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VIA OVERNIGHT DELIVERY

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Ms. Barbara A. Nann, Assistant Regional Counsel
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U.S. Environmental Protection Agency
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Re: Intracoastal Waterway Fish Ingestion Pathway Human Health Baseline Risk Assessment, Gulfco Marine Maintenance Site, Freeport, Texas

Dear Mr. Miller and Ms. Nann:

This letter contains the risk assessment for the fish ingestion pathway that will be incorporated into the Baseline Human Health Risk Assessment (BHHRA) of the Remedial Investigation/Feasibility Study (RI/FS) report for the Gulfco Marine Maintenance Site (the Site). This information is provided by Pastor, Behling & Wheeler, LLC (PBW) on behalf of LDL Coastal Limited LP (LDL), Chromalloy American Corporation (Chromalloy) and The Dow Chemical Company (Dow). In accordance with Paragraph 52 of the modified Unilateral Administrative Order for the Site, I certify that I have been fully authorized by the Respondents to submit these documents and to legally bind all Respondents thereto.

The fish ingestion pathway risk assessment focuses on current and future potential exposures to human receptors consuming fish from the Intracoastal Waterway adjacent to the Site. We have prepared a pathway-specific risk assessment prior to completing the BHHRA to allow us to evaluate potential risks to off-site receptors via the fish ingestion pathway while we are continuing to collect RI data for other media. We request your review and approval of this letter report. Following approval and completion of additional RI sampling activities, this evaluation will be incorporated into the overall BHHRA for the Site.

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INTRODUCTION

A BHHRA is the systematic, scientific characterization of potential adverse effects resulting from exposures to hazardous agents or situations (NRC, 1983). (References cited in this evaluation are listed in Appendix A.) The objective of the BHHRA is to use the results to support risk management decisions and determine if remediation or further action is warranted at a site.

The risk assessment methodology that is used in the BHHRA is based on the approach described by the EPA in *Risk Assessment Guidance for Superfund (RAGS), Volume 1, Human Health Evaluation Manual, Part A* (EPA, 1989). The BHHRA generally consists of the following components:

- The review of analytical data and identification of chemicals of potential concern (COPCs);
- Exposure assessment, including identification of potentially exposed populations, exposure pathways, and chemical intakes;
- Human health toxicity assessment;
- Risk characterization; and
- Uncertainty analysis.

FISH SAMPLING PROGRAM

Section 5.6.8 of the approved RI/FS Work Plan (PBW, 2006a) describes the fish sampling program for the Site while the Field Sampling Plan (FSP) (PBW, 2006b) describes the procedures to be used in implementing that program. Appendix B of this letter provides a documentation of the program activities completed by Benchmark Ecological Services, Inc. (subcontractor to PBW).

The goal of the finfish and blue crab sampling program was to collect nine red drum (*Sciaenops ocellatus*), nine spotted seatrout (*Cynoscion nebulosus*), nine southern flounder (*Paralichthys lethostigma*), and nine blue crab (*Callinectes sapidus*) samples for laboratory analysis. As previously discussed with EPA on December 14, 2006 and documented in the December 2006 monthly status report, only six red drum samples were collected over the sampling period due to an absence of legal size fish. An attached DVD provides the original laboratory reports for these analyses and a narrative of the quality assurance/quality control (QA/QC) evaluation. It should be noted that fish were also collected from a background area and archived for possible future analysis if warranted.

IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN

Fish tissue samples collected at the Site were analyzed for 12 chemicals, based on Intracoastal Waterway sediment data, as specified in your letter dated November 14, 2006. Table 1 contains a summary of the fish tissue sample analytical results. Of the twelve chemicals analyzed, only silver, benzo(b)fluoranthene, and 4,4'-DDE were measured above sample detection limits in any of the 33 samples. Silver was detected in two of nine blue crab samples; in one of nine southern

flounder samples; in one of nine spotted seatrout samples; and in none of the six red drum samples. Benzo(b)fluoranthene was detected in one southern flounder sample and one spotted seatrout sample, but in none of the blue crab or red drum samples. 4, 4'-DDE was detected in two spotted seatrout samples, but not in the southern flounder, blue crab, or red drum samples. It should be noted that all detected silver and benzo(b)fluoranthene results were "J-flagged" by the laboratory meaning that there were estimated values detected below the sample quantitation limit (SQL), i.e., below the calibration range.

If a compound was not detected in a given sample, Table 1 shows the analytical result as less than the sample detection limit (SDL). The SDL, as defined in the approved Quality Assurance Project Plan (QAPP) (PBW, 2006c) and as reported by the laboratory, is equivalent to the SQL as defined by the EPA in *Guidance for Data Useability in Risk Assessment (Part A)* (EPA, 1992b, pg. 49). Specifically, the SDL is the method detection limit (MDL) adjusted to reflect sample-specific action such as dilution or use of smaller aliquot sizes than prescribed in the method. The SQL, as defined in the QAPP (PBW, 2006c), is the method quantitation limit (MQL), which is equivalent to the lowest concentration in the calibration curve, adjusted to reflect sample-specific action, and thus it is not equivalent to the SQL for *RAGS* (EPA, 1989).

Based on the data provided in Table 1, silver, benzo(b)fluoranthene and 4,4'-DDE were considered COPCs to be evaluated in the quantitative risk assessment as these were the only COPCs with a detection frequency of at least five percent (EPA, 1989). Lead was measured in one duplicate sample but not in the original spotted seatrout sample. The measured concentration in the duplicate sample (0.24 mg/kg) was above the SDL of 0.19 mg/kg for the original sample, as well as the SDLs for the other tissue samples. The frequency of detection for lead (if the duplicate sample is considered a Site sample rather than a QA/QC sample) is less than five percent. Lead, therefore, was not retained for further analysis in the risk assessment.

EXPOSURE ASSESSMENT

The purpose of an exposure assessment is to estimate the magnitude and type of exposure to COPCs that is likely to occur due to site-related activities. The exposure assessment consists of characterizing the potentially exposed receptors, identifying exposure pathways (i.e., identifying chemical sources, exposure points, and exposure routes), and quantifying exposure (i.e., combining the exposure concentrations with intake variables). An exposure pathway typically includes the following elements:

- A source and mechanism of contaminant release;
- An environmental retention or transport medium (e.g., air, groundwater, etc.);
- A point of contact with the medium (i.e., receptor); and
- A human intake route (e.g., inhalation, ingestion, etc.).

Each of these elements must generally be present for an exposure pathway to be complete, although it is not necessary that environmental transport occur when assessing exposure from direct contact. Exposure was evaluated for both current and potential future receptors to allow evaluation of long-term risk management options.

In keeping with EPA guidance (EPA, 1992a), the goal of the exposure assessment was to provide a reasonable, high-end (i.e., conservative) estimate of exposure that focuses on potential exposures in the actual population. This concept is termed the reasonable maximum exposure (RME) approach.

This should not be confused with a worst-case scenario, which refers to a combination of events and conditions such that, taken together, produces the highest conceivable exposure (EPA, 1992a). Thus, in accordance with EPA guidance, site-specific exposure assumptions and parameters were used when available and, when not available, assumptions were deliberately chosen to represent a high-end reasonable maximum exposure estimate (EPA, 1989).

Chemical exposure is quantified by the calculation of an intake or dose that is normalized to body weight and exposure time of the receptor. A dose is calculated by combining assumptions regarding contact rate (intake amount and time, frequency and duration of exposure) to a contaminated medium with representative chemical exposure point concentrations for the medium of concern at the point of contact. Receptors are chosen based on their exposure patterns that may put them at risk or at a higher risk than other individuals.

Intake assumptions, in general, are based on reasonable maximum exposure assumptions determined by EPA (1989; 1991a) or based on information obtained from site-specific studies. Reasonable maximum exposure scenarios use a combination of assumptions, such as average values for physical characteristics of the receptors (body weight and corresponding body surface area), UCL values (values at the 90 or 95 percentile of the distribution) for contact rate, and UCL on the mean (95 percent UCL) for the exposure point concentrations. The combination of these factors provides an upper-bound estimate of exposure and risk to that particular receptor. The risks can then be scaled accordingly for other individuals that are exposed at a rate less than the reasonable maximum exposure receptor.

An average or central tendency exposure scenario was evaluated as well. This exposure scenario uses an average exposure point concentration with other exposure assumptions to arrive at an average exposure scenario. Providing both average and RME scenarios gives a range of exposures and assists in understanding and interpreting the measure of the uncertainty surrounding these estimates.

The intake or dose of a particular compound by a receptor is quantified with the generic equation below (EPA, 1989):

$$I = \frac{C \times CR \times EFD}{BW} \times \frac{1}{AT} \qquad \text{(Equation 1)}$$

where:

I	=	the compound intake or dose (mg/Kg BW-day);
C	=	the compound concentration (mg/Kg or mg/L);
CR	=	contact rate or the amount of contaminated medium contacted per event (Kg/day or L/day);
EFD	=	the frequency (days/year) and duration (number of years) of exposure days;
BW	=	the average body weight of the receptor (Kg); and
AT	=	averaging time of the exposure (days); for noncarcinogens, AT equals (ED) x (365 day/year); for chemical carcinogens, AT equals (70 years/lifetime) x (365 day/years).

This equation calculates an intake that is normalized over the body weight of the individual and the time of the exposure. Because the intake or dose is combined with quantitative indices of toxicity

(chemical-specific dose-response information such as reference doses (RfDs) for noncarcinogenic compounds or cancer slope factors (CSFs) for carcinogenic compounds) to give a measure of potential risk, the intake or dose must be calculated in a manner that is compatible with the quantitative dose-response information for chemical constituents evaluated in the analysis. Two different types of health effects are considered in this analysis: carcinogenic effects and noncarcinogenic effects (either chronic or subchronic, depending on the receptor's exposure).

For carcinogenic effects, the relevant intake is the total cumulative intake averaged over a lifetime because the quantitative dose-response function for carcinogens is based on the assumption that cancer results from chronic, lifetime exposures to carcinogenic agents. Thus, for potentially carcinogenic compounds, the averaging time (AT) is equal to 70 years (EPA, 1989).

Noncarcinogenic effects are evaluated for chronic, subchronic, or acute exposures by receptors to systemic or reproductive toxicants. For noncarcinogenic effects, the relevant intake or dose is based on the daily intake averaged over the exposure period of concern. An exposure period for toxicity can be acute (exposure occurring from one event or over one day), subchronic (cumulative exposures occurring from two weeks up to seven years), or chronic (cumulative exposure over seven years to a lifetime in duration). The quantitative dose-response function for noncarcinogenic effects (chronic and subchronic) is based on the assumption that effects occur once a threshold dose is attained from repeated exposure. Therefore, the intake or dose for noncarcinogenic risk assessment is based on an average daily dose that is averaged over the duration of exposure. The averaging time for assessing noncarcinogenic effects is equal to the exposure duration for the receptor.

The following subsections present a quantitative and qualitative assessment of potential exposure to chemicals by identifying potential receptors, exposure pathways, and exposure routes for the COPCs.

Intracoastal Waterway Surface Water Uses

While this pathway-specific risk assessment evaluates only the fish ingestion pathway, there are multiple current uses of the Intracoastal Waterway, including recreational (fishing and boating) and commercial (commercial shipping/barge traffic). The Site is a former barge cleaning facility with two barge slips on the Intracoastal Waterway. A residential development with canals and water access on the Intracoastal Waterway is west of the Site, several lots away. If development of the area near the Site occurs in the future, it is most likely that the development will not change the types of uses of the waterway. Therefore, the exposure assessment focuses on current recreational and/or commercial uses of the Intracoastal Waterway and assumes that these uses are the same in the future.

Receptors and Exposure Pathways

The receptors and exposure routes that are quantified are based on knowledge of contamination profiles in exposure media (both fish and sediment), the understanding of current or potential land uses, and information related to the behaviors and activity patterns of the receptors. Exposure to COPCs through ingestion of fish may occur throughout the Intracoastal Waterway. Given the small size of the Site, lack of habitat and prey items within the Site Intracoastal Waterway shoreline, the relatively large home ranges of most sport fish and legal-sized crab, and the low concentrations of COPCs measured in Site sediment and surface water, it is unlikely that COPCs measured in fish caught near the Site are attributable to impacts by COPCs at the Site. Thus, this

pathway-specific risk assessment most likely represents an evaluation of potential risks associated with ingestion of fish caught adjacent to the Site, and not an evaluation of potential risks associated with this pathway as a result of Site conditions or from Site operations.

Finfish and crab data collected as a part of the RI suggest that the two measured fish tissue concentrations of 4,4'-DDE from the Intracoastal Waterway (0.012 mg/kg and 0.016 mg/kg) are within the range of 4,4'-DDE concentrations measured by the Texas Department of Health (TDH) in many locations along the Texas Gulf Coast, which range from about 0.007 to 0.060 mg/kg depending on the species sampled and location (TDH, 1998). This is not surprising since marine finfish and crab consumed by humans tend to reflect contamination more on a regional basis. The Texas Department of State Health Services (TDSHS, formerly the TDH) typically does not analyze fish samples for silver and their detection limit for benzo(b)fluoranthene was typically 1 mg/kg, which is significantly greater than the two detected concentrations in Gulfco fish samples, as well as the SDLs of this study.

Anglers catch finfish and crab from many different locations within the Intracoastal Waterway and throughout nearby bays. The human health risk assessment will focus on the ingestion of finfish and crab by recreational anglers from the Site only. The BHHRA will evaluate potential exposure to other environmental media at the Site.

Exposure Quantification

The exposed population can include anyone that consumes fish from the Intracoastal Waterway near the Site but exposure is expected to be higher for that portion of the population that engages in recreational fishing (anglers with fishing licenses) on a regular basis. The target population also includes other family members who may or may not fish, but consume fish brought home by the angler. Exposure to chemicals in fish, therefore, occurs primarily through consumption of self-caught fish by anglers and their family members. It should be noted that as part of the National Human Activity Pattern Survey as reported by EPA (1997), most people (92 percent) purchase all of the seafood they consume.

It is known that fishing has occurred at the Site by eye-witness accounts and other evidence prior to installation of a security fence and signage. Any fishermen would be trespassing on the premises. Fishing in the Intracoastal Waterway in front of the Site is somewhat limited because of the hazards associated with barge traffic although the slips are out of the waterway and shipping lane.

Intake from consumption of finfish and shellfish is quantified based on modification of Equation 1 to quantify exposure with the following equation (EPA, 1989):

$$I_{fish} = \frac{Conc_{fish} \times Ing_{fish} \times FI \times EF \times ED}{BW \times AT} \qquad \text{(Equation 2)}$$

where:

I_{fish}	=	average daily dose from ingestion of finfish and crab (mg/Kg/day);
$Conc_{fish}$	=	concentration of COPC in finfish and crab (mg/Kg);
Ing_{fish}	=	finfish and crab ingestion rate (Kg/day);
FI	=	fraction ingested from a source area or location (unitless);

EF	=	exposure frequency (days/year);
ED	=	exposure duration (years/lifetime);
BW	=	body weight (Kg); and
AT	=	averaging time (days/lifetime).

Concentration in fish used in the intake calculations was either the average for the central tendency receptor or the 95 percent UCL concentration for the RME receptor of the COPC in finfish and crab ($Conc_{fish}$) for all species combined. The three fish species and blue crab concentrations were considered together in the exposure point concentration calculation since there is no information related to site-specific consumption patterns for the Site or area. Similarly, a fraction-ingested value of 0.325 was used in the quantitative analysis since there is no information regarding fishing location preferences for this area. This fraction-ingested value was obtained from EPA guidance (EPA, 1997) and recognizes that among fishing households, self-caught fish account for roughly 32.5 percent of the total fish consumed. An average of 7.2 g/day and 95th percentile of 26 g/day ingestion rates for EPA's *Exposure Factors Handbook* (EPA, 1997) for the Gulf Coast region were used to provide the average (central tendency) and RME estimates, respectively. Average and 95th percentile exposure durations of 9 and 30 years, respectively, were used in the evaluation (EPA, 1989).

A childhood receptor was not included in this evaluation since consumption data for marine fish was not available for the Gulf coast region. In general, however, EPA guidance (EPA, 1997) indicates that adults eat more fish than children and that the differences in body weight would probably compensate for the different intake rates in exposure calculations for the fish ingestion pathway.

Table 2 presents a summary of intake assumptions for quantifying exposure from fish ingestion (using Equation 2) for receptors fishing near the Site.

Exposure Point Concentrations

Exposure-specific constituent concentrations were incorporated into the exposure assessment using methodologies described in EPA guidance (EPA, 2002). The general procedure that is recommended by EPA and used in this risk assessment is to estimate a 95 percent upper confidence limit on the mean concentration (95% UCL) for Site COPCs. This was accomplished for the risk assessment as described below:

- Distribution Testing. Appropriate statistical tests (e.g., Shapiro-Wilks test) were conducted to determine the distribution of each data set.

- Estimation of Concentration Term. The 95% UCL of the mean was calculated and used as the concentration term assuming the appropriate distribution.

Distribution testing was conducted and exposure point concentrations were calculated for the three COPCs using EPA's PROUCL software, Version 3.00.02, (EPA, 2004a) using all finfish and crab data. One-half of the sample detection limit was used for samples without a measurement at or above the sample detection limit. Both averages and 95% UCLs are used to provide a range of exposure point concentrations. PROUCL calculates various estimates of the 95% UCL of the mean, and then makes a recommendation on which one should be selected as the best UCL estimate. If the average or 95% UCL is greater than the maximum detected

concentration, the maximum measured concentration was used as the exposure point concentration for the RME evaluation (EPA, 2002).

Appendix C contains the summary output from the PROUCL model, and Table 3 provides the exposure point concentrations used in the intake equations, both average and 95% UCL concentrations. All three data sets were non-normal in their distribution. For benzo(b)fluoranthene, PROUCL recommended using a 99% Chebyshev value for the exposure point concentration. This value, as well as the calculated average, exceeded the maximum measured concentration because of the skewness of the data set. (Some of the samples have elevated reporting limits because dilution was required to achieve a successful analysis for the complex sample matrix.) Thus, the maximum measured concentration of 0.049 mg/kg was used as the exposure point concentration for both the central tendency and RME scenarios. For 4,4'-DDE, PROUCL recommended using either the 95% UCL assuming a normal distribution or a modified-t computation adjusted for skewness for non-normal data. The modified-t UCL was used since it was slightly higher and more conservative than the Student's-t UCL. For silver, PROUCL recommended using the 95% Chebyshev value for the exposure point concentration given the non-normal distribution.

Appendix D contains the spreadsheets detailing the intake calculations.

TOXICITY ASSESSMENT

The toxicity assessment provides a description of the relationship between a dose of a chemical and the anticipated incidence of an adverse health effect (Preuss and Ehrlich, 1987). The purpose of toxicity assessment is to provide a quantitative estimate of the inherent toxicity of COPCs to incorporate into the risk characterization. Toxicity values are derived from the quantitative dose response association and are correlated with the quantitative exposure assessment in the risk characterization.

For risk assessment purposes, toxic constituent effects are separated into two categories of toxicity: carcinogenic effects and noncarcinogenic effects. This division relates to the currently-held EPA policy position that the mechanisms of action for these endpoints differ. The EPA has required that potentially carcinogenic chemicals be treated as if minimum threshold doses do not exist (EPA, 1986), whereas noncarcinogenic effects are recognized as threshold phenomena. In the absence of information to the contrary, the current EPA policy for potential carcinogens only allows for zero risk at zero dose. Thus, for all environmental doses, some level of risk is assumed to be present. More recent scientific evidence indicates that this simplistic assumption is not true for many carcinogenic responses and, thus, EPA developed *Proposed Guidelines for Carcinogen Risk Assessment* (1996) as a revision to its 1986 *Cancer Risk Assessment Guidelines* (EPA, 1986) to account for this new information. These changes are being integrated into the process as an ongoing effort. For this evaluation, however, the cancer slope factors for 4,4'-DDE and benzo(b)fluoranthene are based on a linearized multistage procedure assuming no threshold of safety.

Constituents that are believed to be carcinogenic may also have non-cancer effects. Potential health risks for these constituents are evaluated for both cancer and other types of effects as described below.

It is widely accepted that noncarcinogenic biological effects of chemical substances occur only after a threshold dose is achieved (Klaassen, 1996). This threshold concept of noncarcinogenic effects

assumes that a range of exposures up to some defined threshold can be tolerated without appreciable risk of harm. Adverse effects may be minimized at concentrations below the threshold by pharmacokinetic processes, such as decreased absorption, distribution to non-target organs, metabolism to less toxic chemical forms, and excretion (Klaassen, 1996).

Chronic toxicity values, carcinogenic and noncarcinogenic, for silver and 4,4'-DDE were obtained from EPA's online database Integrated Risk Information System (IRIS) (EPA, 2007), while the cancer slope factor for benzo(b)fluoranthene was obtained via EPA Region 6 screening level tables (EPA, 2004b). Chronic toxicity values were used since the fish ingestion pathway most likely represents a chronic exposure scenario. These values are provided in Table 4.

Benzo(b)fluoranthene is considered a probable human carcinogen by EPA, based on no human data but sufficient data from animal bioassays in which tumors were produced after exposure via different dosing modes. In addition, it is a component of mixtures that have been associated with human cancer. There is no information listed in IRIS related to any noncarcinogenic effects.

4,4'-DDE is also considered a probable human carcinogen by EPA, based on increased incidence of liver tumors in mice and hamsters and thyroid tumors in female rats. There is no human epidemiological data to suggest 4,4'-DDE is carcinogenic to humans but there is evidence of carcinogenicity in humans from DDT, a structural analog. There is no information listed in IRIS related to any noncarcinogenic effects.

Silver is not classified as a human carcinogen because there is no evidence of cancer in humans despite frequent therapeutic use of silver compounds over the years. Noncarcinogenic effects seen in humans ingesting silver is argyria, a medically benign but permanent bluish-gray discoloration of the skin. The RfD for silver is derived from a human study that resulted in argyria following intravaneous exposure.

RISK CHARACTERIZATION

Risk characterization is the integration of the exposure and toxicity information to make quantitative estimates and/or qualitative statements regarding potential risk to human health. This section provides the noncarcinogenic hazard estimates and carcinogenic risk estimates.

Noncarcinogenic Hazards

For noncarcinogenic compounds, a risk is expressed as a hazard quotient (HQ), which is the ratio of a calculated or projected dose (Intake) for a site-specific receptor to an acceptable or RfD for that chemical. The HQ is calculated as follows:

$$HQ = Intake / RfD \qquad \text{(Equation 3)}$$

A RfD is developed based on the assumption that the degree of toxicity of noncarcinogenic compounds is based on the ability of organisms to repair and detoxify after exposure to a compound. This mechanism of repair and detoxification must be exceeded by some critical concentration (threshold) before the health effect is manifested. This threshold view holds that a range of exposures from just above zero to some finite value (i.e., the RfD) can be tolerated by an individual without an appreciable risk of adverse effects. HQs for chemicals that elicit effects on similar target organs and have similar modes of action are combined to calculate a total hazard

index (HI). Cumulative HIs are calculated from exposure to multiple chemicals via different exposure pathways by combining HQs across exposure routes. Adding HQs across chemicals and exposure routes assumes additivity in the mode of action and effect on the target organ. An HI exceeding 1.0 indicates only a potential for an effect since the RfD is determined by reducing a no observable adverse effect level (NOAEL) or lowest observable adverse effect level (LOAEL) with uncertainty factors or modifying factors that can range from 3 to 10,000. These large uncertainty multipliers are used to account for potential interspecific (laboratory species to human) extrapolation and intraspecific sensitivities. Thus, while a ratio of 1.0 is used as a point of departure for assessing the potential for risk, noncarcinogenic effects for some chemicals may not necessarily be manifested unless the HI exceeds 10 or 100.

HQs are summed for all chemical intakes to yield an HI for each exposure pathway. An HI equal to or less than 1.0 indicates that no adverse noncarcinogenic health effects are expected to occur from cumulative exposure to multiple chemicals and exposure pathways. An HI greater than 1.0, however, does not provide a prediction of the severity or probability of the effects, but rather provides an indication that such effects may occur, especially in sensitive subpopulations. An HI above 1.0 indicates the need for further evaluation. For example, effects of different chemicals are not necessarily additive, although the HI approach assumes additivity, nor do all chemicals affect the same target organ. Thus, EPA recommends that if an HI exceeds 1.0, further evaluation should occur to categorize hazards based on chemical-specific and route-specific toxicity (i.e., which chemicals act on the same target organ, by which route of entry) (EPA, 1989).

In this pathway specific risk assessment, silver is the only COPC that has noncarcinogenic effects, so there was no need to categorize hazards based on target organ.

Carcinogenic Risks

Potential carcinogenic effects are characterized in terms of the excess probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen. For chemicals that exhibit carcinogenic effects, EPA has developed a model that is based on the theory that one or more molecular events as a result of exposure to a potential carcinogenic compound can evoke changes in a single cell or a small number of cells that can lead to tumor formation. This non-threshold theory of carcinogenesis suggests that any level of exposure to a carcinogen can result in some finite possibility of generating the disease. To characterize the potential for carcinogenic effects, the estimated intake is combined with a CSF to calculate a probability that an individual would develop cancer over a lifetime of exposure, with the following equation:

$$Risk = Intake \times CSF \qquad \text{(Equation 4)}$$

These probabilities or cancer risks are combined across pathways and chemicals that exhibit similar modes of action for the carcinogen. Cancer risks are evaluated based on an acceptable cancer risk range of 1×10^{-4} to 1×10^{-6}. EPA (1991b) states that carcinogenic effects at a site should first be evaluated based on the 1×10^{-4} cancer risk level, but depending on site-specific conditions, a range of 1×10^{-4} to 1×10^{-6} may be used. Typically, cancer risks less than 1×10^{-6} are considered *de minimus* while cancer risks exceeding 1×10^{-4} are considered unacceptable.

The statements of hazards and/or risk in the risk characterization section must be viewed with the uncertainties that exist in the data, assumptions, methods, and endpoints that are being studied since uncertainty is inherent to the risk assessment process. Therefore, to allow for a meaningful

interpretation of the results, it is essential that an uncertainty analysis (see below) be considered an integral part of risk characterization.

Benzo(b)fluoranthene and 4,4'-DDE are considered probable carcinogens and, as such, were evaluated for their potential cancer risks via the fish ingestion pathway.

Estimated Risk from Fish Ingestion Pathway

Table 5 provides the risk characterization calculations for the fish tissue pathway while Appendix D contains the risk calculation spreadsheets. The hazard indices for the central tendency and RME exposure scenarios are several orders of magnitude below one, indicating that the fish ingestion pathway does not present an unacceptable noncarcinogenic health risk. The cancer risk estimates for the central tendency and RME exposure scenarios are 2×10^{-7} and 2×10^{-6}, respectively. These values are within or below EPA's target risk range, which indicates that adverse carcinogenic health effects are unlikely.

UNCERTAINTY ANALYSIS

The risks/hazards determined in the BLRA are the results of conditional estimates given multiple assumptions for exposure, toxicity, and other variables. Hence, uncertainty is inherent to the process. The uncertainty analysis identifies the relative contribution to overall uncertainty from each assumption or data point used in the risk assessment. Discussion of uncertainty from each of the components of a risk assessment is critical for accurate characterization of risk.

The purpose of this uncertainty analysis is to provide decision makers with additional information on the assumptions and data used in the risk assessment and the implications and limitations of these assumptions and data. The following paragraphs present a discussion of the major areas that are believed to contribute to uncertainty in this risk assessment.

Nature and Extent of Contamination

There is little uncertainty related to defining the nature and extent of contamination in sediment and finfish and crab at the Site since the sampling program satisfied the objectives and procedures presented in the approved RI/FS Work Plan (PBW, 2006a). Uncertainties, if present, would be based on the completeness and representativeness of the analytical data used to support the exposure assessment. The RI involved comprehensive sampling of environmental media, including sediment, water, finfish and crab samples. Because of the sequential nature of the sampling (ie., sediment data were used to identify finfish and crab COPCs), data were collected in a manner appropriate to determine site-related COPCs in the finfish and crab.

As presented in the quality assurance/quality control narrative on the DVD included with this letter, all data were subjected to a complete validation (Level IV) and none of the data for any of the analytes were found to be unusable (ie., "R-flagged"). Some of the data are qualified (ie., "J-flagged") as estimated because the measured concentration is above the laboratory detection limit but below the quantitation limit and/or due to minor quality control deficiencies. According to the *Guidance for Data Useability in Risk Assessment (Part A)* (EPA, 1992b), data that are qualified as estimated should be used for risk assessment purposes. For the three COPCs, only six of the results for benzo(b)fluoranthene, one of the results for 4,4'-DDE, and seven of the results for silver are qualified as estimated and, as such, the data represent a reliable estimate of fish tissue concentrations.

Uncertainties Associated with Exposure Quantification

Because of the lack of site-specific information related to exposure, exposure assumptions were purposefully chosen to be conservative, using information available in EPA guidance and literature. Primarily these assumptions relate to the amount of finfish and crab consumed by local anglers; the species of fish typically consumed; and the fraction of all fish ingested that were caught near the Site.

The ingestion rates used in the risk assessment were obtained from EPA (EPA, 1997), based on a national food survey, using data specifically for the Gulf Coast region. These values represent commonly accepted values for the recreational fisherman and their families. Both average and RME ingestion rates were used to provide a range of exposures.

Blue crab, red drum, southern flounder, and spotted seatrout were the species selected to represent the majority of edible species caught in the Intracoastal Waterway by local fishermen. The risk assessment assumes that these species are ingested at the same frequency, and at the same rate. Upon visual inspection of the data, there was not a difference in measured concentrations between species. Therefore, this assumption likely has very little impact on the estimated risk.

The assumption that probably imparts the most uncertainty to the exposure assessment is the fraction ingestion variable. This variable identifies where fish come from (ie., the grocery store, fish market, restaurant, home-caught, etc.). It was conservatively assumed that 32.5 percent of a recreational fisherman's fish intake comes from fish caught near the Site. During the three week sampling event using gill nets, the catch rate near the Site was much lower than the catch rate for the reference area. The aquatic habitat at the Site is very poor and is not likely to attract or hold fish. In addition, the fish sampling event was timed to coincide with increased fish activity in an effort to expedite sample collection. Thus, the 32.5% fraction ingested assumption is very conservative since it essentially means that 100 percent of the fish a person catches and consumes came from the Site.

Exposure point concentrations are based on the assumption of average exposure to a source medium, using a conservative estimate of the mean with the calculation of a 95% UCL. For silver and 4,4'-DDE, the data were non-normally distributed and a reliable 95% UCL could be calculated. For benzo(b)fluoranthene, the estimated 95% UCL was greater than the maximum measured concentration due to several samples with higher sample detection limits skewing the distribution. Thus, the maximum detected value was used in the risk assessment. The use of the maximum is very conservative considering that an exposure point concentration is intended to represent the average concentration that a receptor may contact.

Uncertainties Associated with Toxicity Assessment

The toxicity assessment, as with the other components of risk assessment, has uncertainty. For example, much of the current understanding about the dose-response relationship of chemicals commonly associated with hazardous waste sites is based on data collected from studies of animals (usually rodents) or studies of human occupational exposures and theories about how humans respond to environmental doses of constituents. Environmentally-relevant exposure concentrations are typically much lower than experimental or occupational exposure concentrations. Therefore, extrapolation from high dose to low dose is often necessary but uncertain.

Toxicity criteria were available for the three COPCs so uncertainty associated with not having toxicity values was not a concern. The cancer slope factor for benzo(b)fluoranthene was derived using a toxicity equivalency factor related to benzo(a)pyrene and not quantitative dose-response

information specific to benzo(b)fluoranthene. This likely imparts some uncertainty in the evaluation but toxicity criteria generally have safety factors and other modifying factors to ensure that they are protective of human health.

Overall, the uncertainty of the evaluation most likely errs on the side of conservatism since most assumptions were purposefully chosen to be overly protective of human health and the environment.

SUMMARY AND CONCLUSIONS

Based on the evaluation presented herein, it is concluded that exposure to site-related COPCs via the fish ingestion pathway does not pose a health threat to recreational anglers fishing at the Site, or their families.

We request EPA's review and approval of this document. The information and evaluation presented here will be included in the BHHRA report once data collection efforts for other pathways and media are complete. Please let us know if you have any questions or comments.

Sincerely,

PASTOR, BEHLING & WHEELER, LLC

Kirby H. Tyndall, Ph.D., DABT
Senior Toxicologist

Eric F. Pastor, P.E.
Principal Engineer

cc: Ms. Luda Voskov – Texas Commission on Environmental Quality
Mr. Larry Champagne – Texas Commission on Environmental Quality
Mr. Brent Murray – Environmental Quality, Inc.
Mr. Rob Rouse – The Dow Chemical Company
Mr. Donnie Belote – The Dow Chemical Company
Mr. Allen Daniels – LDL Coastal Limited, LP
Mr. F. William Mahley – Strasburger & Price, LLP
Mr. James C. Morriss, III – Thompson & Knight, LLP
Ms. Elizabeth Webb – Thompson & Knight, LLP

TABLES

TABLE 1. FISH TISSUE DATA

Sample ID	4,4'-DDE	4,4'-DDT	Benzo(a) anthracene	Benzo (a) pyrene	Benzo(b) fluoranthene	Benzo(k) fluoranthene	Chrysene	Dibenz(a,h) anthracene	Hexachloro benzene	Indeno(1,2,3-cd)pyrene	Lead	Silver	% Moisture	% Lipids
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg		
BLUE CRAB														
IW-BC-00401	<0.00723	<0.00578	<0.056	<0.035	<0.045	<0.038	<0.029	<0.047	<0.056	<0.023	<0.19	<0.053	80.1	0.07
IW-BC-00402	<0.00716	<0.00572	<0.584	<0.359	<0.467	<0.392	<0.298	<0.494	<0.58	<0.235	<0.19	<0.053	81	0.1
IW-BC-00403	<0.00745	<0.00595	<0.056	<0.035	<0.045	<0.038	<0.029	<0.047	<0.056	<0.023	<0.19	<0.053	81.3	0.33
IW-BC-00404	<0.00738	<0.00589	<0.057	<0.035	<0.045	<0.038	<0.029	<0.048	<0.056	<0.023	<0.19	<0.053	78.8	0.08
IW-BC-00405	<0.00723	<0.00578	<0.057	<0.035	<0.046	<0.038	<0.029	<0.048	<0.056	<0.023	<0.19	<0.053	80.5	0.2
IW-BC-00406	<0.0073	<0.00583	<0.057	<0.352	<0.458	<0.384	<0.029	<0.484	<0.056	<0.023	<0.19	<0.053	79.9	0.02
IW-BC-00409	<0.00738	<0.00589	<0.567	<0.348	<0.453	<0.38	<0.289	<0.479	<0.562	<0.229	<0.19	0.11 J	80	0.04
IW-BC-00410	<0.0073	<0.00583	<0.561	<0.345	<0.449	<0.377	<0.286	<0.475	<0.558	<0.226	<0.19	0.078 J	83.3	0.02
IW-BC-00411	<0.00745	<0.00595	<0.058	<0.036	<0.047	<0.039	<0.03	<0.049	<0.058	<0.024	<0.19	<0.053	79.9	0.01
RED DRUM														
IW-RD-00001	<0.0073	<0.00583	<0.058	<0.036	<0.047	<0.039	<0.03	<0.049	<0.058	<0.024	<0.19	<0.053	76.6	0.06
IW-RD-00002	<0.00716	<0.00572	<0.057	<0.035	<0.046	<0.038	<0.029	<0.048	<0.056	<0.023	<0.19	<0.053	80.7	0.12
IW-RD-00003	<0.00723	<0.00578	<0.584	<0.359	<0.467	<0.392	<0.298	<0.494	<0.58	<0.235	<0.19	<0.053	79	2.77
IW-RD-00004	<0.00745	<0.00595	<0.567	<0.348	<0.453	<0.38	<0.289	<0.479	<0.562	<0.229	<0.19	<0.053	81.8	0.03
IW-RD-00005	<0.0073	<0.00583	<0.567	<0.348	<0.453	<0.38	<0.289	<0.479	<0.562	<0.229	<0.19	<0.053	78.7	0.16
IW-RD-00006	<0.00745	<0.00595	<0.572	<0.352	<0.458	<0.384	<0.292	<0.484	<0.568	<0.231	<0.19	<0.053	79.6	0.01
SOUTHERN FLOUNDER														
IW-SF-00301	<0.00745	<0.00595	<0.058	<0.036	<0.046	<0.039	<0.029	<0.049	<0.058	<0.023	<0.19	0.22 J	78	0.49
IW-SF-00302	<0.0073	<0.00583	<0.056	<0.035	0.048 J	<0.038	<0.029	<0.047	<0.056	<0.023	<0.19	<0.053	78.6	1.24
IW-SF-00303	<0.0073	<0.00583	<0.057	<0.352	<0.458	<0.384	<0.029	<0.484	<0.056	<0.023	<0.19	<0.053	77.3	1.24
IW-SF-00304	<0.00723	<0.00578	<0.057	<0.348	<0.453	<0.38	<0.029	<0.479	<0.056	<0.023	<0.19	<0.053	77.8	2.19
IW-SF-00305	<0.00738	<0.00589	<0.561	<0.345	<0.449	<0.377	<0.286	<0.475	<0.558	<0.226	<0.19	<0.053	78.9	0.1
IW-SF-00306	<0.00745	<0.00595	<0.584	<0.359	<0.467	<0.392	<0.298	<0.494	<0.58	<0.235	<0.19	<0.053	77.7	0.1
IW-SF-00307	<0.00745	<0.00595	<0.561	<0.345	<0.449	<0.377	<0.286	<0.475	<0.558	<0.226	<0.19	<0.053	79.1	0.08
IW-SF-00308	<0.00716	<0.00572	<0.578	<0.355	<0.462	<0.388	<0.295	<0.489	<0.574	<0.233	<0.19	<0.053	78.3	0.06
IW-SF-00309	<0.00738	<0.00589	<0.584	<0.359	<0.467	<0.392	<0.298	<0.494	<0.58	<0.235	<0.19	<0.053	77.4	0.06
SPECKLED TROUT														
IW-ST-00101	<0.00745	<0.00595	<0.057	<0.035	<0.045	<0.038	<0.029	<0.048	<0.056	<0.023	<0.19	<0.053	77.9	0.08
IW-ST-00102	<0.00745	<0.00595	<0.058	<0.036	0.049 J	<0.039	<0.03	<0.049	<0.058	<0.024	<0.19	<0.053	73	1.13
IW-ST-00103	<0.00738	<0.00589	<0.058	<0.036	<0.047	<0.039	<0.03	<0.049	<0.058	<0.024	<0.19	<0.053	76.2	0.31
IW-ST-00104	0.012	<0.00589	<0.058	<0.359	<0.467	<0.392	<0.03	<0.494	<0.058	<0.024	<0.19	0.18 J	76.4	1.02
IW-ST-00105	<0.00745	<0.00595	<0.057	<0.352	<0.458	<0.384	<0.029	<0.484	<0.056	<0.023	<0.19	<0.053	73.6	1.41
IW-ST-00106	<0.00716	<0.00572	<0.056	<0.345	<0.449	<0.377	<0.029	<0.475	<0.056	<0.023	<0.19	<0.053	75.3	0.72
IW-ST-00107	<0.00738	<0.00589	<0.058	<0.036	<0.046	<0.039	<0.029	<0.049	<0.058	<0.023	<0.19	<0.053	77.1	2.87
IW-ST-00108	<0.00723	<0.00578	<0.058	<0.036	<0.046	<0.039	<0.029	<0.049	<0.058	<0.023	<0.19	<0.053	75.1	0.79
IW-ST-00109	0.016 J	<0.00595	<0.057	<0.176	<0.229	<0.192	<0.029	<0.242	<0.056	<0.023	<0.19	<0.053	75	0.49
DUPLICATES														
IW-BC-00405 (DUP)	0.011	<0.00578	<0.057	<0.035	<0.045	<0.038	<0.029	<0.048	<0.056	<0.023	<0.19	0.067 J	80.7	0.02
IW-SF-00302 (DUP)	<0.00723	<0.00578	<0.056	<0.035	0.049 J	<0.038	<0.029	<0.047	<0.056	<0.023	<0.19	<0.053	79.2	0.07
IW-ST-00105 (DUP)	<0.00723	<0.00578	<0.058	<0.359	<0.467	<0.392	<0.03	<0.494	<0.058	<0.024	0.24 J	<0.053	72.1	0.36

Notes:

1. J = Estimated concentration between detection limit and quantitation limit.
2. All concentrations reported on a wet weight basis.
3. Values given for hexachlorobenzene are the laboratory reporting limits that were elevated by a factor of two, based on quality assurance evaluation of the data.
4. "<" Values are Gulfco sample detection limits (SDLs). The SDL, as defined by the Gulfco QAPP and as reported by the laboratory, is equivalent to the sample quantitation limit (SQL) as defined by the EPA in Guidance for Data Useability in Risk Assessment (Part A) (EPA, 1992b, pg. 49), i.e., it is the method detection limit (MDL) adjusted to reflect sample-specific action such as dilution or use of smaller aliquot sizes than prescribed in the method. The Gulfco SQL, as defined by the Gulfco QAPP and reported by the laboratory, is the method quantitation limit (MQL), which is equivalent to the lowest concentration in the calibration curve, adjusted to reflect sample-specific action, and thus it is not equivalent to the SQL for RAGS (EPA, 1989).

TABLE 2. EXPOSURE ASSUMPTIONS FOR FISH INGESTION PATHWAY

FISH INGESTION

I fish = (Conc fish * Ing fish * FI * EF * ED) / (BW * AT)

Parameter	Definition	Central Tendency	Reference	RME	Reference
Intake	Intake of chemical (mg/kg-day)				
Conc fish	Finfish and crab concentration (mg/kg)	see Table 3 (average)		see Table 3 (95% UCL)	
Ing fish	Ingestion rate of finfish and crab (kg/day)	0.0072	EPA, 1997	0.026	EPA, 1997
FI	Fraction ingested	0.325	EPA, 1997	0.325	EPA, 1997
EF	Exposure frequency (day/yr)	350	EPA, 1989	350	EPA, 1989
ED	Exposure duration (yr)	9	EPA, 1989	30	EPA, 1989
BW	Body weight (kg)	70	EPA, 1989	70	EPA, 1989
ATc	Averaging time for carcinogens (days)	25550	EPA, 1989	25550	EPA, 1989
ATnc	Averaging time for noncarcinogens (days)	3295	EPA, 1989	9125	EPA, 1989

TABLE 3. EXPOSURE POINT CONCENTRATION FOR FISH TISSUE		
COMPOUND	**Average Fish Concentration mg/kg**	**95% UCL Fish Concentration mg/kg**
Silver	4.32E-02	7.77E-02
4,4'-DDE	4.29E-03	5.10E-03
Benzo(b)fluoranthene*	4.90E-02	4.90E-02

Notes:
* The maximum measured concentration was used since the estimated average and 95% UCL were greater than the maximum.

TABLE 4. TOXICITY ASSESSMENT					
COMPOUND	EPA CANCER CLASSIFICATION	CANCER SLOPE FACTOR	REFERENCE	RfD	REFERENCE
Silver	D - not classifiable	--		0.005	EPA, 2007
4,4'-DDE	B2 - probable human carcinogen	0.34	EPA, 2007	--	
Benzo(b)fluoranthene*	B2 - probable human carcinogen	0.73	EPA, 2004	--	

Notes:
-- No toxicity value is available from EPA.

TABLE 5. RISK CHARACTERIZATION FOR FISH TISSUE INGESTION PATHWAY

COMPOUND	Central Tendency Hazard Quotient	Central Tendency Cancer Risk Estimate	RME Hazard Quotient	RME Cancer Risk Estimate
Silver	2.76E-04	--	2.16E-03	--
4,4'-DDE	--	6.02E-09	--	8.60E-08
Benzo(b)fluoranthene*	--	1.47E-07	--	1.77E-06
PATHWAY TOTAL:	**2.76E-04**	**1.53E-07**	**2.16E-03**	**1.86E-06**

Notes:
-- No toxicity value is available from EPA.

APPENDIX A

REFERENCES

APPENDIX A

REFERENCES

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APPENDIX B

SUMMARY OF GULFCO MARINE MAINTENANCE SUPERFUND SITE INTRACOASTAL WATERWAY FINFISH AND BLUE CRAB SAMPLING STUDY

Benchmark Ecological Services, Inc.

P.O. Box 158
Katy Texas 77492-0158

Phone 281-934-3403
Fax 281-934-3404
E-mail: nhenthorne@benchmarkeco.com

January 12, 2007

Eric Pastor, P.E.
Pastor, Behling, & Wheeler, LLC
2201 Double Creek Dr., Suite 4004
Round Rock, Texas 78664

Subject: Summary of Gulfco Marine Maintenance Superfund Site Intracoastal Waterway Finfish and Blue Crab Sampling Study

Dear Eric:

Benchmark Ecological Services, Inc. conducted field sampling associated with the Gulfco Marine Maintenance Superfund Site, Intracoastal Waterway (ICWW) Finfish and Blue Crab Tissue Sampling Study between 27 November and 14 December 2006. The following report summarizes the sampling event and methods.

Field Study

Blue Crab Samples

The goal of the study was to collect 9 blue crab (*Callinectes sapidus*) samples from the study site and 9 blue crab samples from the background area. Benchmark set 25 commercial crab traps baited with menhaden and Spanish sardines on 27 November 2006. Twenty crab traps were set at the study site and 5 crab traps were set in the background area. The study site was divided into 4 Sample Collection Zones shown in Figure 1. Five crab traps were set in each of the Zones. Crab traps were checked and legal sized blue crabs were removed for processing on the 28, 29, and 30 of November. Table 1 lists the number of blue crab samples collected from each of the sample areas during the sample study.

Table 1 – Number of Blue Crab Samples Collected by Area

Species	Site				Background Area
	Zone 1	Zone 2	Zone 3	Zone 4	
Blue Crab	6	1	1	1	9

Edible tissue from 3 legal sized crabs was composited for each blue crab sample. Blue crabs must have a width of 5 inches between the tips of the primary lateral spines to be legally harvested for commercial or recreational purposes. Legal sized crabs were inspected for injuries, disease and other anomalies. Undersized crabs were released. Physical injuries such as missing periopods (walking legs), chelipeds (claws), or broken spines were observed on several organisms. Benchmark did not find any ulcers, lesions, external deformities, or discoloration that could be the result of disease or exposure to toxic substances. Results of the inspections were noted on field data sheets.

Nine blue crab samples were collected from the study site and nine blue crab samples were collected from the background area. Total weight, width, sample weight, sample date, sample time, sex, and sample station were recorded on data sheets and are summarized in Table 2. Blue crab samples were processed at a house located in the Bridge Harbor subdivision near the site. Blue crab samples collected from the site were analyzed for the chemicals designated by Pastor, Behling and Wheeler, LLC (PBW), and blue crabs collected from the background area were archived. The background area is shown in Figure 2.

N

100 0 100 Feet

Legend

Zone Boundaries

Notes

HGAC 2004 Aerial
5624.sid

Tissue Sampling Zones

PBW, LLC.

Gulfco Marine
Tissue Sampling

BESI Benchmark Ecological Services, Inc.

Project Name: Tissue Stations Project.apr

Date: January 12, 2007

Figure 1

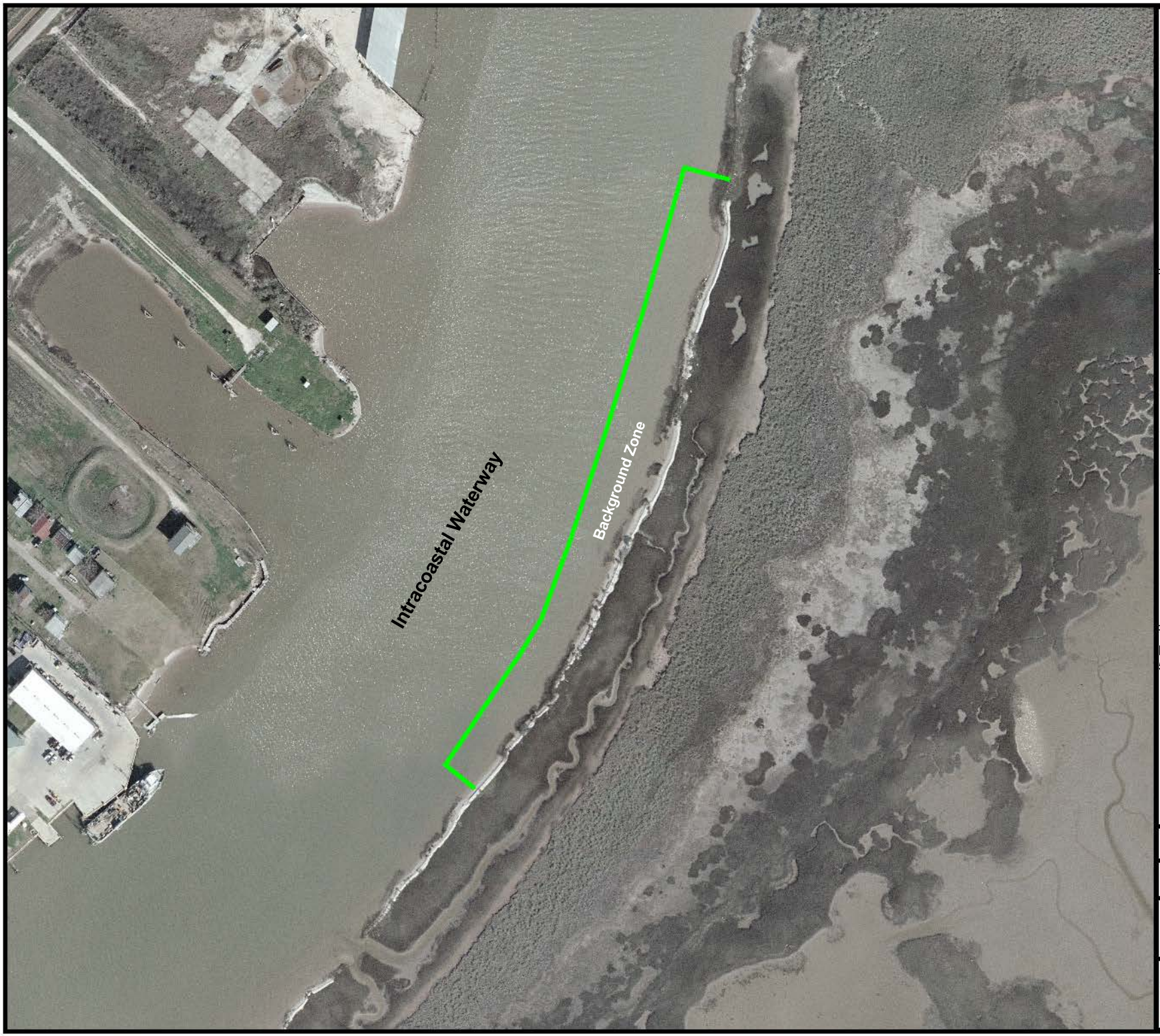
M:\05005\007\Arc\tissue stations project.apr

Table 2 - Blue Crab Field Sampling Data

Location ID	Sample ID	Catch ID	Organism ID	Date	Time	Sex	Width (mm)	Crab Weight (g)	Sample Weight (g)	Analyzed or Archived	Comments
Zone 1	IW-BC-00401	CTZ1-112706	1	11/28/2006	9:39	M	144	215.5	95.2	Analyzed	
		CTZ1-112706	2	11/28/2006	9:39	M	149	204.0			
		CTZ1-112706	3	11/28/2006	9:39	M	133	173.4			
Zone 1	IW-BC-00402	CTZ1-112706	4	11/28/2006	9:39	NR	165	181.1	93.1	Analyzed	
		CTZ1-112706	5	11/29/2006	8:50	F	136	130.9			
		CTZ1-112706	6	11/29/2006	8:50	F	163	233.6			
Zone 1	IW-BC-00406	CTZ1-112706	7	11/29/2006	09:42	M	165	265.4	85.0	Analyzed	
		CTZ1-112706	8	11/29/2006	9:42	F	160	188.8			
		CTZ1-112706	9	11/29/2006	9:42	M	135	187.8			
Zone 1	IW-BC-00409	CTZ1-112706	10	11/30/2006	7:14	F	135	129.6	61.7	Analyzed	
		CTZ1-112706	11	11/30/2006	7:14	M	141	109.2			
		CTZ1-112706	12	11/30/2006	7:14	F	154	160.7			
Zone 1	IW-BC-00410	CTZ1-112706	13	11/30/2006	7:14	F	156	154.1	65.8	Analyzed	
		CTZ1-112706	14	11/30/2006	7:14	F	160	197.3			
		CTZ1-112706	15	11/30/2006	7:14	F	188	238.2			
Zone 1	IW-BC-00411	CTZ1-112706	16	11/30/2006	7:14	M	152	223.2	79.3	Analyzed	
		CTZ1-112706	17	11/30/2006	7:14	M	135	130.5			
		CTZ1-112706	18	11/30/2006	7:14	M	126	126.1			
Zone 2	IW-BC-00403	CTZ2-112706	1	11/28/2006	9:27	M	165	208.9	55.6	Analyzed	EPA subsample (64.8g)
		CTZ2-112706	2	11/28/2006	9:27	M	169	250.8			
		CTZ2-112706	3	11/28/2006	9:27	M	145	229.2			
Zone 3	IW-BC-00404	CTZ3-112706	1	11/28/2006	9:15	M	133	154.9	101.6	Analyzed	
		CTZ3-112706	2	11/29/2006	8:50	F	187	256.1			
		CTZ3-112706	3	11/29/2006	8:50	F	153	184.7			
Zone 4	IW-BC-00405	CTZ4-112706	1	11/28/2006	9:03	M	140	213.8	131.4	Analyzed	Duplicate
		CTZ4-112706	2	11/28/2006	9:03	F	165	240.4			
		CTZ4-112706	3	11/29/2006	8:50	M	156	266.1			
Background	IWB-BC-00421	GNBG-112706	1	11/28/2006	8:10	M	140	198.1	119.5	Archived	Duplicate
		CTBG-112806	2	11/28/2006	8:10	M	130	165.5			
		CTBG-112706	3	11/28/2006	8:10	M	154	209.9			

Table 2 - Blue Crab Field Sampling Data

Location ID	Sample ID	Catch ID	Organism ID	Date	Time	Sex	Width (mm)	Crab Weight (g)	Sample Weight (g)	Analyzed or Archived	Comments
Background	IWB-BC-00422	CTBG-112706	4	11/28/2006	8:10	M	170	244.9	99.1	Archived	
		CTBG-112706	5	11/28/2006	8:10	M	147	197.7			
		CTBG-112706	6	11/28/2006	8:10	M	143	229.3			
Background	IWB-BC-00423	CTBG-112706	7	11/28/2006	8:10	M	158	274.0	84.3	Archived	
		CTBG-112706	8	11/28/2006	8:10	F	160	206.0			
		CTBG-112706	9	11/28/2006	8:10	M	153	224.8			
Background	IWB-BC-00424	CTBG-112706	10	11/28/2006	8:10	M	140	211.0	119.6	Archived	
		CTBG-112706	11	11/28/2006	8:10	M	154	252.3			
		CTBG-112706	12	11/28/2006	8:10	M	134	183.6			
Background	IWB-BC-00425	CTBG-112706	13	11/28/2006	8:10	M	125	145.0	89.7	Archived	
		CTBG-112706	14	11/28/2006	8:10	M	155	192.2			
		CTBG-112706	15	11/29/2006	8:10	M	151	160.1			
Background	IWB-BC-00426	CTBG-112706	16	11/29/2006	8:50	M	156	251.3	108.3	Archived	
		CTBG-112706	17	11/29/2006	8:50	M	162	275.9			
		CTBG-112706	18	11/29/2006	8:50	M	156	215.1			
Background	IWB-BC-00427	CTBG-112706	19	11/29/2006	8:50	F	181	232.9	97.8	Archived	
		CTBG-112706	20	11/29/2006	8:50	M	153	191.9			
		CTBG-112706	21	11/29/2006	8:50	F	175	210.2			
Background	IWB-BC-00428	CTBG-112706	22	11/29/2006	8:50	M	157	268.4	100.1	Archived	
		CTBG-112706	23	11/29/2006	8:50	M	147	186.3			
		CTBG-112706	24	11/29/2006	8:50	M	133	156.5			
Background	IWB-BC-00429	CTBG-112706	25	11/29/2006	8:50	M	165	229.1	84.8	Archived	
		CTBG-112706	26	11/29/2006	8:50	M	135	149.5			
		CTBG-112706	27	11/29/2006	8:50	F	181	191.9			



N

100 0 100 Feet

Legend

Zone Boundaries

Notes

HGAC 2004 Aerial 5624.sid

Tissue Sampling Zones

PBW, LLC.

Gulfco Marine
Tissue Sampling

BESI Benchmark Ecological Services, Inc.

Project Name: Tissue Stations Project.apr

Date: January 12, 2007

Figure 2

M:\05005\007\Arc\tissue stations project.apr

Finfish Samples

The sample plan lists three primary finfish species and three alternate species. The goal of the study was to collect 9 samples of each of the 3 target species from the Intracoastal Waterway (ICWW) adjacent to the study site, and 9 samples of the same species from a background area in the ICWW east of the site. The plan was to meet the sampling requirements of the study with samples from the primary species (*Sciaenops ocellatus* (red drum), *Paralichthys lethostigma* (southern flounder), and *Cynoscion nebulosus* (spotted seatrout)). If a sufficient number of specimens of the primary species was not available, samples of an alternate species could be substituted No substitutions were required, but a few samples of the alternate species were collected, processed and archived. Table 3 lists the number of samples collected by species for each of the sample areas, during the study.

Table 3 – Number of Finfish Samples Collected by Area

Species	Site					Background Area
	Zone 1	Zone 2	Zone 3	Zone 4	Site Total	
Red Drum	5	1	0	0	6	9
Southern Flounder	5	3	1	0	9	9
Spotted Seatrout	4	4	1	0	9	9

Gill nets were used to collect all the finfish samples during the study. Rod and reels were used in addition to gill nets to increase the effort for collecting red drum from the site. Three different gill net mesh sizes were used during the study; 3, 5, and 6 inch stretch mesh. Gill nets were either 150 feet or 50 feet long, and six feet deep. Finfish samples were processed at a house located in the Bridge Harbor subdivision near the site. Fish were inspected for injuries, disease and other anomalies. A few physical injuries were noted that were most likely caused by being captured in gill nets. Benchmark did not find any ulcers, lesions, fin erosion, external deformities or gill discoloration that could be the result of disease or exposure to toxic substances. Results of the inspections were noted on field data sheets.

Nine southern flounder and spotted seatrout were collected and processed from the study site and from the background area. Six red drum samples were collected and processed from the study site and 9 red drum samples were collected from the background area. Total weight, total length, standard length, fillet weight, sample weight, sample date, sample time, and sample station were recorded on data sheets and are summarized in Table 4. Edible tissue fillets were processed and placed in sample jars as specified in the SAP. Finfish samples collected from the site were analyzed for the chemicals designated by PBW and finfish samples collected from the background area were archived.

Table 4 - Finfish Field Sampling Data

Sample ID	Species	Area	Date	Time	Total Length (mm)	Standard Length (mm)	Total Weight (g)	Tissue Weight (g)	Sample Weight (g)	Analyzed or Archived	Comments
IW-RD-00002	Red Drum	Zone 1	11/29/2006	23:46	593	496	1860	251.6	203.3	Analyzed	
IW-RD-00003	Red Drum	Zone 1	12/5/2006	6:45	506	403	1450	194.9	194.9	Analyzed	
IW-RD-00004	Red Drum	Zone 1	12/5/2006	22:05	506	416	1540	233.6	150.3	Analyzed	
IW-RD-00005	Red Drum	Zone 1	12/7/2006	15:38	615	511	2500	362.1	160.3	Analyzed	
IW-RD-00006	Red Drum	Zone 1	12/12/2006	15:39	605	490	2160	285.0	182.4	Analyzed	
IW-SF-00301	Southern Flounder	Zone 1	11/28/2006	6:47	416	345	900	349.8	178.1	Analyzed	MS/MSD; EPA subsample (171.7g)
IW-SF-00306	Southern Flounder	Zone 1	12/8/2006	7:00	448	381	1220	329.6	161.1	Analyzed	
IW-SF-00307	Southern Flounder	Zone 1	12/12/2006	7:34	432	361	860	208.2	202.7	Analyzed	
IW-SF-00308	Southern Flounder	Zone 1	12/12/2006	7:34	369	358	550	123.3	123.3	Analyzed	
IW-SH-00601	Sheepshead	Zone 1	11/28/2006	6:47	404	323	1050	223.5	181.5	Archived	Archive; MS/MSD
IW-SH-00602	Sheepshead	Zone 1	11/28/2006	6:47	367	295	800	175.3	131.6	Archived	Archive; Duplicate
IW-SH-00603	Sheepshead	Zone 1	11/29/2006	6:50	415	329	1360	133.1	133.1	Archived	Archive; Duplicate
IW-ST-00101	Spotted Seatrout	Zone 1	11/27/2006	23:22	410	345	630	269.3	185.5	Analyzed	MS/MSD
IW-ST-00102	Spotted Seatrout	Zone 1	11/27/2006	23:22	390	332	550	239.8	130.7	Analyzed	EPA subsample (109.1g)
IW-ST-00108	Spotted Seatrout	Zone 1	11/28/2006	14:56	394	335	620	127.7	127.7	Analyzed	
IW-ST-00109	Spotted Seatrout	Zone 1	11/28/2006	14:56	392	333	570	123.7	123.7	Analyzed	
IW-ST-00305	Southern Flounder	Zone 1	12/7/2006	7:00	491	412	1520	373.8	175.6	Analyzed	
IW-RD-00001	Red Drum	Zone 2	11/28/2006	7:15	610	500	2140	615.3	178.8	Analyzed	MS/MSD; EPA subsample (187.3g)
IW-SF-00302	Southern Flounder	Zone 2	11/28/2006	7:15	347	286	470	179.5	128.5	Analyzed	Duplicate
IW-SF-00303	Southern Flounder	Zone 2	11/29/2006	7:04	429	356	1010	257.2	171.5	Analyzed	
IW-SF-00304	Southern Flounder	Zone 2	11/28/2006	22:55	457	379	1240	304.1	159.3	Analyzed	
IW-ST-00104	Spotted Seatrout	Zone 2	11/28/2006	15:16	407	343	670	142.8	138.1	Analyzed	
IW-ST-00105	Spotted Seatrout	Zone 2	11/28/2006	15:16	392	331	570	128.1	128.1	Analyzed	Duplicate
IW-ST-00106	Spotted Seatrout	Zone 2	11/28/2006	15:16	388	329	560	119.4	119.4	Analyzed	
IW-ST-00107	Spotted Seatrout	Zone 2	11/28/2006	15:16	452	384	810	171.3	152.1	Analyzed	
IW-SF-00309	Southern Flounder	Zone 3	12/12/2006	7:54	451	385	1130	261.2	193.4	Analyzed	
IW-ST-00103	Spotted Seatrout	Zone 3	11/28/2006	15:39	416	351	660	138.7	138.7	Analyzed	
IWB-RD-00021	Red Drum	Background	11/28/2006	8:07	580	473	1840	317.7	171.4	Archived	MS/MSD
IWB-RD-00022	Red Drum	Background	11/28/2006	15:56	562	466	1770	231.9	158.6	Archived	
IWB-RD-00023	Red Drum	Background	11/28/2006	15:56	541	443	1790	275.3	150.2	Archived	
IWB-RD-00024	Red Drum	Background	11/28/2006	15:56	614	490	2360	350.4	177.0	Archived	Duplicate
IWB-RD-00025	Red Drum	Background	11/28/2006	15:56	636	523	2440	313.0	194.5	Archived	
IWB-RD-00026	Red Drum	Background	11/29/2006	7:48	678	553	3150	449.8	152.2	Archived	

Table 4 - Finfish Field Sampling Data

Sample ID	Species	Area	Date	Time	Total Length (mm)	Standard Length (mm)	Total Weight (g)	Tissue Weight (g)	Sample Weight (g)	Analyzed or Archived	Comments
IWB-RD-00027	Red Drum	Background	12/5/2006	0:56	573	460	2050	311.1	150.6	Archived	
IWB-RD-00028	Red Drum	Background	12/5/2006	0:56	546	445	1850	193.6	150.9	Archived	
IWB-RD-00029	Red Drum	Background	12/5/2006	7:13	586	483	2400	312.9	171.9	Archived	
IWB-SF-00321	Southern Flounder	Background	11/28/2006	0:16	353	295	510	132.4	132.4	Archived	
IWB-SF-00322	Southern Flounder	Background	11/28/2006	8:07	440	373	980	232.3	143.5	Archived	
IWB-SF-00323	Southern Flounder	Background	11/28/2006	8:07	399	335	716	218.8	151.7	Archived	
IWB-SF-00324	Southern Flounder	Background	11/28/2006	8:07	445	366	1160	292.7	165.1	Archived	
IWB-SF-00325	Southern Flounder	Background	11/28/2006	8:07	454	380	1230	335.2	174.4	Archived	Duplicate
IWB-SF-00326	Southern Flounder	Background	11/28/2006	8:07	534	456	1690	398.9	163.8	Archived	MS/MSD
IWB-SF-00327	Southern Flounder	Background	11/28/2006	8:07	453	382	1180	361.7	123.9	Archived	
IWB-SF-00328	Southern Flounder	Background	11/28/2006	15:56	431	362	1030	263.8	188.0	Archived	
IWB-SF-00329	Southern Flounder	Background	11/29/2006	0:02	378	311	630	175.1	151.2	Archived	
IWB-SH-00621	Sheepshead	Background	11/28/2006	8:07	361	293	760	186.5	177.8	Archived	Archive; MS/MSD
IWB-SH-00622	Sheepshead	Background	11/29/2006	7:48	386	303	900	184.0	103.8	Archived	Archive; Duplicate
IWB-ST-00121	Spotted Seatrout	Background	11/28/2006	8:07	410	352	560	233.4	197.5	Archived	MS/MSD
IWB-ST-00122	Spotted Seatrout	Background	11/28/2006	15:56	456	389	820	147.7	147.7	Archived	
IWB-ST-00123	Spotted Seatrout	Background	11/28/2006	15:56	423	355	680	127.3	127.3	Archived	
IWB-ST-00124	Spotted Seatrout	Background	11/29/2006	0:02	425	361	760	165.2	165.2	Archived	Duplicate
IWB-ST-00125	Spotted Seatrout	Background	12/7/2006	8:00	410	361	560	103.7	103.7	Archived	
IWB-ST-00126	Spotted Seatrout	Background	12/7/2006	8:00	389	344	520	106.0	104.8	Archived	
IWB-ST-00127	Spotted Seatrout	Background	12/7/2006	8:00	399	354	660	123.3	123.3	Archived	
IWB-ST-00128	Spotted Seatrout	Background	12/8/2006	8:30	416	363	690	107.2	107.2	Archived	
IWB-ST-00129	Spotted Seatrout	Background	12/8/2006	8:30	401	337	540	116.2	116.2	Archived	

Thank you for the opportunity to participate in this project. If you have any questions or comments, please call me at 281 934-3403, ext. 113.

Sincerely,

Benchmark Ecological Services, Inc.

Neil Henthorne

Project Manager

APPENDIX C

PROUCL OUTPUT

		Variable:	benzo(b)fluoranthene
Raw Statistics		Normal Distribution Test	
Number of Valid Samples	33	Shapiro-Wilk Test Statisitic	0.58542
Number of Unique Samples	10	Shapiro-Wilk 5% Critical Value	0.931
Minimum	0.0225	Data not normal at 5% significance level	
Maximum	0.2335		
Mean	0.080788	95% UCL (Assuming Normal Distribution)	
Median	0.023	Student's-t UCL	0.108066
Standard Deviation	0.092511		
Variance	0.008558	Gamma Distribution Test	
Coefficient of Variation	1.145113	A-D Test Statistic	6.362216
Skewness	1.055897	A-D 5% Critical Value	0.776189
		K-S Test Statistic	0.411634
Gamma Statistics		K-S 5% Critical Value	0.157795
k hat	0.988089	Data do not follow gamma distribution	
k star (bias corrected)	0.918465	at 5% significance level	
Theta hat	0.081762		
Theta star	0.08796	95% UCLs (Assuming Gamma Distribution)	
nu hat	65.21387	Approximate Gamma UCL	0.112038
nu star	60.61867	Adjusted Gamma UCL	0.113967
Approx.Chi Square Value (.05)	43.7105		
Adjusted Level of Significance	0.0419	Lognormal Distribution Test	
Adjusted Chi Square Value	42.97069	Shapiro-Wilk Test Statisitic	0.614881
		Shapiro-Wilk 5% Critical Value	0.931
Log-transformed Statistics		Data not lognormal at 5% significance level	
Minimum of log data	-3.79424		
Maximum of log data	-1.454573	95% UCLs (Assuming Lognormal Distribution)	
Mean of log data	-3.100927	95% H-UCL	0.119192
Standard Deviation of log data	1.028839	95% Chebyshev (MVUE) UCL	0.142332
Variance of log data	1.058509	97.5% Chebyshev (MVUE) UCL	0.171626
		99% Chebyshev (MVUE) UCL	0.229167
		95% Non-parametric UCLs	
		CLT UCL	0.107277
		Adj-CLT UCL (Adjusted for skewness)	0.11044
		Mod-t UCL (Adjusted for skewness)	0.10856
		Jackknife UCL	0.108066
		Standard Bootstrap UCL	0.10697
		Bootstrap-t UCL	0.111727
RECOMMENDATION		Hall's Bootstrap UCL	0.10836
Data are Non-parametric (0.05)		Percentile Bootstrap UCL	0.106333
		BCA Bootstrap UCL	0.123197
Use 99% Chebyshev (Mean, Sd) UCL		95% Chebyshev (Mean, Sd) UCL	0.150984
		97.5% Chebyshev (Mean, Sd) UCL	0.181358
		99% Chebyshev (Mean, Sd) UCL	0.241022
Recommended UCL exceeds the maximum observation			

		Variable:	DDE
Raw Statistics		Normal Distribution Test	
Number of Valid Samples	33	Shapiro-Wilk Test Statisitic	0.288156
Number of Unique Samples	7	Shapiro-Wilk 5% Critical Value	0.931
Minimum	0.00358	Data not normal at 5% significance level	
Maximum	0.016		
Mean	0.004293	95% UCL (Assuming Normal Distribution)	
Median	0.00369	Student's-t UCL	0.005046
Standard Deviation	0.002554		
Variance	6.52E-06	Gamma Distribution Test	
Coefficient of Variation	0.594768	A-D Test Statistic	10.75488
Skewness	4.103704	A-D 5% Critical Value	0.748011
		K-S Test Statistic	0.528904
Gamma Statistics		K-S 5% Critical Value	0.153417
k hat	6.640283	Data do not follow gamma distribution	
k star (bias corrected)	6.056823	at 5% significance level	
Theta hat	0.000647		
Theta star	0.000709	95% UCLs (Assuming Gamma Distribution)	
nu hat	438.2587	Approximate Gamma UCL	0.004843
nu star	399.7503	Adjusted Gamma UCL	0.004873
Approx.Chi Square Value (.05)	354.3965		
Adjusted Level of Significance	0.0419	Lognormal Distribution Test	
Adjusted Chi Square Value	352.2039	Shapiro-Wilk Test Statisitic	0.306966
		Shapiro-Wilk 5% Critical Value	0.931
Log-transformed Statistics		Data not lognormal at 5% significance level	
Minimum of log data	-5.632392		
Maximum of log data	-4.135167	95% UCLs (Assuming Lognormal Distribution)	
Mean of log data	-5.52784	95% H-UCL	0.004646
Standard Deviation of log data	0.324419	95% Chebyshev (MVUE) UCL	0.005232
Variance of log data	0.105248	97.5% Chebyshev (MVUE) UCL	0.005687
		99% Chebyshev (MVUE) UCL	0.006579
		95% Non-parametric UCLs	
		CLT UCL	0.005025
		Adj-CLT UCL (Adjusted for skewness)	0.005364
		Mod-t UCL (Adjusted for skewness)	0.005099
		Jackknife UCL	0.005046
		Standard Bootstrap UCL	0.005014
		Bootstrap-t UCL	0.035764
RECOMMENDATION		Hall's Bootstrap UCL	0.016727
Data are Non-parametric (0.05)		Percentile Bootstrap UCL	0.005049
		BCA Bootstrap UCL	0.004924
Use Student's-t UCL		95% Chebyshev (Mean, Sd) UCL	0.006231
or Modified-t UCL		97.5% Chebyshev (Mean, Sd) UCL	0.00707
		99% Chebyshev (Mean, Sd) UCL	0.008716

		Variable:	silver
Raw Statistics		Normal Distribution Test	
Number of Valid Samples	33	Shapiro-Wilk Test Statisitic	0.433638
Number of Unique Samples	6	Shapiro-Wilk 5% Critical Value	0.931
Minimum	0.0265	Data not normal at 5% significance level	
Maximum	0.22		
Mean	0.043182	95% UCL (Assuming Normal Distribution)	
Median	0.0265	Student's-t UCL	0.056587
Standard Deviation	0.045462		
Variance	0.002067	Gamma Distribution Test	
Coefficient of Variation	1.052808	A-D Test Statistic	9.019378
Skewness	2.98773	A-D 5% Critical Value	0.758377
		K-S Test Statistic	0.512285
Gamma Statistics		K-S 5% Critical Value	0.155112
k hat	2.139432	Data do not follow gamma distribution	
k star (bias corrected)	1.96514	at 5% significance level	
Theta hat	0.020184		
Theta star	0.021974	95% UCLs (Assuming Gamma Distribution)	
nu hat	141.2025	Approximate Gamma UCL	0.053653
nu star	129.6993	Adjusted Gamma UCL	0.05426
Approx.Chi Square Value (.05)	104.3873		
Adjusted Level of Significance	0.0419	Lognormal Distribution Test	
Adjusted Chi Square Value	103.2191	Shapiro-Wilk Test Statisitic	0.457309
		Shapiro-Wilk 5% Critical Value	0.931
Log-transformed Statistics		Data not lognormal at 5% significance level	
Minimum of log data	-3.630611		
Maximum of log data	-1.514128	95% UCLs (Assuming Lognormal Distribution)	
Mean of log data	-3.393885	95% H-UCL	0.049182
Standard Deviation of log data	0.589543	95% Chebyshev (MVUE) UCL	0.058568
Variance of log data	0.347561	97.5% Chebyshev (MVUE) UCL	0.066729
		99% Chebyshev (MVUE) UCL	0.082759
		95% Non-parametric UCLs	
		CLT UCL	0.056199
		Adj-CLT UCL (Adjusted for skewness)	0.060597
		Mod-t UCL (Adjusted for skewness)	0.057273
		Jackknife UCL	0.056587
		Standard Bootstrap UCL	0.055702
		Bootstrap-t UCL	0.069294
RECOMMENDATION		Hall's Bootstrap UCL	0.062572
Data are Non-parametric (0.05)		Percentile Bootstrap UCL	0.05703
		BCA Bootstrap UCL	0.064727
Use 95% Chebyshev (Mean, Sd) UCL		95% Chebyshev (Mean, Sd) UCL	0.077678
		97.5% Chebyshev (Mean, Sd) UCL	0.092604
		99% Chebyshev (Mean, Sd) UCL	0.121925

APPENDIX D

EXPOSURE AND RISK CALCULATION

INTAKE CALCULATIONS FOR FISH INGESTION PATHWAY
CENTRAL TENDENCY RECEPTOR

FISH INGESTION

I fish = (Conc fish * Ing fish * FI * EF * ED) / (BW * AT)

Parameter	Definition	Value	Reference
I fish	Intake of chemical (mg/kg-day)		
Conc fish	Finfish and crab concentration (mg/kg)	see below	
Ing fish	Ingestion rate of finfish and crab (kg/day)	0.0072	EPA, 1997
FI	Fraction ingested	0.325	EPA, 1997
EF	Exposure frequency (day/yr)	350	EPA, 1989
ED	Exposure duration (yr)	9	EPA, 1989
BW	Body weight (kg)	70	EPA, 1989
ATc	Averaging time for carcinogens (days)	25550	EPA, 1989
ATnc	Averaging time for noncarcinogens (days)	3295	EPA, 1989

Chemical	Conc fish	Intake for Carcinogens	Intake for Noncarcinogens
Silver	4.32E-02	1.78E-07	1.38E-06
4,4'-DDE	4.29E-03	1.77E-08	1.37E-07
Benzo(b)fluoranthene	4.90E-02	2.02E-07	1.57E-06

RISK/HAZARD CALCULATIONS FOR FISH INGESTION PATHWAY
CENTRAL TENDENCY RECEPTOR

Cancer Risk =	I fish*CSF	HQ =	I fish / RfD

Parameter	Definition	Default
I fish	Intake of chemical from finfish and crab (mg/kg-day)	
CSF	Cancer slope factor (mg/kg-day)-1	see below
RfD	Reference dose (mg/kg-day)	see below

INGESTION

Chemical	Cancer Slope Factor	RfD	Intake Carc	Intake Noncarc	Cancer Risk	Hazard Quotient
Silver	--	0.005	1.78E-07	1.38E-06	NC	2.76E-04
4,4'-DDE	0.34	--	1.77E-08	1.37E-07	6.02E-09	NC
Benzo(b)fluoranthene	0.73	--	2.02E-07	1.57E-06	1.47E-07	NC
			PATHWAY TOTAL =		1.53E-07	2.76E-04
				TOTAL	**1.53E-07**	**2.76E-04**

NC Not Calculated
-- No value available from EPA

INTAKE CALCULATIONS FOR FISH INGESTION PATHWAY
RME RECEPTOR

FISH INGESTION

I fish = (Conc fish * Ing fish * FI * EF * ED) / (BW * AT)

Parameter	Definition	Value	Reference
I fish	Intake of chemical (mg/kg-day)		
Conc fish	Finfish and crab concentration (mg/kg)	see below	
Ing fish	Ingestion rate of finfish and crab (kg/day)	0.026	EPA, 1997
FI	Fraction ingested	0.325	EPA, 1997
EF	Exposure frequency (day/yr)	350	EPA, 1989
ED	Exposure duration (yr)	30	EPA, 1989
BW	Body weight (kg)	70	EPA, 1989
ATc	Averaging time for carcinogens (days)	25550	EPA, 1989
ATnc	Averaging time for noncarcinogens (days)	9125	EPA, 1989

Chemical	Conc fish	Intake for Carcinogens	Intake for Noncarcinogens
Silver	7.77E-02	3.85E-06	1.08E-05
4,4'-DDE	5.10E-03	2.53E-07	7.08E-07
Benzo(b)fluoranthene	4.90E-02	2.43E-06	6.81E-06

RISK/HAZARD CALCULATIONS FOR FISH INGESTION PATHWAY
RME RECEPTOR

Cancer Risk =	I fish*CSF	HQ =	I fish / RfD

Parameter	Definition	Default
I fish	Intake of chemical (mg/kg-day)	
CSF	Cancer slope factor (mg/kg-day)-1	see below
RfD	Reference dose (mg/kg-day)	see below

INGESTION

Chemical	Cancer Slope Factor	RfD	Intake Carc	Intake Noncarc	Cancer Risk	Hazard Quotient
Silver	--	0.005	3.85E-06	1.08E-05	NC	2.16E-03
4,4'-DDE	0.34	--	2.53E-07	7.08E-07	8.60E-08	NC
Benzo(b)fluoranthene	0.73	--	2.43E-06	6.81E-06	1.77E-06	NC
			PATHWAY TOTAL =		1.86E-06	2.16E-03
				TOTAL	**1.86E-06**	**2.16E-03**

NC Not Calculated
-- No value available from EPA