern impoundments to withstand forces sustained by the river, including a cover design that

Public Participation Activities

EPA in coordination with State, County and local agencies has provided public information and outreach for the site area since 2011 by:

- Hosting 10 community meetings or Open Houses that provided updates to community members on the status of remedial investigations, upcoming actions, and cap repair updates.
- Coordinating 15 Community Awareness Committee Meetings or Teleconferences that provided a forum for members to express concerns on issues and to ensure that EPA provided answers in a timely manner.
- Three Harris County Elected Officials briefings were held to provide updates to the officials.
- A Technical Assistance Grant was awarded to the Galveston Bay Foundation in May 2011 to provide members an ongoing explanation of technical issues. The Grant funding has now expired.
- The site was included as a pilot under the Community Engagement Initiative. Region 6 provided a World Café format at a nearby community in 2010 to kick-off the site work. Residents and media participated to learn more about the Project.
- EPA worked with the Texas Department of State Health Services who has provided 3 different neighborhood health door to door surveys to identify concerns and provide health related information.
- EPA worked with the State to provide extensive River use Warnings, and posting Fish Advisory Signage throughout the area. Health agencies working with the Potentially Responsible Parties provided the signs.

EPA continues to plan and coordinate community meetings, open houses, elected officials briefings, media interviews, public notices, and fact sheets to inform the public and keep residents updated on all site developments that affect cleanup actions. Site fact sheets are available on the Site profile webpage identified on page 2.

considered storm events with a return period of 100 years, and prevent direct human and benthic organism contact with waste materials. Elements of the selected temporary armored cap construction included a perimeter fence on the uplands to prevent unauthorized access; placement of warning signs around the perimeter of the northern impoundments and on the perimeter fence; design and implementation of an operations, monitoring, and maintenance plan; and installation of an armored temporary cap with the following items:

- A stabilizing geotextile underlayment over the northern impoundment eastern cell
- Treatment through solidification of a portion (6,000 cubic yards in the upper 3 feet over 1.2 acres) of the western cell for construction equipment access
- An impervious geomembrane underlayment in the northern impoundment western cell
- A cover consisting of small rock grains over the northwestern area of the northern impoundment western cell
- A cover consisting of small rock grains above the geotextile and geomembrane in the northern impoundment western cell
- A cover consisting of small rock grains above the geotextile in the northern impoundment eastern cell.

From December 2010 through July 2011, the Potentially Responsible Parties constructed a temporary armored cap under Environmental Protection Agency oversight. After the repairs in 2012, the Corps of Engineers reviewed the design of the damaged area and made recommendations that included flattening the impoundment slopes and adding bigger size rock. Even after these changes and repairs, the impoundment continued to experience numerous damages and deficiencies from floods that were less than a 20-year flood, even though the northern impoundment was designed for a 100-year flood.

The Potentially Responsible Parties have continuing obligations with respect to the temporary cap, including cap inspections, surface and bathymetric surveys, sign and fencing inspections, and maintenance. The Operation, Monitoring, and Maintenance Plan has been modified because the original program of regular inspections failed to identify deficiencies in the cap discovered in December 2015 by the Environmental Protection Agency's Dive Team. The temporary armored cap inspection events now include: 1) visual inspection of the security fence, signage and the armored cap, 2) collection of topographic survey data for the portions of the armored cap that are located above the water surface, 3) collection of bathymetric survey data for the portions of the armored cap that are below the water surface, and 4) manual probing of armored cap thickness at areas identified by the topographic or bathymetry surveys as more than 6 inches lower in elevation than during the prior survey. Inspection and repair reports, as needed, are submitted to the Environmental Protection Agency.

General Area of the Time Critical Removal Action

Modified from: Integral Consulting Inc. and Anchor QEA, LLC. 2013. Remedial Investigation Report, San Jacinto River Waste Pits Superfund Site. Prepared for: McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. May.

Site Characteristics

United States Army Corps of Engineers Evaluation

The United States Army Corps of Engineers 2016 report was prepared for EPA in order to evaluate and supplement Feasibility Study work performed by the Potentially Responsible Parties. Alternative 6N* from the Corps report is the same as EPA's 6N used in this Proposed Plan. An EPA analysis of the United States Army Corps of Engineers 2016 report can be found in the Feasibility Study. The United States Army Corps of Engineers report's evaluation of containment is contingent on the continued integrity of the armored cap and is limited by uncertainties in modeling. For example, the report provided the following information that is relevant to consideration of the temporary armored cap and long-term permanence.

According to the report, the most severe event simulated was the hypothetical synoptic occurrence of Hurricane Ike and the October 1994 flood, with a peak discharge of approximately 115,000 cubic feet per second occurring at the time of the peak storm surge height at the Site. The results during the peak of the storm surge showed that the sections using Armor A (3-inches diameter) were completely eroded, while the sections using Armor D (10-inches diameter) were eroded more than 12 inches in about 33 percent of those sections. The sections using Armor B and C (6-inches diameter) incurred a net erosion of more than 9 inches in about 75 percent of those areas. Overall about 80% of the cap experienced significant erosion with scour reaching approximately 2.4-feet through the cap and into the waste material. The scenario defined above may cause significant erosion of the paper mill waste. The releases from catastrophic events can potentially be addressed by additional cap improvements, including upgrading the blended filter in the Northwestern Area to control sediment migration into the cap, upgrading the armor stone size to a diameter of 15 inches and adding 2 feet of additional armor stone over the existing cap across the waste pits to minimize the potential for disturbance during very severe hydrologic and hydrodynamic events. However, the uncertainty inherent in any quantitative analysis technique used to estimate the long-term (500 years or more) reliability of the cap is very high.

The Corps report did not consider changing river conditions. New channels eroding during flooding as well as changes in channel cross section due to bank erosion, shoreline breaches, etc. during a high flow event caused by a major flood or hurricane is beyond the ability of existing sediment transport models to simulate. In addition, the report's evaluation of excavation and removal often focuses on risks which will be reduced and/or eliminated through use of best management practices.

There appears to be no documented cases of any armored cap or armored confined disposal facility breaches. However, there have been many occurrences of breaches and slope failures of armored dikes, jetties, and breakwaters, with some of those structures confining dredged material.

The Site is located in the estuarine portion of the lower San Jacinto River where the river begins to transition from a river system to a delta. River conditions have significantly changed with respect to the location of the waste impoundments. See Figures 3 through 6. These photos clearly show that the river channel has changed due to weather events and sand mining operations. These river changes will continue and could cause a catastrophic release of the highly toxic waste materials from the impoundments, if they remain in place.

Extreme weather events also could result in severe flooding and the possibility of damage to the cap and a release of contaminants from the Site.

Tropical weather systems in the region can have tremendous impacts on regional precipitation and hydrology along the Gulf Coast. Heavy precipitation events produce wide variations in the volume of discharge into and out of the San Jacinto River and may significantly affect variations in flow velocities, sediment transport, suspended sediment loads, and water levels. Floods in the river occur primarily during tropical storms, hurricanes, or intense thunder storms. Extreme flood events have flow rates of 200,000 cubic feet per second or greater. Floods can cause water surface elevations to increase by 10 to 20 feet or more (relative to average flow conditions) and force the river out of its main channel.

Between 1851 and 2004, 25 hurricanes have made landfall along the north Texas Gulf Coast, seven of which were major (Category 3 to 5) storms. Tropical Storm Allison, which hit the Texas Gulf Coast in June 2001, resulted in 5-day and 24-hour rainfall totals of 20 and 13 inches, respectively, in the Houston area, resulting in significant flooding. More recently, Hurricane Rita made landfall in September 2005 as a Category 3 storm with winds at 115 miles per hour. The storm surge caused extensive damage along the Louisiana and extreme southeastern Texas coasts. In September 2008, the eye of Hurricane Ike made landfall at the east end of Galveston Island. Ike made its landfall as a strong Category 2 hurricane, with Category 5 equivalent storm surge, and hurricane-force winds that extended 120 miles from the storm's center.

In October 1994, heavy rainfall occurred in southeast Texas resulting in the San Jacinto River Basin receiving 15 to 20 inches of rain during a week-long period. One of the largest measurements of stream flow ever obtained in Texas, 356,000 cubic feet per second (cfs), was made on the San Jacinto River near Sheldon on 19 October 1994 at a stage of 27 feet. During the measurement, velocities of water that exceeded 15 feet per second (about 10 miles per hour) were observed. Another storm occurring in 1940 had a river stage height of 31.5 feet at the same Sheldon location. The 100-year flood, which is defined as the peak stream flow having a one percent chance of being equaled or exceeded in any given year, was exceeded at 18 of 43 stations monitoring the area. For those stations where the 100-year-flood was exceeded, the flood was from 1.1 to 2.9 times the 100 year-flood.

The 1994 flooding caused major soil erosion and created water channels outside of the San Jacinto River bed. This flooding caused eight pipelines to rupture and 29 others were undermined at river crossings and in new channels created in the flood plain outside of the San Jacinto River boundaries. The largest new channel was cut through the Banana Bend oxbow just west of the Rio Villa Park subdivision, about 2½ miles northwest of the Site. This new channel was approximately 510-feet wide and 15-feet deep. A second major channel cut through Banana Bend just north of the channel through the oxbow. Both of these new channels were cut through areas where sand mining had been done before, as is the case in the vicinity of the Site. Sonar tests in a 130-foot section south of the I-10 Bridge located adjacent to the Site found about 10 to 12-feet of erosion from the bottom of the river bed.

The San Jacinto River is a very dynamic system, subject to changes in size and flow paths as experienced during the 1994 storm. A series of aerial photographs illustrate this variability. An aerial photograph taken in 1956 (Figure 3), before the waste pits were established, shows I-10 crossing the river and extensive islands and land to the north. The next photograph, from 1966 (Figure 4), shows the northern pits located just west of the I-10 Bridge (the pits were built and in operation in the mid–1960s); significant changes to the north can be seen compared to the 1956 photograph. Land erosion and subsidence is evident in the next photograph from 1973 (Figure 5); there is a new passage to the west of the site since the 1966 photograph. Photographs in the 1990's and later (Figure 6) show continued loss of land.

The Corps of Engineers performed an evaluation of the San Jacinto River and the armor cap using hydrodynamic and sediment transport models. These models have to predict the river conditions for a very long time because dioxin is extremely persistent in the environment and will remain toxic for a very long time. The uncertainty inherent in any quantitative analysis technique used to estimate the long-term performance of the river and cap is very high. Further, changes in the river channel due to bank erosion, shoreline breaches, etc. during a high flow event caused by a major flood or hurricane is beyond the ability of any existing sediment transport model to simulate. The changes that the river has experienced over the last 50 years as described above will likely continue in the future; and these changes are specifically what the current models cannot simulate. Therefore, the model predictions should be considered as having a very limited long term reliability.

Future flooding may be even more intense. According to the U.S. National Climate Assessment, flooding along rivers and other areas following heavy downpours and prolonged rains is exceeding the limits of flood protection infrastructure designed for historical conditions. Sea level rise, storm surge, and heavy downpours in combination with the pattern of continued development in coastal areas are increasing damage to U.S. infrastructure and are also increasing risks to ports and other installations. Because the intensity of future storms and flooding may increase, estimates regarding the ability of a cap (even a cap with increased armoring) to contain the dioxin waste material is highly uncertain.

The waste material is highly toxic and may be highly mobile in a severe storm and therefore is considered a Principal Threat Waste. The Environmental Protection Agency considers material at the Site with more than 300 ng/kg dioxin to be Principal Threat Waste. This concentration was calculated by multiplying the sediment Preliminary Remediation Goal of 30 ng/kg by a factor of 10.

Nature and Extent of Contamination – Waste Pits North of I-10

The waste material in the Site pits contains tetra-chlorinated dioxin, which is one of the most toxic kinds of dioxin. Surface water samples prior to construction of the cap show that there were dioxin releases to the river (samples collected from 2002 to 2009); and the University of Houston indicated that high levels of dioxin were present in the river surrounding the Site and within a mile downstream of the Site. Dioxins biodegrade very slowly. The Environmental Protection Agency estimates that, for dioxins that are not exposed to sunlight, the dioxin half-life is in a range from 25 to 100 years. The tetra-dioxin found at the Site has much more bio-concentration potential in organisms as opposed to the more highly chlorinated

Principal Threat Wastes

The National Contingency Plan establishes an expectation that EPA will use treatment to address the principal threats posed by a site wherever practicable (National Contingency Plan § 300.430(a)(1)(iii)(A)). In general, principal threat wastes are those source materials considered to be highly toxic or highly mobile and which generally cannot be contained in a reliable manner or would present a significant risk to human health or the environment should exposure occur. The "principal threat" concept is applied to the characterization of "source materials" at a Superfund site.

Elevated concentrations of dioxin have been detected at the Site:

- Waste material in the waste pits (more than 43,000 ng/kg)
- Soil in the Southern Impoundment (more than 50,000 ng/kg).

Dioxin is highly toxic and persistent in nature (will not breakdown for hundreds of years). With the regular occurrence of severe storms and flooding in the area, there is uncertainty that the waste material can be reliably contained over the long term and therefore should be considered potentially highly mobile due to its location in a dynamic river environment.

Because the dioxin waste in the northern impoundments and southern impoundment at the site is both highly toxic and potentially highly mobile (due to river flooding), it is considered a principal threat waste. The Environmental Protection Agency considers material at the Site with more than 300 ng/kg of dioxin to be Principal Threat Waste.

dioxin congeners, including the octa-chlorinated dioxin, which is generally found in higher concentrations throughout the River. The tetra-dioxin also is more resistant to biotransformation in the environment than the octa-dioxin.

The EPA classifies dioxin as a probable human carcinogen. Dioxin increases the risk for several individual cancers, including soft-tissue malignant tumor (sarcoma), lung cancer, cancer of the lymphatic tissue (non-Hodgkin's lymphoma), and malignant enlargement of the lymph nodes, spleen, and liver (Hodgkin's disease). Dioxins have also been linked to many non-cancer effects, including birth defects, reproductive abnormalities, developmental effects, immune dysfunction, liver damage (hepatotoxicity), peripheral nerve damage (neuropathy), hormone disruption, and dermatological disorders (chloracne).

The waste material in the pits north of I-10 contain elevated concentrations of dioxins and polychlorinated bi-phenyls. The highest average concentrations of dioxin in surface and subsurface material north of I-10 occur in the northern impoundments (Figure 7). The maximum dioxin concentration in surface material (43,000 ng/kg) occurs in the northwest portion of the western cell of the impoundments. A water sample collected from within the waste pits contained 3,770 pg/L dioxin

The sample with the highest dioxin-like polychlorinated bi-phenyl concentration of 2.83 ng/kg was collected from within the northern impoundments. Concentrations of polychlorinated bi-phenyls in sediments were either significantly correlated with concentrations of dioxins or were non-detect.

Ground water sampling was conducted at three locations within the perimeter of the northern waste pits from each of two ground water bearing units below the waste pits. These ground water units contained brackish to saline ground water. Samples from five of the six wells did not detect any dioxins. The sixth well screened in the uppermost ground water bearing unit below the waste pits did detect dioxin/furan at a concentration (2.64 pg/L) that is much lower than the maximum contaminant level of 30 pg/L for a drinking water zone. Harris County also sampled a total of 101 private water wells near the Site located to the east of the San Jacinto River. The analysis results did not find any exceedances of dioxin drinking water standards.

Surface soil samples were collected from areas adjacent to the waste pits on both the east and west banks of the San Jacinto River. These samples, collected within the 100-year flood plain, contained a maximum dioxin level of 12 ng/kg, which is within the background dioxin range for soils (0.4 to 23 ng/kg).

Nature and Extent of Contamination – Surface Water and Sediment

Sediment is the material deposited at the bottom of the San Jacinto River outside of the waste pits. Dioxin results in this sediment are typically three to four orders of magnitude lower than the waste within the pits. The attached map shows that there are elevated levels of dioxins associated with Site wastes in sediments outside of the waste pits (Figure 7). The maximum background sediment dioxin level is less than 7.2 ng/kg.

The highest dioxin levels outside of the waste pits are in the sand separation area, which is located in the San Jacinto River approximately 1000 feet northwest from the waste pits. The sand separation area (Figure 2) is where sand was separated from the rest of the dredged material during sand mining. To date, two sample results over 300 ng/kg were found in the sand separation area, but based on other samples, the EPA does not believe these two results are representative, and additional sediment sampling may be conducted there.

Surface water samples collected between 2002 and 2009 by the Texas Commission on Environmental Quality and the University of Houston showed elevated levels of dioxins in the San Jacinto River near and downstream from the waste pits.

The average surface sediment dioxin concentration within the Preliminary Site Perimeter, including the sand separation area, is 12.5 ng/kg outside of the temporary cap. About 190 acres (Figure 8) in this area exceed the sediment background concentration. Even though the average sediment concentration is 12.5 ng/kg, there are about 43 acres (Figure 9) that exceed the sediment PRG of 30 ng/kg, discussed in the "Remedial Action Objectives and Preliminary Remediation Levels" section below. The location of the surface sediment background samples is shown in Figure 10.

The dioxin-like Polychlorinated Bi-Phenyl concentrations outside of the waste pits are below 1 ng/kg except for one surface sample (6.85 ng/kg) and one subsurface sample (1.58 ng/kg) located along the northwest portion of the peninsula south of I-10. The dioxin-like Polychlorinated Bi-Phenyl concentrations do not significantly add to the total dioxin equivalent concentration.

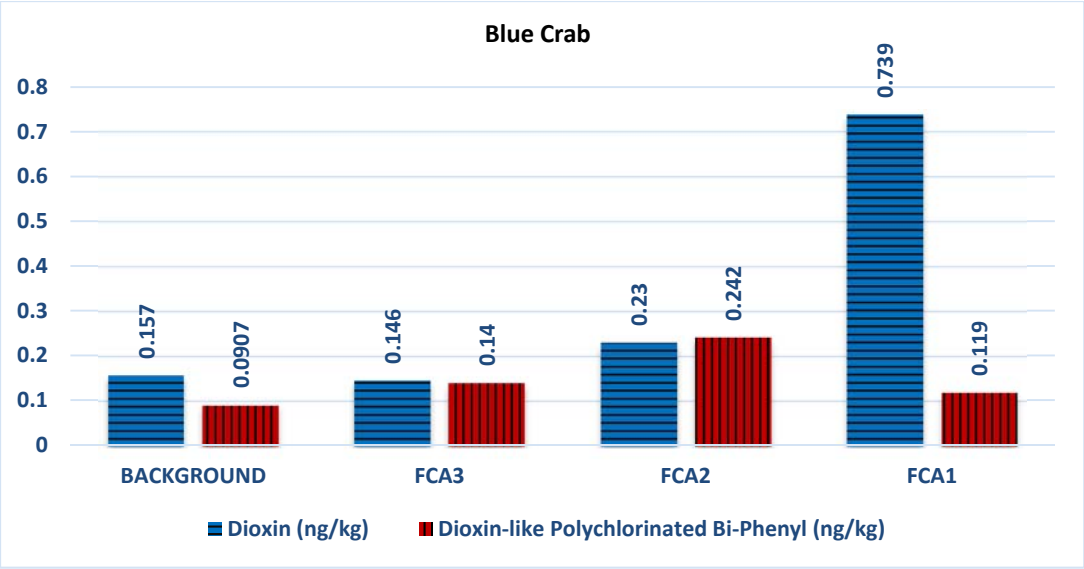
Nature and Extent of Contamination – Tissue

Tissue samples were collected from three Site fish collection areas (Figure 11):

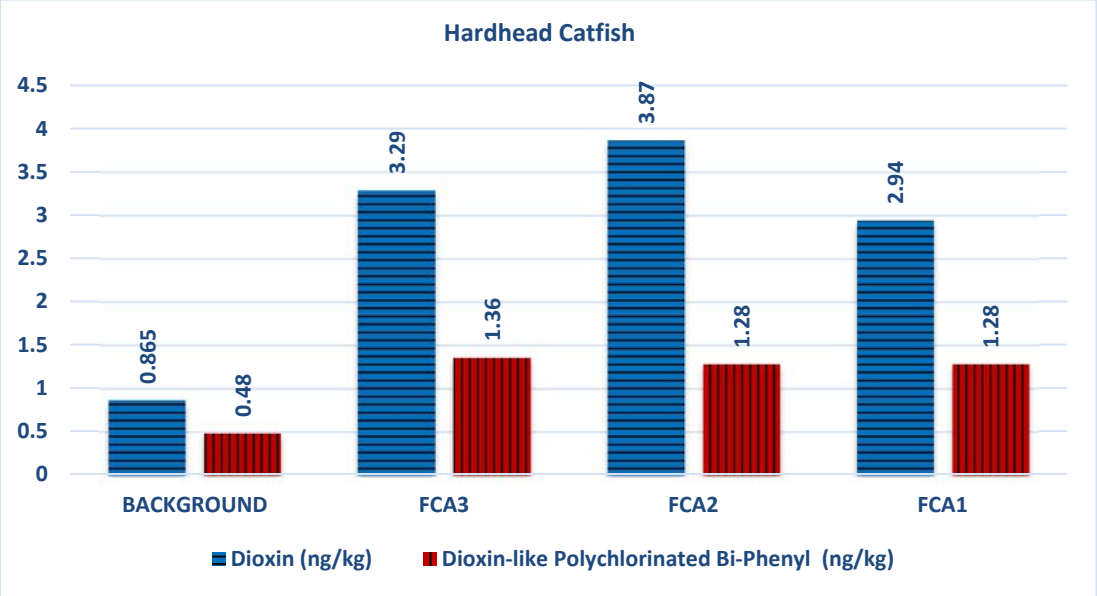
- Downstream of I-10, referred to below as "downstream"
- In the area surrounding the impoundments north of I-10 and the sand separation area, referred to as "adjacent to the northern impoundments"
- Immediately upstream of the northern impoundments and upland separation area, referred to as "upstream."

Data for blue crab, hardhead catfish, and Gulf killifish are summarized in the figures below. The maximum detected values and highest mean values of dioxin and dioxin-like polychlorinated bi-phenyl generally were collected from the fish collection area adjacent to the northern impoundments.

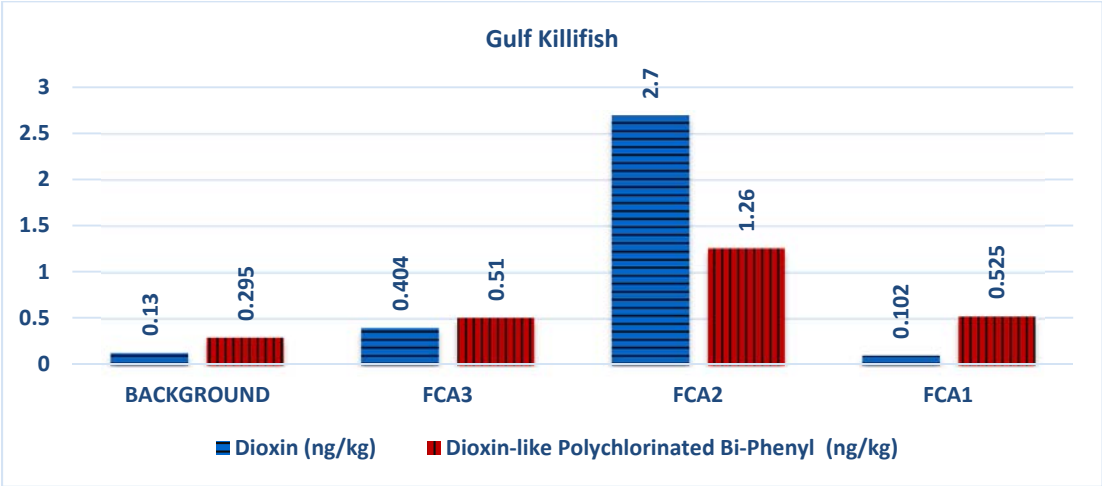
Summary of Average Tissue Results



FCA 3: Immediately Upstream
FCA 2: Adjacent to the Northern Impoundments
FCA 1: Immediately Downstream



076826



Nature and Extent of Contamination – Impoundment South of I-10

The Southern Impoundment located south of I-10 at the San Jacinto River was constructed and used in the mid-1960s for the disposal of paper mill waste containing dioxin. This impoundment contains the paper mill waste and debris, which was covered with soil. The maximum surface soil dioxin concentration in the Southern Impoundment is 36.9 ng/kg (Figure 12) which is below the level considered protective for nonrestrictive use.

In subsurface soils from 6 to 24 inches, dioxin results are 303 ng/kg, with an average of 16.5 ng/kg. Dioxin results deeper than 2 feet have a maximum of 50,100 ng/kg and an average of 743 ng/kg.

Ground water sampling was conducted at two locations outside of the southern impoundment; one was below the impoundment and the other was located downgradient to the west of the impoundment. The water in this area is brackish. Neither of these samples detected any dioxin or furan. Water samples collected from within the southern impoundment contained dioxin up to a maximum of 60.2 pg/L.

Summary of Nature and Extent of Contamination

There are high levels of dioxin/furans in the waste material in the northern impoundments and at the 6 -10 foot depth in the southern impoundment. Tetra-dioxin contamination associated with the Site is also present in sediments surrounding the impoundments, although not at levels, when averaged, that are above the sediment cleanup level. Tissue samples from blue crab, hardhead catfish, clams and Gulf killifish show elevated levels of dioxins in the vicinity of the Site.

Resource Use

Current land use at the Site is primarily industrial and commercial use. Current land use surrounding the Site includes mixed residential and industrial uses to the west, and undeveloped or residential areas to the east and north. Immediately south of the Site is commercial/industrial land use. The future land use is not anticipated to be different from the current land use.

The area south of the Site is dominated by activities associated with the Houston Ship Channel, specifically industrial sites that are served by the barges and ocean-going vessels that use the Houston Ship Channel. From the Site north to Lake Houston, there is less industrialization along the river.

Commercial and recreational fishing activity occurs throughout Galveston Bay. The San Jacinto River along with nearby Upper Galveston Bay, Tabbs Bay, and the San Jacinto State Park have many points of public access. Through Texas Department of State Health Services (TDSHS) outreach activities, most of the people interviewed along the San Jacinto River, Houston Ship Channel, and Upper Galveston Bay have told TDSHS that they are fishing and/or crabbing for recreational purposes. However, some people do admit to consuming fish and/or crabs from these areas despite the fact that consumption of mollusks and shellfish (clams, mussels, and oysters) taken from public fresh waters is prohibited by TDSHS. Within public salt waters, these shellfish may be taken only from waters approved by TDSHS. TDSHS shellfish harvest maps designate approved or conditionally approved harvest areas. Waters near the Site are not included on these maps.

Although the Site is private land, nearby access points along the San Jacinto River allow for a variety of recreational activities including picnicking, swimming, nature walks, bird watching, wading, fishing, boating, water sports, and other shoreline uses. In the area to the south of the I-10 Bridge on the west side of the river, children and adults have been reported to play along the shoreline, wade in the water, and fish.

Scope and Role of Response Action

The purpose of this response action is to implement a site-wide strategy that addresses the contaminated material at the Site with the primary objectives of preventing human and ecological exposure to contaminants, and preventing further migration of contaminants. The Preferred Alternative, 6N and 4S, consisting of removal of waste materials that exceed the Preliminary Remediation Goals, Monitored Natural Recovery, and Institutional Controls, is intended to address the threats to human health and environment. This response action will prevent future releases of dioxins from the former waste impoundments, reduce human exposure to dioxins from consumption of fish, reduce human exposure to dioxins from contact with contaminated materials; and reduce exposures of benthic macroinvertebrates (clams, crabs, etc.) to dioxin. The Preferred Alternative is the only one that will reliably result in no future catastrophic release. The San Jacinto River has been subject to severe flooding in the past and future flooding may even be more severe. The river has also experienced significant changes over the last 50 to 60 years as a result of subsidence and flooding cutting new channels. This is expected to continue in the future. Dioxin in the environment is very persistent, and is expected to remain toxic for hundreds of years. Therefore, any cleanup approach involving containment would have to reliably achieve containment for a very long time. The methods that can be used to predict the long-term performance of the river and the stability of a containment remedy have a high degree of uncertainty, as well as not being able to predict future changes in the river channels and riverbanks. The containment alternatives, while costing less, cannot be shown to reliably contain the waste material long-term due to the location of the waste pits in the San Jacinto River, which is prone to severe storms and flooding, and the uncertainty of available methods to assess the long-term capability of the containment systems. The benefit of removal of the dioxin waste material is that it will eliminate the possibility of a catastrophic release that could result in a much more severe impact to the environment.

Summary of Site Risks

A Baseline Human Health Risk Assessment (human health risk assessment) and Baseline Ecological Risk Assessments (ecological risk assessments) were conducted to estimate the potential for current/future risk from exposure to contaminants from the Site. The human health risk assessment and ecological risk assessments were conducted to determine potential pathways by which people (human receptors) or animals (ecological receptors) could be exposed to upland or aquatic contamination in waste material, sediment, soil, water, or biota; the amount of contamination receptors of concern may be exposed to; and the toxicity of those contaminants if no action were taken to address contamination at the Site. Some of the human health

risk determinations subsequently were modified by the Environmental Protection Agency based on further risk analysis as documented in memoranda included as part of the Site administrative record.

The risk assessments were conducted on the baseline conditions that existed before the installation of the temporary armored cap over the northern waste pits that was completed as part of a removal action. This temporary cap was built to stabilize the northern waste pits and prevent direct human exposures until a permanent remedy could be selected for the Site. These assessments provide the basis for taking action and identify the contaminants and exposure pathways that need to be addressed by the remedial action.

What is Risk and How is it Calculated?

A Superfund human health risk assessment estimates the "baseline risk." This is an estimate of the likelihood of health problems occurring if no cleanup action was taken at a site. To estimate the baseline risk at a site, a four-step process is used:

Step 1: Analyze Contamination
Step 2: Estimate Exposure
Step 3: Assess Potential Health Dangers
Step 4: Characterize Site Risk

In Step 1, the concentrations of contaminants found at a site are examined as well as past scientific studies that demonstrate the effects these contaminants may have on people (or animals, when human studies are unavailable). Comparisons between site-specific concentrations and concentrations reported in past studies help determine which contaminants are most likely to pose the greatest threat to human health.

In Step 2, the different ways that people might be exposed to the contaminants identified in Step 1, the concentrations that people might be exposed to, and the potential frequency and duration of exposure are considered. Using this information, a "reasonable maximum exposure" scenario is calculated, which portrays the highest level of human exposure that could reasonably be expected to occur.

In Step 3, the information from Step 2 is combined with information on the toxicity of each chemical to assess potential health risks. Two types of risk, cancer risk and non-cancer risk, are considered. The likelihood of any kind of cancer resulting from a site is generally expressed as an upper-bound probability; for example, a "1 in 10,000 chance." In other words, for every 10,000 people that could be exposed, one extra cancer may occur as a result of exposure to site contaminants. An extra cancer case means that one more person could get cancer than would normally be expected to from all other causes. For non-cancer risks, a hazard index (HI) is calculated. The key concept here is that a "threshold level" exists below which non-cancer health effects are no longer predicted.

In Step 4, it is determined if site risks are great enough to cause health problems for people at or near the site. The results of the three previous steps are combined, evaluated, and summarized. The potential risks from the individual chemicals are added up. If cancer or non-cancer risks are found to be unacceptable, the contributing chemicals are then identified as contaminants of concern. For cumulative cancer risks, the EPA has determined increased cancer risk in excess of 10^{-4} (1 in 10,000) is unacceptable. The risk range of 10^{-6} to 10^{-4} may be evaluated to determine whether risk is acceptable for future site conditions (such as land use and potential users). For cumulative non-cancer risks, the EPA has established an HI of less than 1.0 as acceptable.

It is the Environmental Protection Agency's current judgment that the Preferred Remedy identified in this Proposed Plan is necessary to protect public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

Human Health Risk

The human health risk assessment identified non-cancer hazards greater than one for some recreational fisher exposure scenarios (direct exposure to surface areas identified and the ingestion of catfish, clam, or crab from fishing areas identified), for some recreational visitor exposure scenarios (direct exposure to the surface area identified), and for some future construction worker exposure scenarios. The tables below provide a summary of Site related non-cancer hazard quotients above one. Hazard quotients greater than one indicate the potential of contaminants of concern (e.g. dioxin) may cause adverse health effects to those that are exposed in the manner specified in the tables. There were no cancer risks above the upper limit of the Environmental Protection Agency's target cancer risk range ($1x10^{-4}$) for all surface areas identified in the human health risk assessment except for Beach Area E, which had an excess cancer risk of 6.6×10^{-4} for a recreational fisher exposed through ingestion and dermal contact with surface waste material and sediment. The basis for action at the Site are the unacceptable hazards to the recreational fisher (Hazard Index 65), to the recreational visitor (Hazard Index 66), and to the construction worker (Hazard Index 46). The three tables below provide more information on these hazards. For the recreational fisher (Figures 13 and 14) and the recreational visitor (Figure 14), risk assessments were done for areas both north and south of I-10. For the construction worker, the risk assessment applies to the area south of I-10 (Figure 15).

Non-Cancer Hazards for a Recreational Fisher

Chemical	Primary Target Organ	Non-Cancer Hazard Quotient			Exposure Route Total
		Incidental Ingestion of Sediment	Dermal Contact with Sediment	Consumption of Fish or Shellfish	
Scenario 1A: Direct Exposure Beach Area A; Ingestion of Catfish from Fish Collection Area 2/3					
Dioxins and dioxin-like Polychlorinated Bi-Phenyls	Reproductive/Developmental	0.0006	0.0016	1.8	1.8
Scenario 2A: Direct Exposure Beach Area B/C; Ingestion of Catfish from Fish Collection Area 2/3					
Dioxins and dioxin-like Polychlorinated Bi-Phenyls	Reproductive/Developmental	0.0081	0.0229	1.8	1.8
Scenario 3A: Direct Exposure Beach Area E; Ingestion of Catfish from Fish Collection Area 2/3					
Dioxins and dioxin-like Polychlorinated Bi-Phenyls	Reproductive/Developmental	16	47	1.8	65
Scenario 3B: Direct Exposure Beach Area E; Ingestion of Clam from Fish Collection Area 2					
Dioxins and dioxin-like Polychlorinated Bi-Phenyls	Reproductive/Developmental	16	47	0.27	64
Scenario 3C: Direct Exposure Beach Area E; Ingestion of Crab from Fish Collection Area 2/3					
Dioxins and dioxin-like Polychlorinated Bi-Phenyls	Reproductive/Developmental	16	47	0.008	63
Scenario 4A: Direct Exposure Beach Area D; Ingestion of Catfish from Fish Collection Area 1					
Dioxins and dioxin-like Polychlorinated Bi-Phenyls	Reproductive/Developmental	0.0027	0.0076	1.8	1.8
Note: Polychlorinated Biphenyls - PCBs Dioxins – see Glossary					

Non-Cancer Hazards for a Recreational Visitor

Chemical	Primary Target Organ	Non-Cancer Hazard Quotient				Total
		Incidental Ingestion of Sediment	Incidental Ingestion of Soil	Dermal Contact with Sediment	Dermal Contact with Soil	
Scenario 3: Direct Exposure Beach Area E						
Dioxin	Reproductive/ Developmental	17	0.03	49	0.0021	66
Note: Dioxin – 2,3,7,8-tetrachlorodibenzo-p-dioxin toxicity equivalent quotient						

Non-Cancer Hazards for a Future Construction Worker

Chemical	Primary Target Organ	Non-Cancer Hazard Quotient		Total
		Incidental Ingestion of Soil	Dermal Contact with Soil	
Scenario DS-1: Direct Exposure to Surface and Subsurface Soils				
Dioxin	Reproductive/Developmental	9.6	0.49	10
Scenario DS-2: Direct Exposure to Surface and Subsurface Soils				
Dioxin	Reproductive/Developmental	44	2.2	46
Scenario DS-4: Direct Exposure to Surface and Subsurface Soils				
Dioxin	Reproductive/Developmental	32	1.6	34
Scenario DS-5: Direct Exposure to Surface and Subsurface Soils				
Dioxin	Reproductive/Developmental	2.2	0.11	2.3
Note: Dioxin – 2,3,7,8-tetrachlorodibenzo-p-dioxin toxicity equivalent quotient				

Ecological Risk

Baseline risks to ecological receptors associated with the wastes in the impoundments north of I-10 are the result of exposures to dioxins localized to the immediate vicinity of the impoundments. Baseline ecological risks include reproductive risks to mollusks from dioxin, but primarily in the area that surrounds the former waste impoundments north of I-10, and low risks of reproductive effects in individual mollusks in sediments adjacent to the sand separation area, but not to populations of mollusks. Baseline risks include moderate risks to individual birds like the killdeer or spotted sandpiper whose foraging area could regularly include the shoreline adjacent to the impoundments north of I-10, but low risk to populations because of the low to moderate probability that individual exposures reach effects levels. Baseline risks include risks to individual small mammals with home ranges that include areas adjacent to the impoundments such as the marsh rice rat, but low to negligible risks to small mammal populations because of the moderate probability that exposures will reach levels associated with reproductive effects in individuals, and because small mammals reproduce rapidly. Baseline risks to benthic macroinvertebrate communities and populations of fish, birds, mammals, and reptiles resulting from the presence of metals, bis(2-ethylhexyl) phthalate, Polychlorinated Bi-Phenyls, carbazole, and phenol on the Site are negligible. Risks to fish populations from all chemicals of potential concern are negligible.

There are negligible risks to populations of wading birds represented by the great blue heron, and to populations of diving birds like the neotropic cormorant. There are negligible risks to populations of terrestrial mammals such as the raccoon. There are low to negligible risks to individual terrestrial insectivorous birds like the killdeer from exposure to zinc, and negligible risks to populations of such birds. Although the upper bound of estimated daily intakes of zinc by individual killdeer is about equal to conservative effects thresholds, the exposure estimate is influenced by the use of generic models to estimate zinc concentrations in the foods of the killdeer, and this model likely overestimates ingested tissue concentrations, resulting in overestimates of exposure and risk. The highest exposures of killdeer to zinc occur outside of the northern impoundment perimeter, and background exposures less than 30 percent were lower than on the Site. In addition, the low probability of individual exposures exceeding effects levels indicates low risk to populations. There are also low to negligible risks to individual terrestrial insect eating birds from exposure to dioxins. The ecological risk assessments identified risk to ecological receptors as summarized in the tables below.

Ecological Risks

Receptor of Concern	Feeding Guild	Contaminant of Concern	Baseline Risk Identified
Benthic Macroinvertebrates			
Mollusks	Filter feeders	2,3,7,8-TCDD	Reproductive risks to mollusks (primarily in the area which surrounds the waste impoundments)
Individual mollusks	Filter feeders	2,3,7,8-TCDD	Low risks of reproductive effects (sediments adjacent to the sand separation area)
Birds			
Spotted sandpiper	Invertivore (probing)	Dioxin	Low risk to populations
Killdeer	Invertivore (terrestrial)	Dioxin	Low risk to populations
Mammals			
Marsh rice rat	Omnivore	Dioxin	Low to negligible risk to populations

Note:
2,3,7,8-TCDD – 2,3,7,8-tetrachlorodibenzo-p-dioxin
Dioxin – toxicity equivalent quotient for 2,3,7,8-tetrachlorodibenzo-p-dioxin calculated using toxicity equivalent factors for mammals

Remedial Action Objectives and Preliminary Remediation Levels

Remedial Action Objectives describe what the proposed site cleanup is expected to accomplish. According to the National Contingency Plan, 40 Code of Federal Regulations §300.430(a)(1)(i), the "national goal of the remedy selection process is to select remedies that are protective of human health and the environment, that maintain protection over time, and that minimize untreated waste." Based on information relating to types of contaminants, environmental media of concern, and potential exposure pathways, site specific remedial action objectives were developed. The remedial action objectives developed consider the current and reasonably anticipated future land use including the use for industrial applications and by recreational fishers. Concentrations of polychlorinated bi-phenyls in waste materials and sediments were either significantly correlated with concentrations of dioxins or were generally below detection limits. Therefore, no remedial action objective was developed for polychlorinated bi-phenyls because remediation of material contaminated with dioxins will also remediate the co-located polychlorinated bi-phenyls. While the human health risk assessment considered subsistence fisher populations, the Texas Department of State and Health Services (DSHS) could not identify subsistence fishers in the area of the Site. Therefore this receptor is not considered to be consistent with the current or future land use. The Environmental Protection Agency used the next most conservative value of a child recreational fisher for its risk calculations.

The following Preliminary Remediation Goals provide numerical criteria that will be used to measure the progress in meeting the Remedial Action Objectives. The preliminary remediation goals are acceptable exposure levels (i.e., contaminant concentration levels) that are protective of human health and the environment, and are developed considering applicable, relevant, and appropriate requirements, as specified in the National Contingency Plan. Site risk-based preliminary remediation goals are presented below:

- Dioxin in sediment – 30 ng/kg (recreational fisher). This level is also protective for ecological risk.
- Dioxin in paper mill waste material in the waste pits – 200 ng/kg (recreational visitor).
- Dioxin in paper mill waste material and soil in the Southern Impoundment – 240 ng/kg (Southern Impoundment construction worker).
- Texas Surface Water Quality Standard for Dioxins/Furans – 7.97×10^{-8} µg/L (as TCDD equivalents). [30 Texas Administrative Code §307.6(d)(a)(A) and (B) and §307.10]. This standard was updated by the Texas Commission on Environmental Quality in 2014 and approved by the Environmental Protection Agency to base the dioxin standard on water column criteria. The standard was calculated based on an oral cancer slope factor of 156,000 found in in the Environmental Protection Agency 2002 National Recommended Water Quality Criteria Matrix.

The sediment Preliminary Remediation Goal of 30 ng/kg was developed for the Site based on protecting human health of the most vulnerable potentially exposed group or individual of the community. In this case a recreational child fisher was assumed to get exposed to contaminated sediment through incidental ingestion, dermal contact, and from the ingestion of fish/shellfish. The 30 ng/kg is associated with a non-cancer Hazard Index of one with the understanding that by protecting at a Hazard Index of one will also be protecting for cancer effects near the middle (2.1×10^{-5}) of the Environmental Protection Agency's generally acceptable cancer risk range.

For the river areas outside of the armor cap, the surface area–weighted average dioxin concentration in sediment located just south of the waste pits (Figure 11) is 16.1 ng/kg, and the surface area–weighted average dioxin concentration in sediment in areas located adjacent to and upstream of the waste pits is 11.2 ng/kg. Because the average dioxin concentrations in sediment both upstream and downstream of the waste pits are less than the 30 ng/kg Preliminary Remediation Goal for sediment, remediation of the sediment is not required.

The 200 ng/kg Preliminary Remediation Goal for the waste material areas is associated with a non-cancer Hazard Index of one. In this case a recreational visitor was assumed to get exposed to contaminated waste material and sediment. The waste material areas include the northern waste pits (Figure 2).

The 240 ng/kg Preliminary Remediation Goal applies to waste material and soil for the Southern Impoundment (Figure 15) and is associated with a non-cancer Hazard Index of one. In this case a construction worker was assumed to get exposed to contaminated soils in the area during construction activities. The surface soil in this area is less than the protective level of 51 ng/kg for unlimited use and unrestrictive access.

The background sediment upstream from the Site has a dioxin concentration of 7.2 ng/kg, which is well below the sediment Preliminary Remediation Goal of 30 ng/kg. Therefore re-contamination of the Site by new sediment being carried downstream is not likely.

There are no preliminary remediation goals for fish tissue because the required sediment cleanup measures at the Site will reduce contaminant concentrations in tissue, but these concentrations will continue to be affected by factors outside the scope of the Comprehensive Environmental Response, Compensation, and Liability Act Site cleanup, including upstream and downstream dioxin inputs from other sources. Measuring trends against target tissue concentrations is useful for assessing risk reduction and for risk communication, but tissue preliminary remediation goals are not required to evaluate these trends.

It is anticipated that the 200 ng/kg dioxin Preliminary Remediation Goal for the waste material areas, as well as the 30 ng/kg dioxin Preliminary Remediation Goal in sediment, will be achieved relatively soon after construction of the Preferred Alternative (Alternative 6N) is completed, or approximately 2 years after construction begins. The 240 ng/kg dioxin Preliminary Remediation Goal for the Southern Impoundment will be achieved when construction of the Preferred Alternative there (Alternative 4S) is completed, or approximately 7 months after construction begins.

Summary of Remedial Alternatives

The feasibility study identified and screened possible response actions and remedial technologies applicable to the Site. Following the screening process, remedial alternatives were developed to address the area north of I-10 and the area south of I-10. Alternatives that address the area north of I-10 and aquatic environment include the letter "N" in the title (e.g., 1N, 2N), and alternatives that address the area south of I-10 include the letter "S" in the title (e.g., 1S, 2S). During the Feasibility Study, cost estimates are developed for each remedial action alternative for comparison purposes. The expected accuracy of Feasibility Study cost estimates ranges from –30 percent to +50 percent. The total present worth costs for this and all other alternatives are calculated using a 30 year timeframe and a 7% discount rate.

Alternatives for the San Jacinto River and Area North of I-10:

Alternative 1N – Temporary Armored Cap and Ongoing Operations, Inspection, and Maintenance (No Further Action)

Estimated Maintenance Cost (e.g., inspection, maintenance): $0.4 million
Estimated Total Present Worth Cost: $0.4 million
Estimated Construction Time: Construction complete

Under this alternative, No Further Action would be conducted for the temporary armored cap constructed under the Time Critical Removal Action and no additional remedial action would be implemented. Treatment through solidification of a portion (6,000 cubic yards) of the paper mill waste material was completed to aid construction of the cap. However, this alternative has no further provision for treatment or removal of the Principal Threat Waste. This alternative includes ongoing operations, inspection, and maintenance of the armored cap, which includes inspection and periodic maintenance. This alternative has no provision for the sand separation area.

Alternative 2N – Armored Cap, Institutional Controls, Ground Water Monitoring, and Monitored Natural Recovery

Estimated Maintenance Cost: $2.0 million
Estimated Total Present Worth Cost: $2.0 million
Estimated Construction Time: Construction complete

This alternative includes all of the elements discussed under Alternative 1N, plus institutional and engineering controls, ground water monitoring, and Monitored Natural Recovery. Monitored Natural Recovery would be used to achieve the Preliminary Remediation Goal for sediment in the sand separation area and the Texas Surface Water Quality Standard in the San Jacinto River. Hydrodynamic and sediment transport modeling of the San Jacinto River in the vicinity of the Site determined that there is a net deposition of sediment that will support Monitored Natural Recovery. Further, approximately two feet of sediment deposition found over the toe of the cap in the northwest area during an Environmental Protection Agency Dive Team inspection of the cap also supports the depositional nature of the area. Because future sedimentation is uncertain, monitoring will be conducted to access natural recovery.

This Alternative 2N this would not result in treatment of the Principal Threat Waste other than the solidification for the original construction of the cap.

Ground water monitoring would be implemented to ensure that there are no long-term unacceptable impacts to ground water resulting from the waste left in place. Under this remedial alternative, the following institutional and engineering controls would be implemented:

- Restrictions on dredging and anchoring would be established to protect the integrity of the armored cap and to limit potential disturbance and resuspension of buried sediment under the residuals cover layers.
- Alert property owners of the presence of subsurface materials exceeding Remediation Levels.
- Public notices and signage around the perimeter of the temporary armored cap site would be maintained or provided, as appropriate.
- As a result of the long term persistence of dioxin, it is anticipated that the institutional controls will be essentially permanent measures.

This alternative includes ongoing operations, inspection, and maintenance of the armored cap, which includes inspection and periodic maintenance, and the Environmental Protection Agency 5-year reviews as required under the National Contingency Plan in 40 Code of Federal Regulations 300.430 (f)(iv)(2). A periodic sampling and analytical program would also be implemented to monitor the progress of natural recovery. The current temporary cap has had no impact on navigation, and this alternative is not expected to be different.

Alternative 3N – Upgraded Cap, Institutional Controls, Ground Water Monitoring, and Monitored Natural Recovery

Estimated Capital Cost: $1.77 million
Estimated In-Direct and Operation & Maintenance Cost: $2.38 million
Estimated Total Present Worth Cost: $4.1 million
Estimated Construction Time: 2 months

This alternative includes the actions described under Alternative 2N plus additional improvements to the temporary armored cap to create an upgraded cap. The improvements use a higher factor of safety of 1.5 for sizing the armor stone, and include flattening submerged slopes from 2 horizontal to 1 vertical (2H:1V) to 3H:1V and flattening the slopes in the surf zone from 3H:1V to 5 horizontal to 1 vertical (5H:1V). In addition, the Upgraded Cap uses larger rock sized for the "No Displacement" design scenario, which is more conservative than the "Minor Displacement" scenario used in the Armored Cap's design. This alternative will increase the long-term stability of the armored cap compared to Alternatives 1N and 2N. However, the upgraded cap under Alternative 3N is expected to experience 80% erosion of the cap during a severe storm as determined by the Corps of Engineers' report (Appendix A of the Feasibility Study). Cost estimates for this alternative also include additional measures to protect the upgraded cap from potential vessel traffic in the form of a protective perimeter barrier and could include construction of a 5-foot high submerged rock berm outside the perimeter of the upgraded cap, in areas where vessels could potentially impact the cap. Monitored Natural Recovery would be used to achieve the Preliminary Remediation Goal for sediment in the sand separation area and the Texas Surface Water Quality Standard in the San Jacinto River.

Institutional Controls

Institutional controls are non-engineered instruments such as administrative and legal controls that help minimize the potential for human exposure to contamination and protect the integrity of a remedy by limiting land or resource use.

Engineering Controls

Engineering controls are physical measures such as fencing or signage that are used to limit access to contaminated areas or areas that may pose a physical hazard.

Monitored Natural Recovery

Monitored Natural Recovery is a technology in which contaminant concentrations are monitored with no other remedial actions taken to address contamination. Monitored Natural Recovery assesses the natural attenuation of contaminants by physical, chemical, and biological processes.

This Alternative 3N would not result in treatment other than the solidification for construction of a portion of the Principal Threat Waste, which is defined as material containing dioxin greater than 300 ng/kg.

Upon completion, the Upgraded Cap would be constructed to a standard that exceeds Environmental Protection Agency and United States Army Corps of Engineers design guidance, and meets or exceeds the recommended enhancements suggested by the United States Army Corps of Engineers in their 2013 evaluation. Ground water monitoring would be implemented to ensure that there are no long-term unacceptable impacts to ground water resulting from the waste left in place. Institutional controls would be implemented to place restrictions on dredging and anchoring to protect the integrity of the armored cap and to limit potential disturbance and resuspension of buried sediment near the sand separation area. Under this remedial alternative, the following institutional and engineering controls would be implemented:

- Restrictions on dredging and anchoring would be established to protect the integrity of the armored cap and to limit potential disturbance and resuspension of buried sediment under the residuals cover layers.
- Alert property owners of the presence of subsurface materials exceeding Remediation Levels.
- Public notices and signage around the perimeter of the temporary armored cap site would be maintained or provided, as appropriate.
- As a result of the long term persistence of dioxin, it is anticipated that the institutional controls will be essentially permanent measures.

This alternative includes ongoing operations, inspection, and maintenance of the armored cap, which includes inspection and periodic maintenance, and the Environmental Protection Agency 5-year reviews as required under the National Contingency Plan in 40 Code of Federal Regulations 300.430 (f)(iv)(2). A periodic sampling and analytical program would also be implemented to monitor the progress of natural recovery. The current temporary cap has had no impact on navigation, and this alternative is not expected to be different.

Alternative 3aN – Enhanced Cap, Protective Pilings, Institutional Controls, Ground Water Monitoring, and Monitored Natural Recovery

Estimated Capital Cost: $19.7 million
Estimated In-Direct and Operation & Maintenance Cost: $5.1 million
Estimated Total Present Worth Cost: $24.8 million
Estimated Construction Time: 15 months

The Corps of Engineers determined that the cap considered for Alternative 3N may experience 80% erosion of the armor cap (Appendix A of the Feasibility Study), and substantial erosion of the underlying paper mill waste material in a future severe storm. This alternative, 3aN, includes the actions described under Alternative 3N plus additional enhancements to the armored cap recommended by the Corps of Engineers to create an enhanced cap with increased long-term stability.

The additional cap enhancements added for this alternative include pre-stressed concrete or concrete filled steel pipe pilings placed 30 feet apart around the perimeter of the cap to protect from barge strikes. The spacing is designed to catch a typical barge, which is 35 feet wide. An additional armor stone cap with a thickness of at least 24 inches would be placed over the armor cap for Alternative 3N. The armor stone would have a median diameter of 15 inches. This additional armor stone would cover 13.4 acres of the 17.1 acre armored cap. Also, a

course gravel filter layer would be placed on 1.5 acres of the Northwest Area where there is currently no geotextile under the armor cap. The actual scope and design of the cap enhancements, and additional area needed to construct the required slopes, would be determined in the Remedial Design. This additional weight of rock on top of the waste pits may cause cap settling and/or pushing the waste material out the sides of the cap; the Remedial Design will consider the significance of and design issues related to this. Monitored Natural Recovery would be used to achieve the Preliminary Remediation Goal for sediment in the sand separation area and the Texas Surface Water Quality Standard in the San Jacinto River.

This Alternative 3aN this would not result in treatment of the Principal Threat Waste, which is defined as Site material containing dioxin greater than 300 ng/kg, with the exception of the solidification for construction of the western cell of the original cap. Alternative 3aN also would require ongoing maintenance to ensure cap integrity over the hundreds of years the Site waste will remain toxic.

Ground water monitoring would be implemented to ensure that there are no long-term unacceptable impacts to ground water resulting from the waste left in place. Institutional controls would be implemented to place restrictions on dredging and anchoring to protect the integrity of the armored cap and to limit potential disturbance and resuspension of buried sediment near the sand separation area. Under this remedial alternative, the following institutional and engineering controls would be implemented:

- Restrictions on dredging and anchoring would be established to protect the integrity of the armored cap and to limit potential disturbance and resuspension of buried sediment under the residuals cover layers
- Alert property owners of the presence of subsurface materials exceeding Remediation Levels
- Public notices and signage around the perimeter of the temporary armored cap site would be maintained or provided, as appropriate
- As a result of the long term persistence of dioxin, it is anticipated that the institutional controls will be essentially permanent measures.

This alternative includes ongoing operations, inspection, and maintenance of the armored cap, which includes inspection and periodic maintenance, and the Environmental Protection Agency 5-year reviews as required under the National Contingency Plan in 40 Code of Federal Regulations 300.430 (f)(iv)(2). A periodic sampling and analytical program would also be implemented to monitor the progress of natural recovery. The current temporary cap has had no impact on navigation, and this alternative is not expected to be different

Alternative 4N – Partial Solidification/Stabilization, Upgraded Cap, Institutional Controls, Ground Water Monitoring, and Monitored Natural Recovery

Estimated Capital Cost: $11.1 million
Estimated In-Direct and Operation & Maintenance Cost: $3.7 million
Estimated Total Present Worth Cost: $14.8 million
Estimated Construction Time: 17 months

This remedial alternative provides for solidification and stabilization of the most highly contaminated material. The purpose of solidification/stabilization at the Site is to reduce the mobility of the waste material thereby reducing the potential for a dioxin release into the San Jacinto River. A dioxin and furan value that exceeds 13,000 ng/kg dioxin was used to define the most highly contaminated material. This alternative would result in treatment of a portion of the Principal Threat Waste. Under this alternative, 3.6 acres of the armor cap would be removed and about 52,000 cubic yards of materials beneath the cap exceeding 13,000 ng/kg dioxin,

regardless of waste material depth, would undergo solidification and stabilization. The type of amendments would be determined during the Remedial Design. The extent of the area for partial solidification and stabilization is the western cell and a portion of the eastern cell that is currently covered by the armored cap. The maximum depth of solidification and stabilization in the western cell would be to approximately 10-feet below the current base of the armored cap and on average approximately 5-feet below the current base of the armored cap in the eastern cell and northwestern area.

For solidification/stabilization, amendments, such as Portland cement or other materials, would be mixed with the waste material. Mixing of amendments and the waste material could be accomplished using large-diameter augers or conventional excavators. Before mixing, portions of the armored cap armor rock where mixing will occur would need to be removed and stockpiled for reuse, if possible, or washed to remove adhering sediment and disposed in an appropriate facility. The geotextile and geomembrane in those areas would also need to be removed and disposed of as contaminated debris. Submerged areas to be stabilized would need to be isolated from the surface water with sheet piling and mostly dewatered prior to mixing with treatment reagents using conventional or long reach excavators.

Finally, an upgraded cap would be constructed as described in 3N, including replacement of the armor rock layer geomembrane and geotextile over the solidification and stabilization footprint; and the measures described under Alternative 3N to protect the upgraded cap from vessel traffic would be implemented. Monitored Natural Recovery would be used to achieve the sediment Preliminary Remediation Goal in the sand separation area and the Texas Surface Water Quality Standard in the San Jacinto River. Institutional controls would be implemented to place restrictions on dredging and anchoring to protect the integrity of the armored cap and to limit potential disturbance and resuspension of buried sediment near the sand separation area. Under this remedial alternative, the following institutional and engineering controls would be implemented:

- Restrictions on dredging and anchoring would be established to protect the integrity of the armored cap and to limit potential disturbance and resuspension of buried sediment under the residuals cover layers.
- Alert property owners of the presence of subsurface materials exceeding Remediation Levels.
- Public notices and signage around the perimeter of the temporary armored cap site would be maintained or provided, as appropriate.
- As a result of the long term persistence of dioxin, it is anticipated that the institutional controls will be essentially permanent measures.

Ground water monitoring would be implemented to ensure that there are no long-term unacceptable impacts to ground water resulting from the waste left in place.

The estimated footprint of this alternative is approximately 2.6 acres in the western cell and 1.0 acre of submerged waste material spanning the eastern cell and the northwestern area. Based on the horizontal and vertical limits identified for this alternative, a total of approximately 52,000 cubic yards of soil and waste material would be treated.

This alternative includes ongoing operations, inspection, and maintenance of the armored cap, which includes inspection and periodic maintenance, and the Environmental Protection Agency 5-year reviews as required under the National Contingency Plan in 40 Code of Federal Regulations 300.430 (f)(iv)(2). A periodic sampling and analytical program would also be implemented to monitor the progress of natural recovery. The current temporary cap has had no impact on navigation, and this alternative is not expected to be different.

Alternative 5N – Partial Removal, Upgraded Cap, Institutional Controls, Ground Water Monitoring, and Monitored Natural Recovery

Estimated Capital Cost: $24.86 million
Estimated In-Direct and Operation & Maintenance Cost: $4.94 million
Estimated Total Present Worth Cost: $29.8 million
Estimated Construction Time: 13 months

This remedial alternative provides for removal and offsite disposal of the most highly contaminated material. A dioxin and furan value that exceeds 13,000 ng/kg dioxin was used to define the most highly contaminated material; however, this would not result in removal or treatment of all of the Principal Threat Waste, which is defined as Site material containing dioxin greater than 300 ng/kg. Under this alternative, 3.6 acres of the armor cap would be removed and about 52,000 cubic yards of materials beneath the cap exceeding 13,000 ng/kg dioxin, regardless of waste material depth, would be removed. The lateral and vertical extent and volume of waste material removed under this alternative is the same as the waste material to be treated as described in the previous section for alternative 4N. Construction of an upgraded cap, institutional controls, and Monitored Natural Recovery for the sand separation area, as described in Alternative 3N, are also included in this remedial alternative.

To mitigate potential water quality issues, submerged areas would need to be isolated using berms, sheet piles, and/or turbidity barrier/silt curtains prior to excavating waste material. Upland areas would not need to be isolated with sheet piling, but the excavation would require continuous dewatering and may need to be timed to try to avoid high water and times of year when storms are most likely.

Excavated waste material would be dewatered or solidified for disposal at an off-site approved permitted facility. Effluent from excavated waste material dewatering would need to be handled appropriately, potentially including treatment prior to disposal. Following completion of the excavation, the work area would be backfilled to replace the excavated waste material and then the upgraded cap would be constructed, including replacing the armor rock layer above the excavation footprint and the geomembrane and geotextile layers. Institutional controls would be implemented to place restrictions on dredging and anchoring to protect the integrity of the armored cap and to limit potential disturbance and resuspension of buried sediment near the sand separation area. Under this remedial alternative, the following institutional and engineering controls would be implemented:

- Restrictions on dredging and anchoring would be established to protect the integrity of the armored cap and to limit potential disturbance and resuspension of buried sediment under the residuals cover layers.
- Alert property owners of the presence of subsurface materials exceeding Remediation Levels.
- Public notices and signage around the perimeter of the temporary armored cap site would be maintained or provided, as appropriate.
- As a result of the long term persistence of dioxin, it is anticipated that the institutional controls will be essentially permanent measures.

Ground water monitoring would be implemented to ensure that there are no long-term unacceptable impacts to ground water resulting from the waste left in place.

This alternative includes ongoing operations, inspection, and maintenance of the armored cap, which includes inspection and periodic maintenance, and the Environmental Protection Agency 5-year reviews as required under the National Contingency Plan in 40 Code of Federal Regulations 300.430 (f)(iv)(2). A periodic sampling and analytical program would also be implemented to monitor the progress of natural recovery. The current temporary cap has had no impact on navigation, and this alternative is not expected to be different.

Alternative 5aN - Partial Removal, Upgraded Cap, Institutional Controls, Ground Water Monitoring, and Monitored Natural Recovery

Estimated Capital Cost: $60.38 million
Estimated In-Direct and Operation & Maintenance Cost: $9.21 million
Estimated Total Present Worth Cost: $69.6 million
Estimated Construction Time: 19 months

For this alternative, the Preliminary Remediation Goal for a recreational visitor (200 ng/kg dioxin) was considered for the areas within the armored cap, which are either above the water or where the water depth is 10 feet or less. As an additional criterion, locations exceeding 13,000 ng/kg dioxin are also removed regardless of water depth; however, all samples exceeding 13,000 ng/kg dioxin are located in areas where the water depth is 10 feet or less. This alternative entails removal of approximately 137,600 cubic yards of waste material from the waste pits.

As with Alternatives 4N and 5N, the existing armored cap (consisting of cap rock, geomembrane, and geotextile) would need to be removed prior to beginning excavation work.

This alternative also includes an engineered barrier to manage water quality during construction. In shallow water areas (water depths up to approximately 3 feet), this barrier would be constructed as an earthen berm, extending to an elevation at least 2 feet above the high water elevation in consideration of wind-generated waves and vessel wakes.

Submerged areas would need to be isolated using berms, sheet piles, and/or turbidity barrier/silt curtains prior to excavating waste material. Excavated waste material would be offloaded, dewatered, and stabilized at a dedicated offloading location, as necessary, to eliminate free liquids for transportation and disposal. Following removal of impacted waste material, the area from which waste materials are removed would be covered with a residuals management layer of clean cover material.

In the deeper water areas of the waste pits where removal is not conducted, the existing armored cap would be maintained. Monitored Natural Recovery would be used to achieve the Preliminary Remediation Goal for sediment in the sand separation area. Institutional controls would be implemented to place restrictions on dredging and anchoring to protect the integrity of the armored cap and to limit potential disturbance and resuspension of buried waste material near the sand separation area. Under this remedial alternative, the following institutional and engineering controls would be implemented:

- Restrictions on dredging and anchoring would be established to protect the integrity of the armored cap and to limit potential disturbance and resuspension of buried sediment under the residuals cover layers.
- Alert property owners of the presence of subsurface materials exceeding Remediation Levels.
- Public notices and signage around the perimeter of the temporary armored cap site would be maintained or provided, as appropriate.
- As a result of the long term persistence of dioxin, it is anticipated that the institutional controls will be essentially permanent measures.

Ground water monitoring would be implemented to ensure that there are no long-term unacceptable impacts to ground water resulting from the waste left in place.

This alternative includes ongoing operations, inspection, and maintenance of the armored cap, which includes inspection and periodic maintenance, and the Environmental Protection Agency 5-year reviews as required under the National Contingency Plan in 40 Code of Federal Regulations 300.430 (f)(iv)(2). A periodic sampling and analytical program would also be implemented to monitor the progress of natural recovery. The current temporary cap has had no impact on navigation, and this alternative is not expected to be different.

Alternative 6N - Removal of Waste Materials Exceeding Cleanup Levels, MNR, and Institutional Controls

Estimated Capital Cost: $ 77 million
Estimated In-Direct and Operation & Maintenance Cost: $10 million
Estimated Total Present Worth Cost: $ 87 million
Estimated Construction Time: 19 months

This alternative involves the removal of all waste material that exceeds the Preliminary Remediation Goal of 200 ng/kg regardless of depth in the northern waste pits. Sheet piles will be used around all areas to be removed to reduce resuspension of the waste material. Monitored Natural Recovery (MNR) will be used for the sediment in the sand separation area. This would involve removal of the majority of the existing armored cap and the removal of 152,000 cubic yards of material. Alternative 6N includes Best Management Practices recommended by the Corps of Engineers.

This removal alternative will utilize Best Management Practices to reduce and control the re-suspension of waste material and sediment. While the Best Management Practices identified below were recommended by the Corps of Engineers and were used for costing purposes, the final use and design of Best Management Practices will be determined during the Remedial Design. The Best Management Practices may include, but are not limited to, the following:

- The removal will be completed in stages or sections as appropriate to limit the exposure of the uncovered sections of the waste pits to potential storms.
- Raised berms and sheet piles in addition to dewatering and removal in the dry where feasible will be used to reduce the re-suspension and spreading of the removed material.
- The berms would be armored on both sides with armor material removed from the areas that have geotextile present.
- Approximately three-fourths of the waste material will be excavated in the dry behind sheet pile walls. An excavation dewatering and water treatment system will operate on any day of excavation.
- Residual concentrations of contaminants following excavation and removal will be covered by at least two layers of clean fill to limit intermixing of residual material with the clean fill.
- Removal of submerged waste materials in the Northwest area will include isolation of the work area with berms/sheet piles if practicable.

Excavated waste material would be dewatered (decanted) and stabilized by addition of Portland cement or other additive at the offloading location, as necessary, to eliminate free liquids for transportation and disposal. Some operations, such as water treatment, may be barge mounted. In the Northwest area only, the residual concentrations of contaminants following excavation and removal will be covered by at least two layers of clean fill to limit intermixing of residual material with the clean fill, and armored. The protective berms will be

left in place after construction to provide a barrier, limiting barge and boat traffic over the site. Institutional controls will be used to prevent disturbance of the sediment residuals below the residual cover layers.

This alternative entails removal of approximately 152,000 cubic yards of waste material from the waste pits footprint, which would require a relatively large offloading and waste material processing facility to efficiently accomplish the work. Additional activities would include management and disposal of dewatering effluent, including treatment if necessary. Material that is removed would be transported in compliance with applicable requirements and permanently managed in an approved permitted facility cleared by the Environmental Protection Agency's regional offsite rule contact. Approximately 13,300 truck trips may be required to transport the waste material to the off-site approved permitted facility; however, capacity of roads to handle the loads will impact the truck size that can be used. The method of transportation and number of trips will be determined during the Remedial Design, as well as other transportation alternatives, including rail transport. The material will require dewatering by removal and/or treatment so that there are no free liquids.

Under this remedial alternative, the following institutional and engineering controls would be implemented:

- Restrictions on dredging and anchoring would be established to protect the integrity of the armored cap and to limit potential disturbance and resuspension of buried sediment under the residuals cover layers
- Alert property owners of the presence of subsurface materials exceeding Remediation Levels.
- Public notices and signage around the perimeter of the temporary armored cap site would be maintained or provided, as appropriate.
- As a result of the long term persistence of dioxin, it is anticipated that the institutional controls will be essentially permanent measures.

This alternative includes the Environmental Protection Agency 5-year reviews as required under the National Contingency Plan in 40 Code of Federal Regulations 300.430 (f)(iv)(2). The current temporary cap has had no impact on navigation, and this alternative is not expected to be different.

Alternatives for the Former Southern Impoundment:

Alternative 1S – No Action

Estimated Capital Cost: $0
Estimated In-Direct and Operation & Maintenance Cost: $0
Estimated Total Present Worth Cost: $0
Estimated Construction Time: None

Under this remedial alternative for the area of investigation south of I-10, impacted soil would remain in place and no steps would be taken to alert future landowners or construction workers of the presence, at depth, of dioxin concentrations exceeding cleanup goals.

Alternative 2S – Institutional Controls and Ground Water Monitoring

Estimated Capital Cost: $65,000
Estimated In-Direct and Operation & Maintenance Cost: $959,000
Estimated Total Present Worth Cost: $1.02 million
Estimated Construction Time: None

This alternative would apply to locations in the area south of I-10 where the dioxin concentration in certain levels within the upper 10 feet of soil exceed the cleanup goal for the future construction worker (240 ng/kg $TEQ_{DF,M}$). The upper 10 feet depth is based on the depth for the exposure scenario, i.e., construction

worker. Dioxin concentrations in the upper 10 feet of soil exceed the Preliminary Remediation Goal. Ground water monitoring would be implemented to ensure that there are no long-term unacceptable impacts to ground water resulting from the waste left in place. Under this remedial alternative, the following institutional controls would be implemented:

- Deed restrictions would be applied to parcels in which the depth-weighted average dioxin concentrations in the upper 10 feet of subsurface soil exceed the soil cleanup goal for the future construction worker.
- Notices would be attached to deeds of affected properties to alert potential future purchasers of the presence of waste and soil with dioxin concentrations exceeding the soil cleanup goal.
- As a result of the long term persistence of dioxin, it is anticipated that the institutional controls will be essentially permanent measures.

This alternative includes ongoing ground water monitoring, and the Environmental Protection Agency 5-year reviews as required under the National Contingency Plan in 40 Code of Federal Regulations 300.430 (f)(iv)(2).

Alternative 3S – Enhanced Institutional Controls and Ground Water Monitoring

Estimated Capital Cost: $367,000
Estimated In-Direct and Operation & Maintenance Cost: $1.04 million
Estimated Total Present Worth Cost: $1.4 million
Estimated Construction Time: 1 month

This remedial alternative would incorporate the Institutional controls identified in Alternative 2S and add physical features to enhance the effectiveness of the institutional controls. The physical features would include bollards to define the areal extent of the remedial action areas at the surface and a marker layer that would alert workers digging in the area that deeper soil may be impacted.
Implementation of this remedial alternative may include the following steps:

- Removing up to 2 feet of surface soil.
- Temporarily stockpiling the soil onsite.
- Placing the marker layer (such as a geogrid or similar durable and readily visible material) at the bottom of the excavation.
- Returning the soil to the excavation and re-establishing vegetative cover.
- Placing bollards at the corners of the remedial action areas.

Under this remedial alternative, the following institutional controls would be implemented:

- Deed restrictions would be applied to parcels in which the depth-weighted average dioxin concentrations in the upper 10 feet of subsurface soil exceed the soil cleanup goal for the future construction worker.
- Notices would be attached to deeds of affected properties to alert potential future purchasers of the presence of waste and soil with dioxin concentrations exceeding the soil cleanup goal.
- As a result of the long term persistence of dioxin, it is anticipated that the institutional controls will be essentially permanent measures.

This alternative includes ongoing ground water monitoring, and the Environmental Protection Agency 5-year reviews as required under the National Contingency Plan in 40 Code of Federal Regulations 300.430 (f)(iv)(2).

Alternative 4S – Removal and Offsite Disposal, Institutional Controls

Estimated Capital Cost: $9.07 million
Estimated In-Direct and Operation & Maintenance Cost: $0.85 million
Estimated Total Present Worth Cost: $9.9 million
Estimated Construction Time: 7 months

This remedial alternative involves excavation and replacement of soil in the areas exceeding the preliminary remediation goal. Implementation of this remedial alternative would require dewatering to lower the water table to allow excavation of impacted soil in relatively dry conditions, and may need to be timed to try to avoid high water and periods when storms are most likely. Excavated soil would be further dewatered or solidified, as necessary, prior to transporting it for disposal. Effluent from excavation and subsequent dewatering would need to be handled appropriately, potentially including treatment prior to disposal. Excavated soil would be disposed of at an approved permitted landfill, the excavation would be backfilled with imported soil, and vegetation would be re-established. An existing building (an elevated frame structure) and a concrete slab would need to be demolished and removed prior to excavating the underlying soil. These features would be replaced, if necessary. Ground water monitoring is not a part of this Alternative 4S because material containing dioxin above the Preliminary Remediation Goal will be removed and disposed of off-site.

The removal volume (50,000 cubic yards) was calculated assuming a conservative excavation side slope of 2 horizontal to 1 vertical. Transportation and disposal costs were estimated assuming that all of the excavated material would be transported to a licensed landfill for disposal. Institutional controls will applied to insure the continued industrial use of the area.

Under this remedial alternative, the following institutional controls would be implemented:

- Deed restrictions would be applied to parcels where dioxin concentrations do not allow for unrestricted use and unlimited access.
- Notices would be attached to deeds of affected properties to alert potential future purchasers of the presence of waste and soil with dioxin concentrations exceeding protective level of 51 ng/kg for unlimited use and unrestrictive access.
- As a result of the long term persistence of dioxin, it is anticipated that the institutional controls will be essentially permanent measures.

Evaluation of Alternatives

The National Contingency Plan requires the use of nine criteria to evaluate the difference of remediation alternatives individually and in comparison to each other. These criteria include *threshold criteria*, which requires that each alternative must meet in order to be eligible for selection. *Primary balancing criteria* are used to weigh major trade-offs among alternatives, and *modifying criteria* involve state and community acceptance.

The two threshold criteria are: 1) overall protection of human health and the environment, and 2) compliance with applicable, relevant, and appropriate requirements. The five primary balancing criteria are: 3) long-term effectiveness and permanence; 4) reduction of toxicity, mobility, or volume through treatment; 5) short-term effectiveness; 6) implement-ability; and 7) cost. The two modifying criteria are: 8) state acceptance, and 9) community acceptance. Environmental Protection Agency assesses public comment on the Proposed Plan to gauge community acceptance.

This section of the Proposed Plan discusses the relative performance of each alternative against the nine criteria and the rationale for selecting the Preferred Alternatives.

Several treatment technologies, including thermal (in-pile thermal desorption) and chemical (solvated electron technology and base catalyzed decomposition) processes, were also considered for use at the Site but were not included in a remedial alternative, as discussed further in the Feasibility Study. The feasibility study contains a detailed analysis of each alternative against the criteria and a comparative analysis of how the alternatives compare to each other. A summary is provided below.

Threshold Criteria

The two threshold criteria are overall protection of human health and the environment, and compliance with applicable, relevant, and appropriate requirements. The containment alternatives (2N through 5aN) will only remain protective if they are properly maintained for the length of time (hundreds of years) that the impounded waste retains its toxicity, and their integrity is not compromised by extreme weather events, barge strikes and/or changes in the river channel which could result in a future release. Alternative 6N best realizes the Threshold Criteria because the waste material would be removed and therefore not subject to a potential future release.

One of the applicable requirements is the Clean Water Act §404(b)(1), which addressed discharges of dredge and fill material into waters of the United States. The San Jacinto River is a water of the United States. Dredge and fill permits are applicable to dredging, in-water disposal, capping, construction of berms or levees, stream channelization, excavation and/or dewatering. Permits are not required, however, for on-site CERCLA actions. Under the 404(b)(1) guidelines, efforts should be made to avoid, minimize, and mitigate adverse effects on the waters of the U.S. and, where possible, select a practicable (engineering feasible) alternative with the least adverse effects. The substantive requirements of Section 404 were considered in the selection of the preferred remedial action. The preferred remedial action is designed to minimize adverse impacts to waters of the United States through the use of best management practices to minimize releases to the San Jacinto River. Additional evaluations will be conducted during the Remedial Design to determine the potential habitat impacts related to impacts of dredging and placement of the clean residual layer management materials to document compliance with CWA Section 404(b)(1).

Several facilities have been identified for the excavation alternatives that could potentially receive the waste material, however, the actual disposal location would be determined during the Remedial Design. Any potential releases during excavation will be reduced through implementation of best management practices.

There are significant differences between the northern area alternatives regarding the amount of potential dioxin impacts to the San Jacinto River, and when those impacts may occur. For example, Alternatives 3N would not result in any significant short term dioxin impact during construction because the existing cap is not removed. However, based on the Corps of Engineers review (Appendix A of the Feasibility Study), a severe future storm could result in significant erosion of 80% of the armor cap and up to 2.4 feet of scour into the waste pits. Removal alternatives will result in some releases of waste materials during implementation, estimated by the Corps of Engineers to be between 0.2% and 0.34%.

For the area south of I-10, other than Alternative 1S, the remedial alternatives considered in the Feasibility Study Report meet both of the threshold criteria: protectiveness and compliance with applicable, relevant, and appropriate requirements. However, the removal alternative (4S) is more protective in the long-term and permanent because the waste material could not be potentially compromised by future extreme weather events. The potentially affected receptor (future construction worker) would be protected from exposure to soil with elevated dioxin concentrations by warnings and restrictions (Alternatives 2S and 3S) or removal of impacted soil (Alternative 4S).

Primary Balancing Criteria – Long-Term Effectiveness and Permanence

All alternatives that leave waste material in place (Alternatives1N through 5aN) are less permanent than the removal alternative (6N).

Alternatives 1N, 2N, and 3N are containment alternatives with some long-term protectiveness. However, the area is prone to tropical storms and hurricanes which could damage a cap. In addition, future flooding may be even more intense than experienced in the past, which would increase the uncertainty of the long-term effectiveness of all of the containment alternatives.

Alternative 3aN is an enhanced capping alternative with armor cap improvements (larger 15" armor stone, 24" of additional cap thickness on top of the Alternative 3N cap) recommended by the Corps of Engineers to address the deficiencies of Alternative 3N. Alternative 3aN would be better able to withstand a future severe storm, although the Corps of Engineers did not model this. However, there still remains the uncertainties related to changes in channel planform morphology that may occur due to bank erosion, shoreline breaches, etc. during a high flow event caused by a major flood or hurricane, which is beyond the ability of existing sediment transport models to simulate, as well as the uncertainty of making predictions that would have to remain relevant for hundreds of years into the future. To add to these uncertainties, future flooding may be even more intense. According to the U.S. National Climate Assessment, flooding along rivers and other areas following heavy downpours and prolonged rains is exceeding the limits of flood protection infrastructure designed for historical conditions. Sea level rise, storm surge, and heavy downpours in combination with the pattern of continued development in coastal areas are increasing damage to U.S. infrastructure and are also increasing risks to ports and other installations. Aerial photographs document that the Site, even over just the last 60 years, is in a dynamic river environment that raises concerns about the permanence of any manmade structure.

Alternatives 4N, 5N, and 5aN all provide increased long term effectiveness compared to Alternatives 1N, 2N, and 3N because the most highly contaminated waste would either be stabilized or removed. However, uncertainties still remain regarding long-term effectiveness of the cap and the potential impact of severe future storms and hurricanes. Alternative 6N provides the greatest long-term protectiveness and effectiveness because the waste material would be permanently removed from the San Jacinto River and there would be no potential for a future release above the risk based level from the Site. Also, with Alternative 6N, there would be no concerns regarding the long-term viability and effectiveness of a maintenance program that would have to endure for an extremely long time (more than 500 years). Alternative 6N is also the only alternative that provides for complete removal of the Principal Threat Waste from the northern impoundments.

Ground water monitoring would be included in Alternatives 2N through 5aN, where waste above the preliminary remediation goals is left in place, to confirm that there would be no long-term future unacceptable impacts to ground water.

For the area south of I-10, soil with dioxin concentrations exceeding the cleanup goal is isolated from the surface by relatively clean overburden. The only route of potential exposure is through excavation into the impacted depth interval. The physical markers (Alternative 3S) would draw attention to the institutional controls and enhance their effectiveness. Alternative 4S would achieve long-term effectiveness by permanently removing the impacted soil from the 0- to 10-foot depth interval from the Site and securely disposing of the soil in an approved permitted landfill. While the institutional controls, particularly with the addition of physical markers (Alternative 3S), would provide reliable long-term protection, they rely on the integrity of future construction workers to comply with the restrictions. Therefore, complete removal of the impacted soil in the depth interval of potential excavation (Alternative 4S) will provide the highest level of long-term effectiveness because it is not subject to inappropriate future use of the area or any erosion/scour of the waste material that may result from a future extreme storm. Alternative 4S is also the only alternative that provides for complete removal of the Principal Threat Waste from the southern impoundment. Ground water monitoring would be included in Alternatives 2S

and 3S, where waste above the preliminary remediation goals is left in place, to confirm that there would be no long-term future unacceptable impacts to ground water.

Primary Balancing Criteria – Reduction of Toxicity, Mobility, or Volume through Treatment

Alternatives 1N, 2N, 3N, or 3aN do not include additional measures to reduce the toxicity, mobility, or volume of material. However, a portion of the soils in the western cell were previously solidified during the temporary armored cap construction. Thus, these alternatives are comparable in reduction of toxicity, mobility, or volume of material. Alternative 3N further reduces potential mobility, and to a further extent 3aN, within the temporary armored cap site by increasing the protection of the armored slopes, and both rank more favorably than Alternatives 1N and 2N. Alternatives 4N and 5N take additional measures through solidification and stabilization (Alternative 4N) or removal (Alternative 5N) of approximately 52,000 cubic yards of waste materials, and are comparatively better than Alternative 3N and 3aN for reduction of toxicity, mobility, or volume of material. Alternative 5aN removes approximately 137,600 cubic yards of waste material, and thus compares more favorably for reduction of toxicity, mobility, or volume of material than Alternatives 4N and 5N. Alternative 6N has the greatest volume of removal – 200,100 cubic yards. This alternative is the most effective in reducing the toxicity, mobility, and volume of waste compared to all of the other alternatives.

Alternatives 1S, 2S and 3S do not include any reduction in the toxicity, mobility, or volume of impacted soil. Alternative 4S is the only alternative that reduces the volume by complete removal of soils above the Preliminary Remediation Goal. The excavated soil will likely require dewatering either by physical removal and/or treatment with Portland cement or a similar material to eliminate free liquids for transportation and disposal.

Primary Balancing Criteria – Short-Term Effectiveness

Alternatives 1N and 2N do not entail any construction, and thus have no short-term impacts. Alternative 3N has the shortest construction duration (two months) of the remaining alternatives. Alternatives 3aN, 4N, 5N, 5aN, and 6N have estimated construction durations ranging from 13 to 19 months. Alternative 3N does not result in water column, sediment, or tissue impacts (except for minor turbidity during armor rock placement), and has the lowest risk to worker safety, the lowest greenhouse gas and particulate matter emissions, and the least traffic and ozone (smog) impact. Further, Alternative 3N does not disturb the armored cap or require handling of waste materials. Compared to Alternatives 4N, 5N, 5aN, and 6N, which all include at least some cap removal, Alternatives 3N and 3aN rank more favorably for short-term effectiveness because there is no cap removal and little potential for short-term dioxin releases to the San Jacinto River.

All of the alternatives involving either partial or full removal of the waste materials, including Alternatives 5N, 5aN, and 6N, would have re-suspension of sediment. Alternative 5N uses silt curtains to control the re-suspension of sediment. Silt curtains are the least effective controls. Alternative 5aN uses more effective re-suspension controls including sheet piles and earthen berms. Alternative 6N adds removal in the dry in addition to sheet piles and earthen berms and results in the most effective control of re-suspension. The actual design and application of Best Management Practices for construction will be determined during the Remedial Design.

Alternatives 4N, 5N, 5aN, and 6N each have short-term impacts associated with sediment residuals and re-suspension as well as a high-water event during construction. However, the actual impacts would be reduced to the maximum extent practicable by the use of Best Management Practices during construction, especially in Alternative 6N with the most extensive application of Best Management Practices.

Alternative 5aN and 6N has a longer construction duration than the other alternatives. Compared to the other alternatives, there is higher potential worker safety issues and higher environmental impacts due emissions of ozone precursors, particulate matter (smog-forming), and greenhouse gases.

Best Management Practices can successfully mitigate and control re-suspension of sediment. Alternative 6N, the preferred alternative, will include design and construction methodologies to mitigate and reduce the impact of storms during construction. These methodologies may include armor cap removal in sections, raised berms, operational controls, etc. Substantial containment structures are needed to isolate the removal operations, residuals and exposed sediment. To control the sediment re-suspension during construction, the containment structures would consist of berms and sheet pile walls or caissons to an elevation of about +10 NAVD88 (protection from 25-year or 50-year flood stage). If performing excavation of the waste materials in the dry, the top of the berms would preferably be no lower than +5 NAVD88 (protection from 5-year or 10-year flood stage).

For the Southern Impoundment, Alternative 2S for the southern area does not entail any construction, and thus has no short-term impacts. Excavations (Alternatives 3S and 4S) would require Best Management Practices to control dust and storm water. Short-term impacts associated with Alternative 3S would be minimal given the shallow depth of excavation, limited volume of material that would be moved, and absence of significant concentrations of contaminants of concern in the shallow soil. Alternative 4S would require exposing soil with dioxin concentrations exceeding the Preliminary Remediation Levels, which introduces the potential for exposure to contaminants of concern through direct contact with the soil, inhalation or ingestion of impacted dust, and contact with impacted soil suspended in runoff. The volume of soil and the duration of the project would also be greater than for Alternative 3S; and Alternative 4S would require offsite transportation of the soil to a disposal facility, increasing the potential for exposure to contaminants of concern, emissions of greenhouse gasses, nitrogen oxides, and particulate matter, and potential tracking of contaminants of concern offsite. However, measures developed in the Remedial Design would be implemented to reduce the amount of any materials lost during transportation. During the Remedial Design, a plan will be prepared for notification of downstream stakeholders regarding Site activities and any unexpected conditions at the Site.

Primary Balancing Criteria – Implementability

Alternatives 1N and 2N do not have any implementability issues because they do not entail construction. Both are more favorable from an implementability standpoint compared to Alternatives 3N, 4N, 5N, 5aN, and 6N. Alternative 3N is a short-duration project that entails proven technology (i.e., the same activities were demonstrated during construction of the temporary armored cap) that can be deployed with readily-available materials and local, experienced contractors.

Implementability issues, such as the temporary armored cap site access, limited staging areas, restrictions on equipment size, and availability of offsite staging area properties are greater for Alternatives 4N, 5N, 5aN, and 6N compared to Alternative 3N and 3aN because of the much larger scope and scale of these alternatives. Identifying and securing an offsite staging area is considered an even greater challenge for Alternatives 5N, 5aN, and 6N compared to Alternative 4N because removed waste material and sediment may need to be managed at the offsite staging area, which requires a larger footprint, and given the nature of the dredged material, might make finding a willing landowner difficult. Proper management of cap material and excavated wastes, and onsite processing and management for removed sediments for offsite transportation to neighboring roadways, will be critical for effective implementation of Alternatives 5N, 5aN, and 6N.

For the southern area, there are no significant implementability concerns associated with Alternatives 2S and 3S. None of the alternatives requires specialized equipment, techniques, or personnel. Coordination with property owners would be required to establish institutional controls and for access to the project work site. Alternative 4S would involve more physical activity for implementation, including offsite transportation of impacted soil, but the operations are routine for remedial actions. The additional implementability concerns are the increased truck traffic on Market Street and the potential for flooding while impacted soil is exposed during implementation of Alternative 4S. Provisions may need to be made to handle the additional volume of traffic. The

duration of the excavation should not exceed 7 months, and implementation could be timed for periods when high water is least likely.

Primary Balancing Criteria – Cost

The estimated present worth costs for alternatives range from $0.4 million for Alternative 1N to $87 million for Alternative 6N, and from $0 for Alternative 1S to $9.9 million for Alternative 4S. Costs for each alternative are presented with the descriptions of each alternative.

Modifying Criteria

The Texas Commission on Environmental Quality, the support agency, has been informed about the Preferred Remedy for the Site. Community acceptance will be determined through the Public Comment process based on letters and emails received during the public comment period and the questions received at the public meeting. Prior to the public comment period, the Environmental Protection Agency has received about 4,000 letters and emails supporting either the full removal alternative or the capping alternative.

Preferred Remedy

The Preferred Remedy for cleaning up the Site is Alternative 6N (Removal of Waste Materials Exceeding Cleanup Levels, Monitored Natural Recovery, and Institutional Controls) and Alternative 4S (Removal and Offsite Disposal with Institutional Controls). These alternatives will achieve protectiveness by removal of dioxin waste materials that are considered Principal Threat Waste and removal dioxin contaminated materials at concentrations greater than the Preliminary Remediation Goals, resulting in a permanent solution to address the highly toxic dioxin waste materials from the Northern and Southern impoundments. The removed material will be transported to and disposed of at an approved permitted disposal facility.

Based on the information available at this time, the Environmental Protection Agency believes that the Preferred Remedy is protective of human health and the environment, complies with applicable, relevant, and appropriate requirements, and provides the best balance of tradeoffs among the balancing criteria. It reduces risks within a reasonable time frame, provides for long-term reliability of the remedy, and minimizes reliance on institutional controls. It will achieve substantial risk reduction by removing the contaminated materials and manages the remaining risks to human health through institutional controls. The Environmental Protection Agency considered several options for contaminated materials. The Environmental Protection Agency's preferred remedy includes full removal of contaminated waste materials above cleanup levels for the following reasons:

- The material is highly toxic and may be highly mobile in a severe storm and therefore is considered a Principal Threat Waste. The Environmental Protection Agency considers material at the Site with more than 300 ng/kg dioxin to be Principal Threat Waste. This concentration was calculated by multiplying the sediment Preliminary Remediation Goal of 30 ng/kg by a factor of 10.
- The location of materials, either partially submerged within the San Jacinto River (northern impoundments) or on a small peninsula on the San Jacinto River (southern impoundment), is in a river environment that is subject to dramatic change, creating concerns about the permanence of an armored cap.
- The area has a high threat of repeated storm surges and flooding from hurricanes and tropical storms, which, if the material was left in place, could result in a release of hazardous substances.
- The history of repeated armor cap maintenance as a result of floods that are much less severe than the design 100-year flood.

For all of these factors, the Preferred Remedy provides greater permanence in comparison to other alternatives. Less costly alternatives rely on remedies that have a higher chance of failure by leaving Principal Threat Waste materials in the river, resulting in greater uncertainty as to their long-term effectiveness. The Preferred Remedy can change in response to comment received during the public comment period or new information presented to the Environmental Protection Agency.

EPA Enforcement Process

Following the public comment period and consideration of the comments received, the Environmental Protection Agency, in consultation with the Texas Commission on Environmental Quality, will issue a Record of Decision to select a remedial action for the Site. The Record of Decision will also include a Responsiveness Summary where the Environmental Protection Agency will respond to the comments received during the comment period.

Once the Environmental Protection Agency signs the Record of Decision, it will use the special negotiation procedures found in Section 122(e) of the Comprehensive Environmental Response, Compensation and Liability Act to facilitate a settlement between the Potentially Responsible Parties and the Environmental Protection Agency for implementation of the selected response action. Pursuant to Section 122(e), the Environmental Protection Agency will send special notice letters to the Potentially Responsible Parties, which will trigger a sixty (60)-day moratorium on certain Environmental Protection Agency response activities at the Site while negotiations commence. During this 60-day moratorium, the Environmental Protection Agency will not begin response action at the Site, although the Environmental Protection Agency reserves the right to take action at the Site at any time should a significant threat to the human health or the environment arise.

If, after 60 days, the parties provide the Environmental Protection Agency with a good faith offer to conduct or finance the response action and reimburse the Environmental Protection Agency for its costs incurred to date, the Environmental Protection Agency will extend the negotiation period for an additional 60 days. If settlement is reached between the Environmental Protection Agency and the Potentially Responsible Parties, the settlement will be embodied in a Consent Decree for Remedial Design/Remedial Action. Because a Remedial Design/Remedial Action Consent Decree is a highly complex agreement, the period for negotiation after receipt of a good faith offer often extends longer than the additional 60 days. Once approved by the Environmental Protection Agency and the U.S. Department of Justice, the Consent Decree will then be lodged in federal court for judicial approval.

If a timely settlement cannot be reached, the Environmental Protection Agency may take appropriate action at the Site, which may include either of the following options: (1) the Environmental Protection Agency may issue a Unilateral Administrative Order to the potentially responsible parties under Section 106(a) of the Comprehensive Environmental Response, Compensation and Liability Act, requiring the parties to perform the remedy described in the Record of Decision; or (2) the Environmental Protection Agency may fund the remedial action and pursue a cost recovery claim under 107 of the Comprehensive Environmental Response, Compensation and Liability Act against the Potentially Responsible Parties. If the recipients of a Unilateral Administrative Order refuse to comply with the Order, the Environmental Protection Agency may pursue civil litigation against the recipients to require compliance.

Once either a Consent Decree or a Unilateral Administrative Order is in place, the Potentially Responsible Parties must develop work plans for construction of the remedy and for protection of the public during construction. Next, a contractor must be selected subject to review by the Environmental Protection Agency prior to mobilizing for construction. As a result, there will likely be a period of approximately two years or more following the signing of the Record of Decision before physical construction of the remedy begins at the Site.

Glossary

Administrative Record – All documents which the Environmental Protection Agency considered or relied upon in selecting the response action at a Superfund site, culminating in the Record of Decision for a Remedial Action.

Applicable, Relevant, and Appropriate Requirements (ARARs) – Generally, any Federal, State, or local requirements or regulations that would apply to a remedial action if it were not being conducted under the Comprehensive Environmental Response, Compensation, and Liability Act, or that while not strictly applicable, are relevant in the sense that they regulate similar situations or actions and are appropriate to be followed in implementing a particular remedial action.

Contaminants of Concern - Those chemicals that are identified as a potential threat to human health or the environment, are evaluated further in the baseline risk assessment, and are identified in the remedial investigation/feasibility study as needing to be addressed by the response action proposed in the Record of Decision.

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) – Also known as Superfund. The Comprehensive Environmental Response, Compensation, and Liability Act is a Federal law passed in 1980 and modified in 1986 by the Superfund Amendments and Reauthorization Act. Under the Comprehensive Environmental Response, Compensation, and Liability Act, the Environmental Protection Agency can either pay for the site cleanup or take legal action to force parties responsible for site contamination to clean up the Site or pay back the Federal government for the cost of the cleanup.

Baseline Ecological Risk Assessment– A study that determines and evaluates risks that site contamination poses to ecological receptors.

Code of Federal Regulations (CFR) - Codification of the general and permanent rules published in the Federal Register by the departments and agencies of the Federal Government.

Dioxins - A mixture of up to 7 dioxin and 10 furan chemical compounds combined using the toxicity equivalence approach. Toxicity Equivalents, or TEQs, are used to report the toxicity-weighted mass of mixtures of dioxins and furans. Within the TEQ method, each dioxin or furan compound is assigned a Toxicity Equivalence Factor (TEF). This factor denotes a given dioxin, or furan compound's toxicity relative to 2,3,7,8-tetra chlorodibenzo-p-dioxin (2,3,7,8-TCDD, or TCDD), which is assigned the maximum toxicity designation of one. Other dioxin or furan compounds are given equal or lower numbers, with each number roughly proportional to its toxicity relative to that of 2,3,7,8-TCDD. Toxicity equivalence is the product of the concentration of an individual dioxin like compound in an environmental mixture and its corresponding toxicity equivalence factor for that compound. Dioxin TEQs can also be combined with dioxin-like Polychlorinated Bi-Phenyl TEQs (see Dioxin-like Polychlorinated Bi-Phenyls below) when appropriate.

Dioxin-Like Polychlorinated Bi-Phenyls - A mixture of up to 12 Polychlorinated biphenyl (PCB) chemical compounds that have a mechanism of toxicity very similar to 2,3,7,8-tetra chlorodibenzo-p-dioxin (2,3,7,8-TCDD, or TCDD). Dioxin-like Polychlorinated Bi-Phenyls can also be combined using the toxicity equivalence approach. Toxicity Equivalents, or TEQs, are used to report the toxicity-weighted mass of mixtures of dioxin-like Polychlorinated Bi-Phenyls. Within the TEQ method, each dioxin-like Polychlorinated Bi-Phenyl compound is assigned a Toxicity Equivalence Factor (TEF). This factor denotes a given compound's toxicity relative to 2,3,7,8-TCDD, which is assigned the maximum toxicity designation of one. Other dioxin and dioxin-like Polychlorinated Bi-Phenyl compounds are given equal or lower numbers, with each number roughly proportional to its toxicity relative to that of 2,3,7,8-TCDD. Toxicity equivalence is the product of the concentration of an individual dioxin-like Polychlorinated Bi-Phenyl compound in an environmental mixture and its corresponding toxicity equivalence factor for that compound. Dioxin-like Polychlorinated Bi-Phenyl TEQs can also be combined with dioxin TEQs (see Dioxins above) when appropriate.

Engineering Controls – Instruments such as fencing or signage that are used to limit access to contaminated areas or areas that may pose a physical hazard.

Feasibility Study– A detailed evaluation of alternatives for cleaning up a site.

Five-Year Reviews – A review generally required by statute or program policy when hazardous substances remain at a site above levels which permit unrestricted use and unlimited exposure. Five-year reviews provide an opportunity to evaluate the implementation and performance of a remedy to determine whether it remains protective of human health and the environment. Reviews are performed five years after completion of the remedy construction at Superfund-financed sites, and are repeated every succeeding five years so long as future uses at a site remain restricted.

Hazard Index (HI) – In the baseline risk assessment, ration of the dose calculated for a receptor divided by the toxicity value. When the HI exceeds 1.0, a health risk or ecological risk is assumed to exist.

Human Health Risk Assessment – Estimates the current and possible future risk if no action were taken to clean up a site. The Environmental Protection Agency's Superfund risk assessors determine how threatening a hazardous waste site is to human health and the environment. They seek to determine a safe level for each potentially dangerous contaminant present (e.g., a level at which ill health effects are unlikely and the probability of cancer is very small). Living near a Superfund site doesn't automatically place a person at risk; that depends on the chemicals present and how a person is exposed to the chemical.

Implementability – One of the Environmental Protection Agency's primary balancing criteria addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability of services and materials, administrative feasibility, and coordination with other governmental entities are also considered.

Institutional Controls – Non-engineered instruments, such as administrative and/or legal controls, that help to minimize the potential for human exposure to contamination and/or protect the integrity of the remedy. Institutional controls work by limiting land or ground water use and/or providing information that helps modify or guide a person's action at a site. Some common examples include restrictive covenants, deed notices, or local ordinances.

Long-term Effectiveness and Permanence – One of the Environmental Protection Agency's primary balancing criteria that refers to the expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup levels have been met. This criterion includes the consideration of residual risk that will remain onsite following remediation and the adequacy and reliability of controls.

Monitored Natural Recovery - A technology in which contaminant concentrations are monitored with no other remedial actions taken to address contamination. Monitored Natural Recovery assesses the natural attenuation of contaminants by physical, chemical, and biological processes.

Operable Unit - An operable unit is a discrete action that comprises an incremental step toward comprehensively addressing site contamination.

Nanograms per Kilogram (ng/kg) - Is a measurement of concentration used to measure how many nanograms of a contaminant are present in one kilogram of solid material (e.g., soil, sediment, tissue). One ng/kg is equal to 0.000001 milligrams per kilogram (mg/kg).

National Priorities List (NPL) – The Environmental Protection Agency's list of the most serious uncontrolled or abandoned hazardous waste sites identified for possible long-term remedial response.

Preliminary Remediation Goal - Upper concentration limits for specific chemicals in specific environmental media that are anticipated to protect human health or the environment.

Principal Threat Wastes - Those materials considered to be highly toxic or highly mobile that generally cannot be reliably contained, or would present a significant risk to human health or the environment should exposure occur. The Environmental Protection Agency expects to use treatment when practical to address the principal threats posed by a site. The "principal threat" concept is applied to the characterization of "source materials" at a Superfund site. A source material is material that includes or contains hazardous substances, pollutants, or contaminants that act as a reservoir for migration of contamination to ground water, surface water, or air, or acts as a source for direct exposure.

Reasonable Maximum Exposure– The maximum exposure reasonably expected to occur in a population.

Reduction of Toxicity, Mobility, or Volume Through Treatment – One of the Environmental Protection Agency's primary balancing criteria that refers to the anticipated performance of the treatment technologies that may be included as part of the remedy.

Remedial Investigation– The collection and assessment of data to determine the nature and extent of contamination at a site.

Sediment - material that sinks to the bottom of the river.

Surface Area - Weighted Average Concentration – Average concentration for an area calculated by applying a surface area weighting factor to each concentration value.

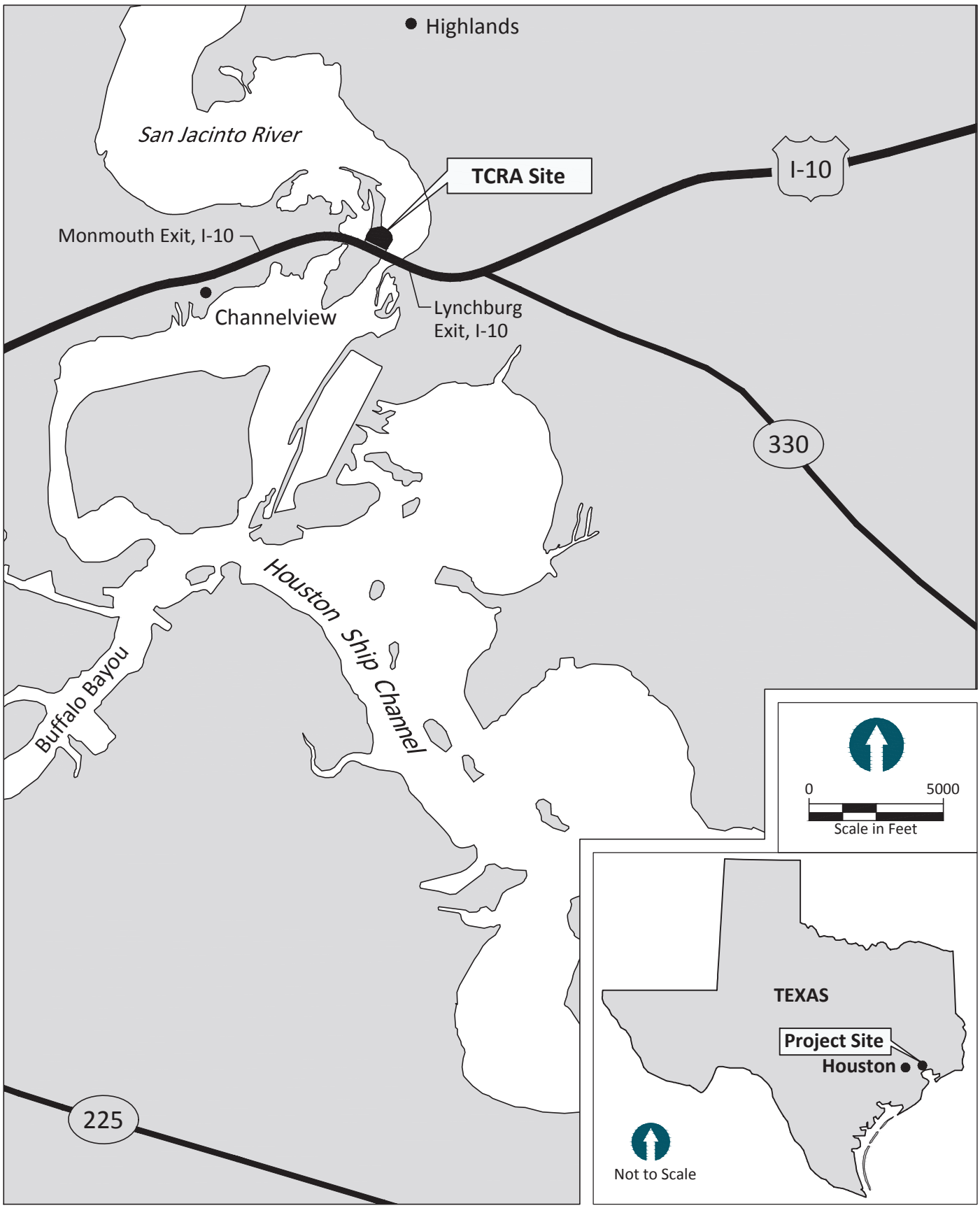
Short-term Effectiveness – One of the Environmental Protection Agency's primary balancing criteria that addresses the period of time needed to implement the remedy and any adverse impacts that may be posed to workers, the community, and the environment during construction and operation of the remedy until cleanup levels are achieved.

$TEQ_{DF,M}$ – 2,3,7,8-tetrachlorodibenzo-p-dioxin toxicity equivalent quotient calculated using toxicity equivalent factors for mammals

$TEQ_{P,M}$ – Dioxin-like Polychlorinated Bi-Phenyl congener toxicity equivalent quotient calculated using toxicity equivalency factors for mammals.

Waste Material – the waste that was transported and disposed of at the Site.

SITE FIGURES



Modified from: Anchor QEA, LLC. 2014. Draft Final Interim Feasibility Study Report, San Jacinto Waste Pits Superfund Site. Prepared for: McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. March.

076856

Figure 1
Site Location
San Jacinto River Waste Pits Site

USEPA's Preliminary Site Perimeter
Original 1966 Perimeter of the Impoundments North of I-10
Approximate TCRA Footprint
Soil Investigation Area 4

FEATURE SOURCES:
Aerial Imagery: 0.5-meter. Photo Date: 01/14/2009
Texas Strategic Mapping Program (StratMap), TNRIS

0 800
Scale in Feet

Figure 2
Site Overview
San Jacinto River Waste Pits Site

[a] Designation of the sand separation area is intended to be a general reference to areas in which such activities are believed to have taken place based on visual observations of aerial photography from 1998 through 2002.

Modified from: Integral Consulting Inc. and Anchor QEA, LLC. 2013. Remedial Investigation Report, San Jacinto River Waste Pits Superfund Site. Prepared for: McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. May.

076857

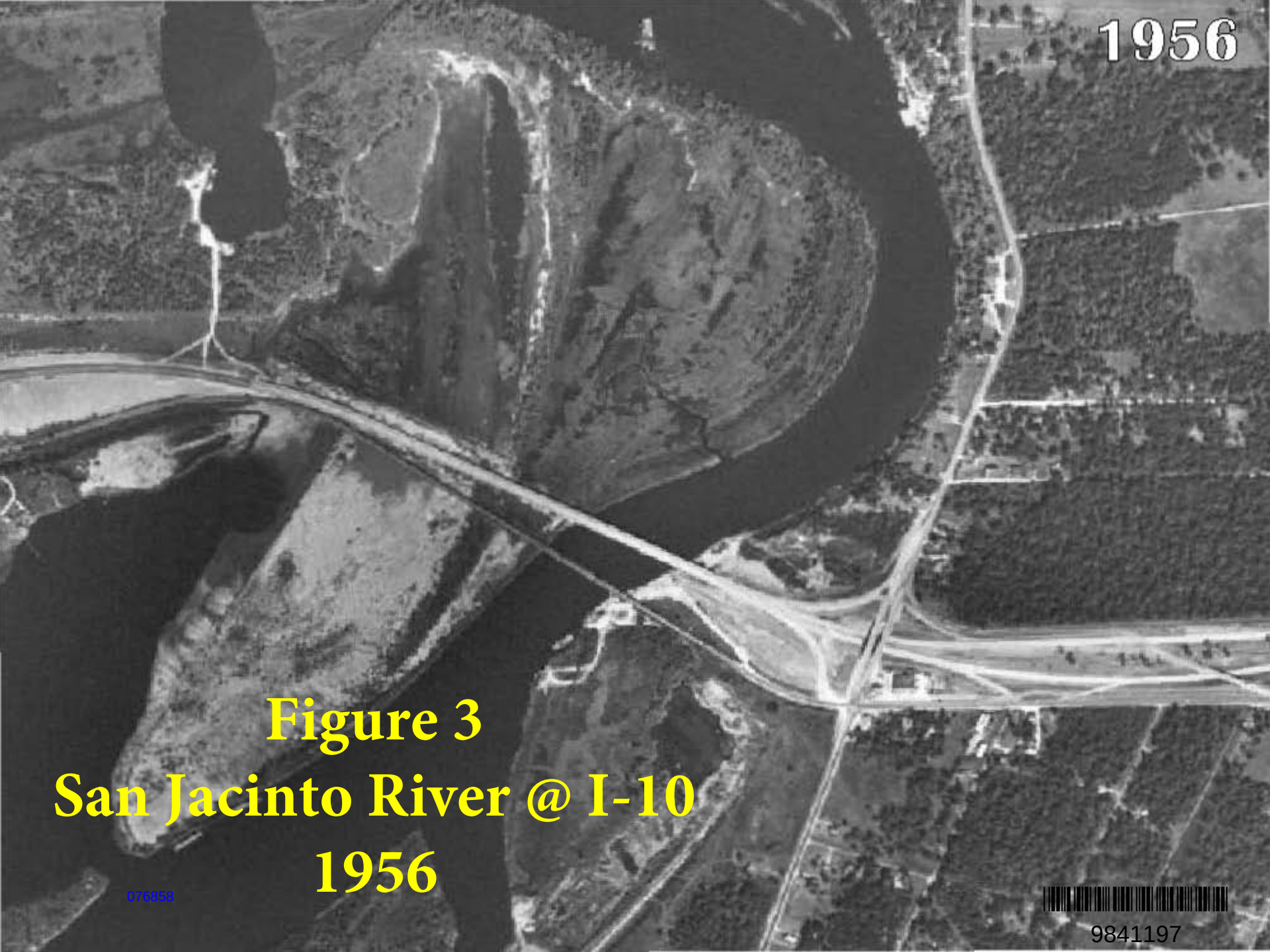


Figure 3
San Jacinto River @ I-10
1956

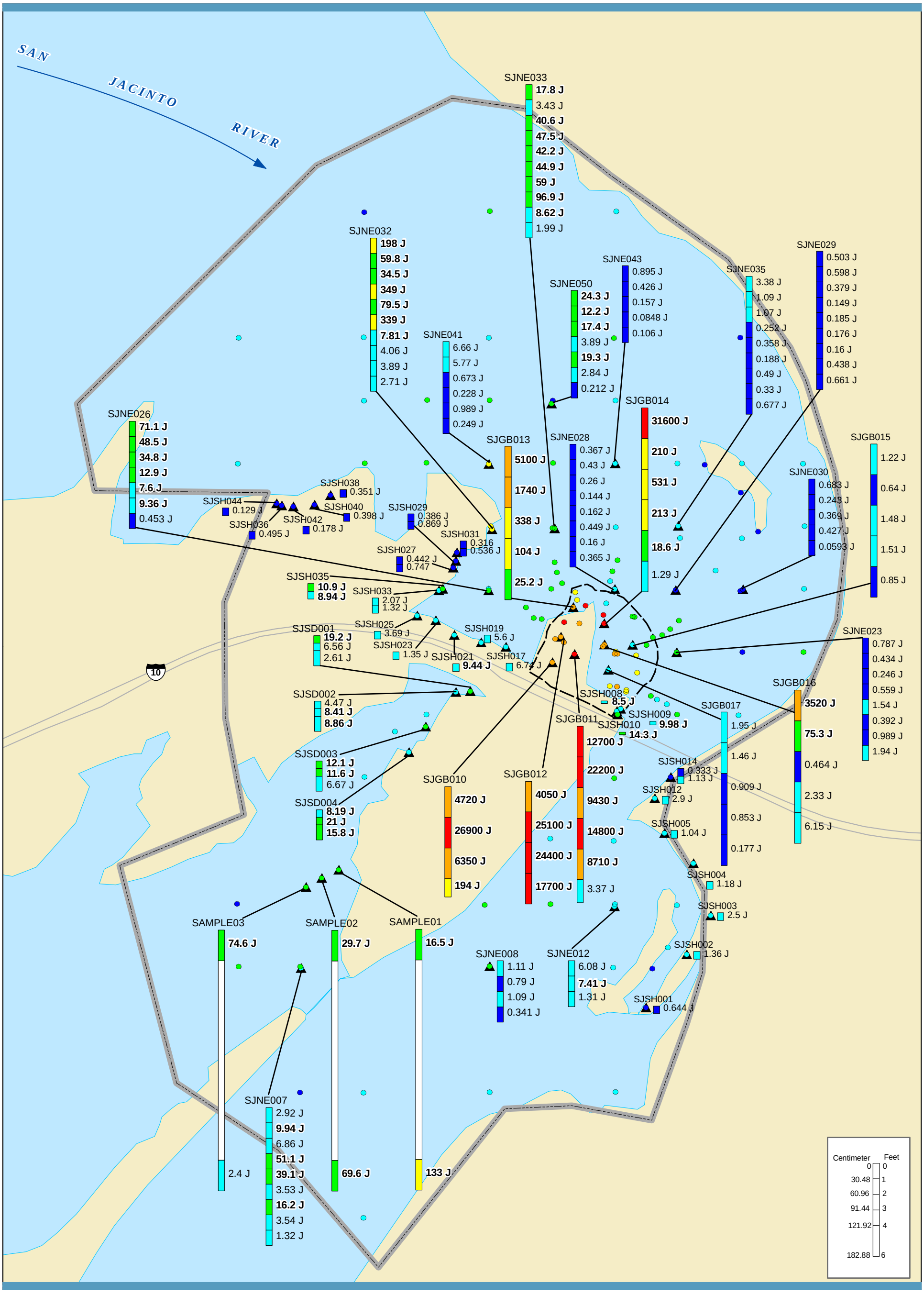
Figure 4
San Jacinto River @ I-10
1966

076859

Figure 5
San Jacinto River @ I-10
1973

076860

Figure 6
San Jacinto River @ I-10
1997



USEPA's Preliminary Site Perimeter

Original 1966 Perimeter of the Impoundments North of I-10

Core Location

Surface Sediment Sample Location

$TEQ_{DF,M}$ (ng/kg dw)

Cores

- =10000
- 1000 - 10000
- 100 - 1000
- 10 - 100
- 1 - 10
- <1
- No analysis

0 800

Scale in Feet

Notes:
$TEQ_{DF,M}$ = Toxicity equivalent for 2,3,7,8-TCDD calculated for dioxins and furans using mammalian TEFs from van den Berg et al. (2006) (nondetect = 1/2 detection limit)

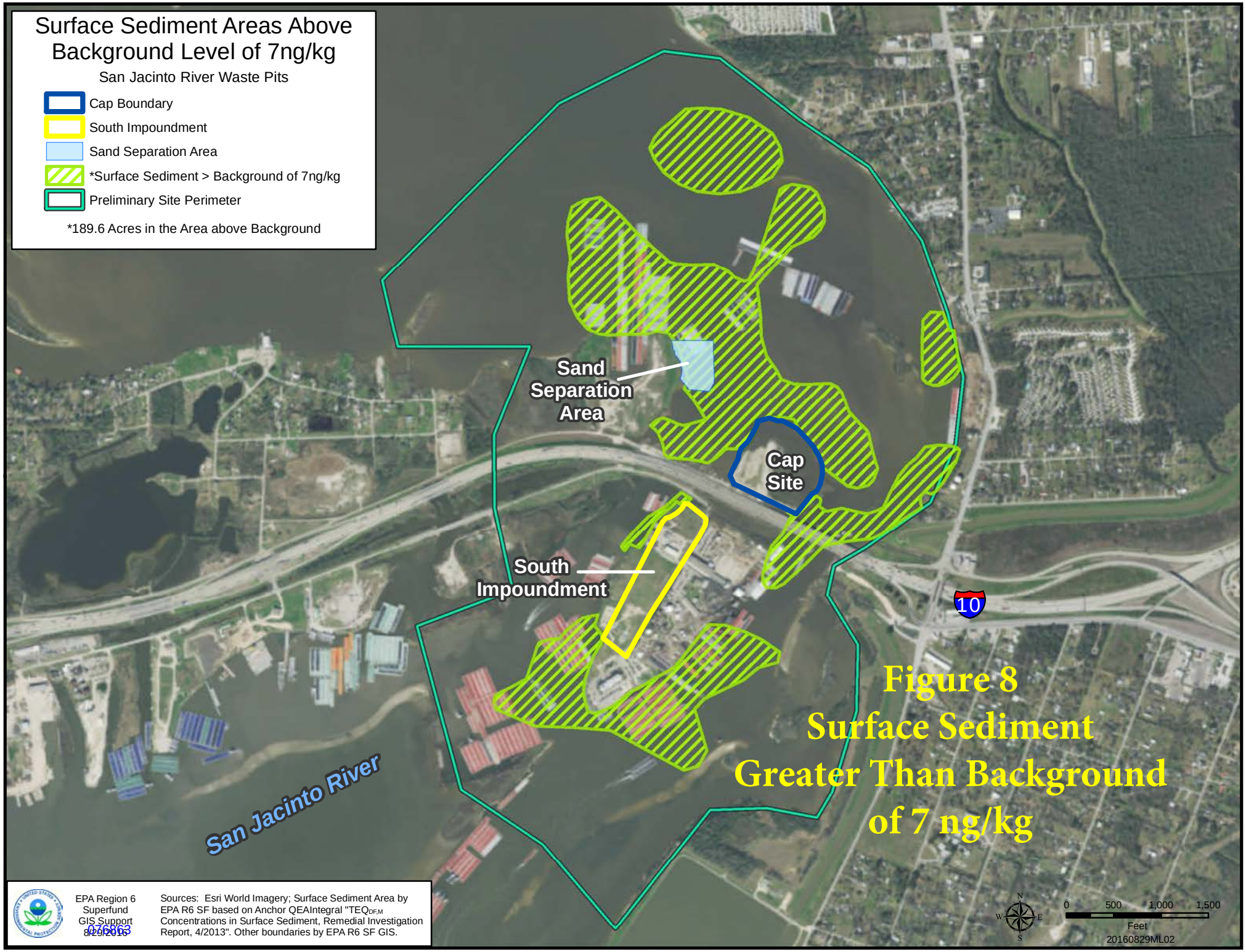
J = Estimated. One or more congeners used to calculate the $TEQ_{DF,M}$ was not detected.

Concentrations in bold indicate values above reference envelope value (REV); REV= 7.2 ng/kg dw

Figure 7
TEQ_{DF} Concentrations in Waste Material & Sediment Cores

San Jacinto River Waste Pits Site

Modified from: Integral Consulting Inc. and Anchor QEA, LLC. 2013. Remedial Investigation Report, San Jacinto River Waste Pits Superfund Site. Prepared for: McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. May.


Surface Sediment Areas Above Background Level of 7ng/kg
San Jacinto River Waste Pits
Cap Boundary
South Impoundment
Sand Separation Area
*Surface Sediment > Background of 7ng/kg
Preliminary Site Perimeter
*189.6 Acres in the Area above Background
Sand Separation Area
Cap Site
South Impoundment
10
San Jacinto River
Figure 8
Surface Sediment
Greater Than Background
of 7 ng/kg
EPA Region 6
Superfund
GIS Support
8/29/2016
Sources: Esri World Imagery; Surface Sediment Area by EPA R6 SF based on Anchor QEAIntegral "TEQ$_{DFM}$ Concentrations in Surface Sediment, Remedial Investigation Report, 4/2013". Other boundaries by EPA R6 SF GIS.
N
W
E
S
0
500
1,000
1,500
Feet
20160829ML02

076863

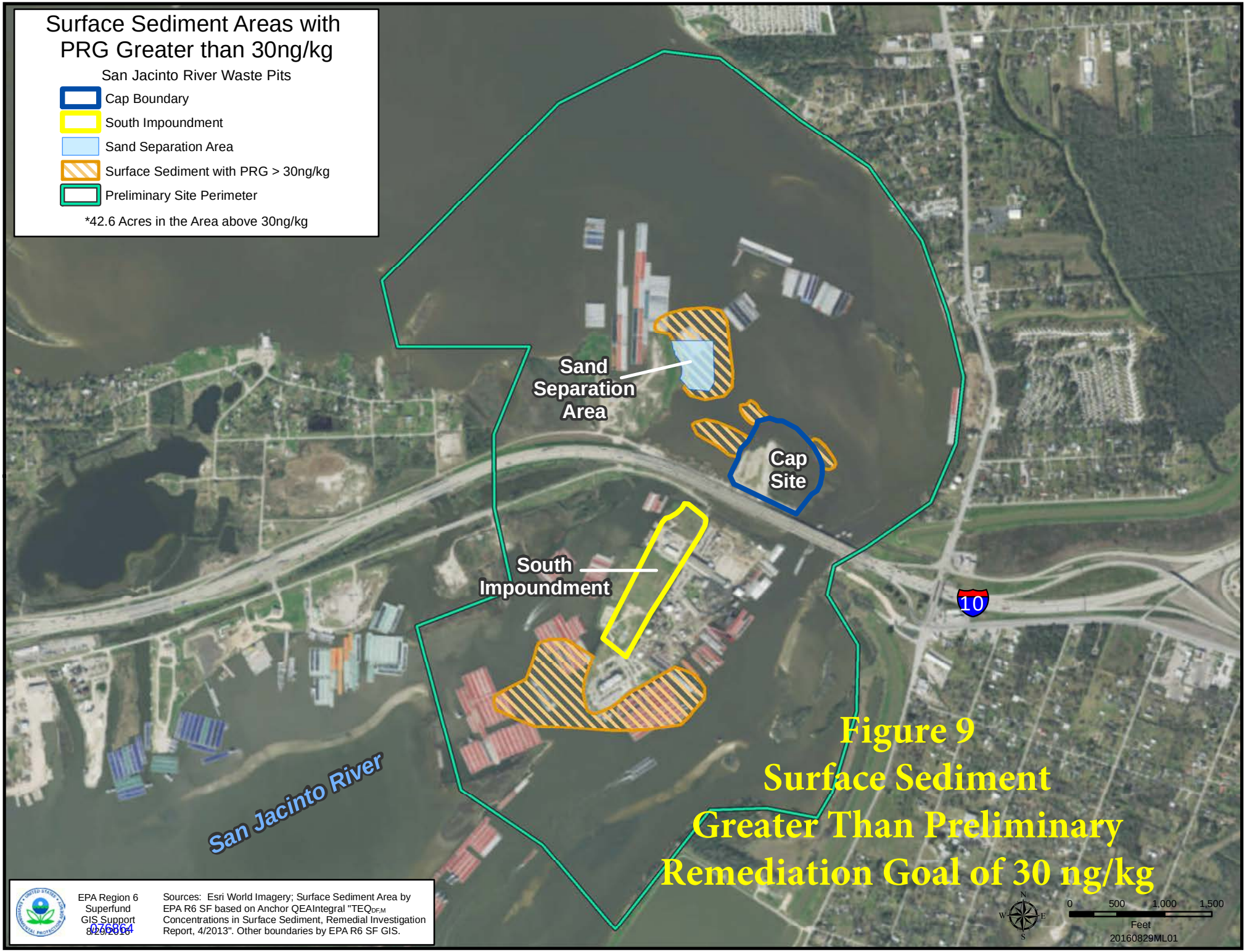
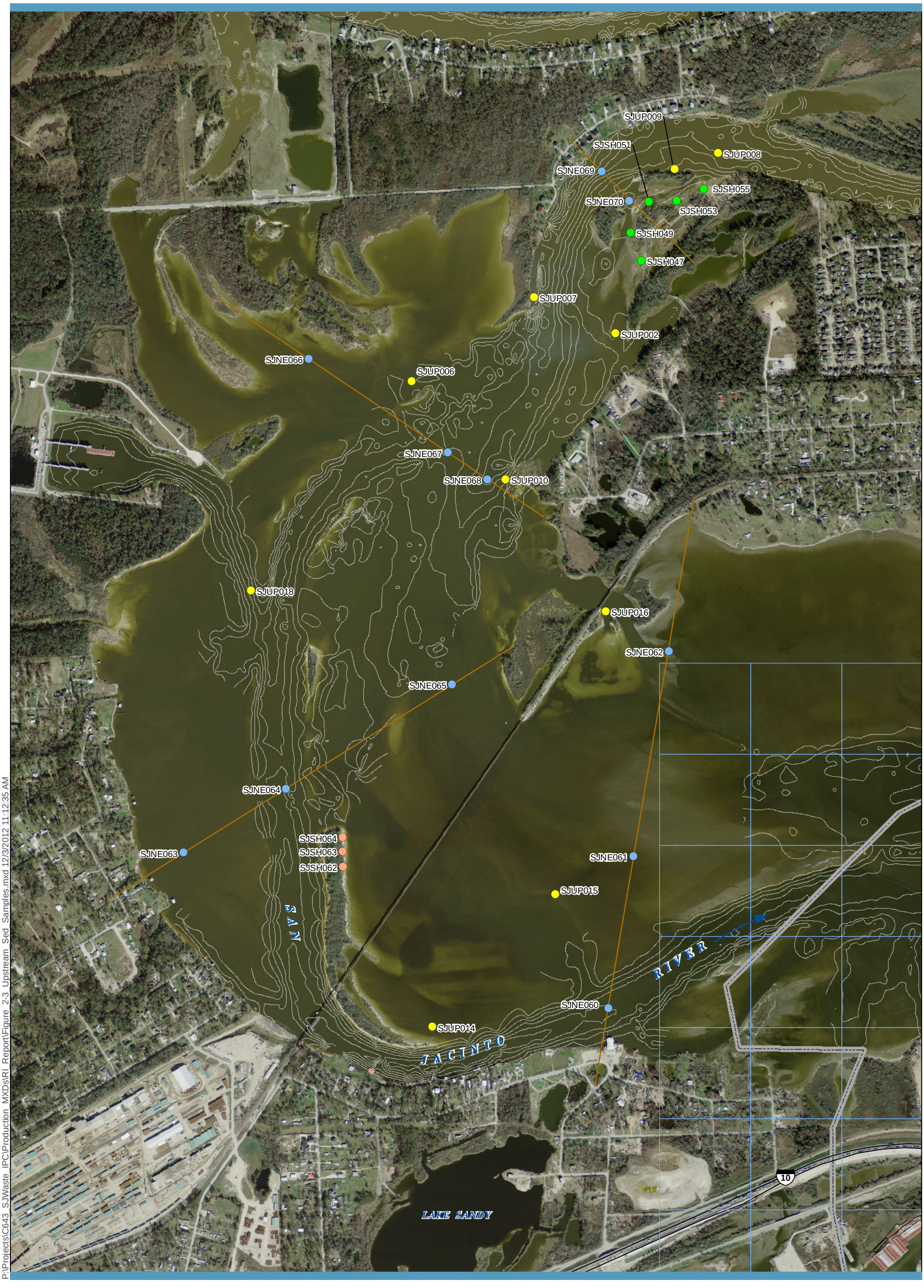


Figure 9
Surface Sediment
Greater Than Preliminary
Remediation Goal of 30 ng/kg



P:\Projects\C643_SJWaste_IPC\Production_MXDs\RI_Report\Figure_2-3_Upstream_Sed_Samples.mxd 12/3/2012 11:12:35 AM

ANCHOR QEA integral consulting inc

0 800
Scale in Feet
076865

USEPA's Preliminary Site Perimeter
1-Meter 1995 Bathymetric Contour
Sampling Transect

BERA = Baseline Ecological Risk Assessment
BHHRA = Baseline Human Health Risk Assessment
COPC = Chemical of Potential Concern

FEATURE SOURCES:
Aerial Imagery: 0.5-meter 2008/2009 DOQQs
- Texas Strategic Mapping Program (StratMap), TNRIS;
Contours: NOS Survey H10619 (1995)

Actual Sample Location

- Surface Sediment for BHHRA (Primary COPCs)[a]
- Surface Sediment (Dioxins and Furans only)
- Surface Sediment COPCs)
- Surface Sediment for BERA (Primary COPCs)

[a]Subsurface samples were collected at SJSH047 and SJSH055 but were determined to be unnecessary (Integral 2011a), and were disposed.

Figure 10
Upstream Background Sediment Sampling Locations
Remedial Investigation Report
San Jacinto River Waste Pits Superfund Site

P:\Projects\C643_SJWaste_IPC\Production_MXDs\RI_Report\Figure_2-6_fish_collection_tissue_sampling.mxd 5/10/2013 4:21:17 PM

ANCHOR QEA

integral consulting inc

USEPA's Preliminary Site Perimeter

Original 1966 Perimeter of the Impoundments North of I-10

Approximate TCRA Footprint

Clams and Small Fish

Small Fish

Clams

Large Fish and Blue Crab Fish Collection Areas

0 800

Scale in Feet

076866

[a] Designation of the sand separation area is intended to be a general reference to areas in which such activities are believed to have taken place based on visual observations of aerial photography from 1998 through 2002.

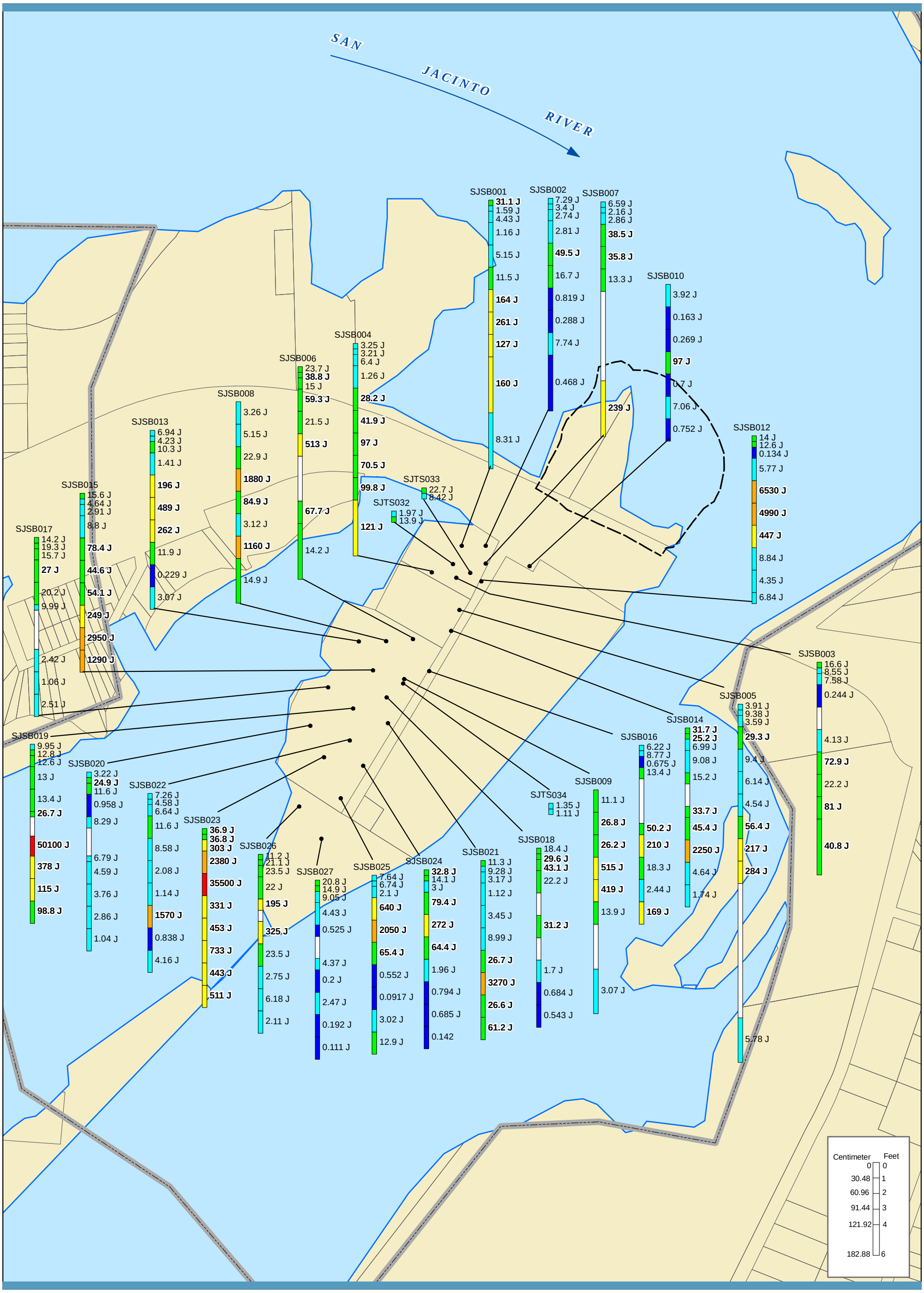
FEATURE SOURCES:
Aerial Imagery: 0.5-meter January 2009 DOQQs - Texas Strategic Mapping Program (StratMap), TNIS

Figure 11

Fish Collection Areas (FCA) and Tissue Sampling Transects

within USEPA's Preliminary Site Perimeter
Remedial Investigation Report

San Jacinto River Waste Pits Superfund Site



USEPA's Preliminary Site Perimeter

Original 1966 Perimeter of the Impoundments North of I-10

Soil Boring Location

$TEQ_{DF,M}$ (ng/kg dw)

Cores

- =10000
- 1000 - 10000
- 100 - 1000
- 10 - 100
- 1 - 10
- <1
- No analysis

0 400 Feet

FEATURE SOURCES:
Parcel Boundaries: Harris County Appraisal District
Hydrology: Harris County Flood Control District

Notes:
$TEQ_{DF,M}$ = toxicity equivalent for dioxins and furans using mammalian TEFs from van den Berg et al. (2006) (nondetect =1/2 detection limit)

J = Estimated, One or more congeners used to calculate the $TEQ_{DF,M}$ was not detected

Concentrations in bold indicate values above reference envelope value (REV);
REV= 24.3 ng/kg dw

Figure 12
Distribution of TEQ_{DF} in Soil Investigation Area 4 and Adjacent Soils
San Jacinto River Waste Pits Site

Modified from: Integral Consulting Inc. and Anchor QEA, LLC. 2013. Remedial Investigation Report, San Jacinto River Waste Pits Superfund Site. Prepared for: McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. May.

Large Fish Collection Location (University of Houston and Parsons, 2009)

Large Fish and Blue Crab Fish Collection Area

Hardhead Catfish Fillet and Blue Crab Exposure Unit: "FCA 1"

Hardhead Catfish Fillet and Blue Crab Exposure Unit: "FCA 2/3"

Clam Exposure Unit: "FCA 1/3"

Clam Exposure Unit: "FCA 2"

Original 1966 Perimeter of the Impoundments North of I-10

USEPA's Preliminary Site Perimeter

0 1,000

Feet

Figure 13
Exposure Units for Fish and Shellfish Tissue, Area North of I-10 and Aquatic Environment
San Jacinto River Waste Pits Site

Modified from: Integral Consulting Inc. and Anchor QEA, LLC. 2013. Baseline Human Health Risk Assessment, San Jacinto River Waste Pits Superfund Site. Prepared for: McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. May.

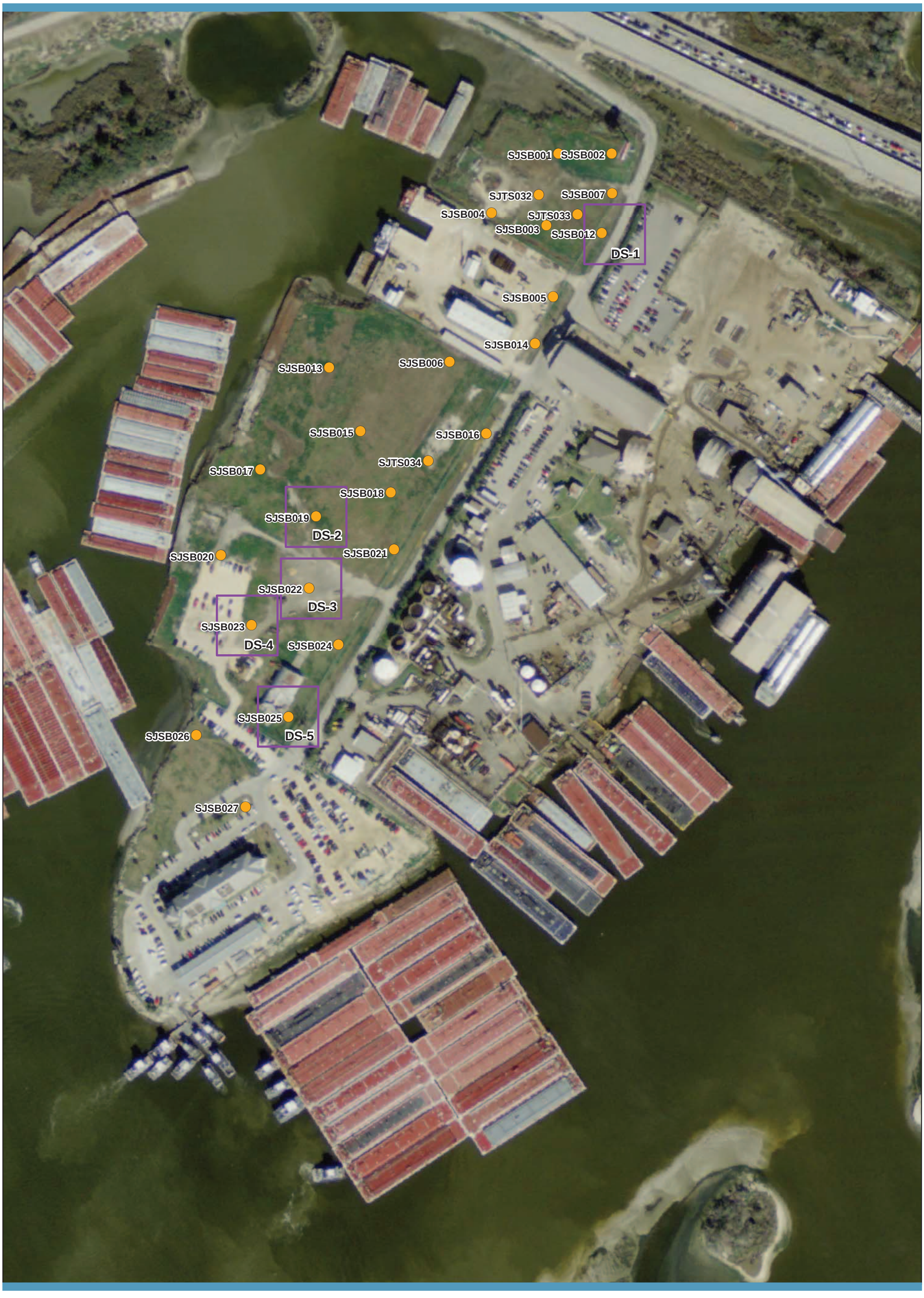
Surface Sediment Sample Location
Exposure Unit Designation
USEPA's Preliminary Site Perimeter
0 Contour (NAVD 88)[a]
-2 (feet)[b]
-1 (feet)[b]

0 1,000
Feet

Notes: [a] Tidal conditions under which this contour was measured are unknown.
[b] Contours reflect pre-TCRA conditions.

Figure 14
Exposure Units for Sediment, Area North of I-10 and Aquatic Environment Baseline
San Jacinto River Waste Pits Site

Modified from: Integral Consulting Inc. and Anchor QEA, LLC. 2013. Baseline Human Health Risk Assessment, San Jacinto River Waste Pits Superfund Site. Prepared for: McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. May.



0 400
Feet

Surface and Subsurface Soil Sample Location
Exposure Unit for Deep Soils, 0-10 feet

FEATURE SOURCES:
Aerial Imagery: 0.5-meter 2008/2009 DOQQs - Texas Strategic Mapping Program (StratMap), TNRIS

Figure 15
Exposure Unit for Soils, Area of Investigation
on the Peninsula South of I-10, 0-10 feet
San Jacinto River Waste Pits Site

Modified from: Integral Consulting Inc. and Anchor QEA, LLC. 2013. Baseline Human Health Risk Assessment, San Jacinto River Waste Pits Superfund Site.
Prepared for: McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. May.