February 2, 2012

Technical Memorandum
Fish and Crab Consumption Rates
for the LPRSA Human Health Risk Assessment

1.0 Summary of the Issue

Fish and crab ingestion rates are needed to develop a human health risk assessment that characterizes the risk posed to individuals who consume contaminated fish and crabs in the 17.4 miles of the Lower Passaic River Study Area (LPRSA), which is a tributary of the Newark Bay Estuary, in the New York/New Jersey Harbor Estuary. This document presents a detailed evaluation of LPRSA-pertinent angler and creel surveys to identify ingestion rates for the Lower Passaic River. The analysis provides a weight-of-evidence approach for evaluating consumption for the reasonable maximum exposure (RME). The RME is the highest exposure reasonably expected to occur at a site under both current and future uses (EPA 1989) and is consistent with the goals of the Superfund program to design remedies that are protective of all individuals who may be exposed at a site (55 FR 8710, March 8, 1990). U.S. Environmental Protection Agency (EPA) Superfund risk assessment guidance requires the evaluation of completed exposure pathways under current and future conditions (EPA 1989).

A paper by Urban et al. (2009), funded by a company that is a member of the Cooperating Parties Group (CPG[1]), identified a fish consumption rate of 1.8 g/day for the Lower Passaic River. The value was based on data from an angler and creel survey conducted in the lower six miles of the LPRSA described in Ray et al. (2007b) and Urban et al. (2009). This fish consumption rate was calculated by including a large majority of anglers (54 of 61 anglers) who stated that they did not consume the fish they caught and thus had zero fish consumption from the Lower Passaic River (Ray et al. 2007b). Anglers with zero fish consumption are not exposed through a fish consumption pathway and cannot be considered as part of the RME for individuals who may be exposed. Therefore, they should not have been included in the calculation of a fish ingestion rate for the RME individual. Fish consumption rates from Ray et al. (2007b) that are based only on anglers who consume fish from the Lower Passaic River are 23.95 g/day (estimated maximum annual consumption, Table 3, Ray et al 2007b) and 28 g/day (the reported maximum, p. 525, Ray et al 2007b).[2] These two values are comparable to the 26 g/day consumption rate for anglers recommended in EPA's 1997 Exposure Factors Handbook (EFH, EPA 1997) (errata at www.epa.gov/ncea/pdfs/efh/addendum-table.pdf), which Urban et al.

[1] The CPG is a group of potentially responsible parties who signed an agreement with EPA to implement a remedial investigation and feasibility study for the LPRSA, under EPA oversight.

[2] There is some debate as to whether 28 g/day is the maximum rate among the fish consumers, or 23.95 g/day is the maximum and the higher value is an estimated number based on sensitivity analysis. For this technical memorandum, the distinction is irrelevant.

(2009) rejected because "use of the default values would clearly inflate actual fish consumption" in the Lower Passaic River.

However, the workplan for the survey described in Ray et al. (2007b) was submitted to EPA for review and was not approved, because it was inconsistent with EPA guidance in planning, implementation and analysis. Therefore, the survey and its results may not be used in the LPRSA risk assessment without caveat. This technical memorandum considers all other relevant angler and creel surveys in order to develop fish and crab ingestion rates for the LPRSA.

1.1. Relevant Guidance

The 1992 Exposure Assessment Guidelines issued by EPA, defines exposure as contact between a chemical, physical, or biological agent and a target (e.g., exposed individual) [EPA 1992]. Based on this definition, this evaluation of fish consumption surveys will include consumption patterns only among anglers reporting consumption of fish and/or crabs. Non-consumers will not be further evaluated since the fish ingestion exposure pathway is not complete.

This approach of evaluating only fish consumers is consistent with the Risk Assessment Guidance for Superfund (RAGS) – Part A (EPA 1989) that defines the RME as the maximum exposure that is reasonably expected to occur under baseline conditions and is not a worst-case exposure scenario. This approach is reaffirmed in the National Oil and Hazardous Substances Pollution Contingency Plan (55 FR 8710, March 8, 1990) which clarified that only potential exposures that are likely to occur are included in the RME evaluation. RAGS Part A guidance (EPA 1989) further indicates that current and future exposures are evaluated in the absence of Institutional Controls such as the health advisories for fish and crab consumption that are in effect on the Lower Passaic River.

RAGS Part A recommends the following procedures for calculating a contact rate. "Contact rate reflects the amount of contaminated medium contacted per unit time or event. If statistical data are available for a contact rate, use the 95th percentile value for this variable." (EPA 1989, p.6-22). RAGS Part A goes on to say that "the 90th percentile value can be used if the 95th percentile value is not available." Consistent with this recommendation, in those cases where fish ingestion rate data are available and supportive of statistical calculations, the 95th percentile, or other similar high end value such as the 90th percentile, is used in the calculation and is noted in the text.

In accordance with the Superfund 1991 Standard Default Exposure Assumptions guidance, the fish pathway should be evaluated when there is access to a contaminated water body large enough to produce a consistent supply of edible-sized fish over the anticipated exposure period (EPA 1991). This criterion has been met for the Lower Passaic River. EPA also provides

guidance recommending the use of default exposure assumptions to reduce unwarranted variability in the exposure assumptions used by Regional Superfund staff to characterize exposures to human populations in the baseline risk assessment (EPA 1991). Further, the guidance was developed to encourage a consistent approach to assessing exposures where there is lack of site-specific data or consensus on which parameter value to choose, given a range of possibilities (EPA 1991).

Based on these guidance documents, this analysis evaluates the number of anglers reporting fish consumption in the available surveys, variability in fish ingestion rates across surveys, and consistency with fish ingestion rates used by Region 2 in Records of Decision since 1991. The analysis also provides information regarding application of a Fraction Ingested value equal to one.

2.0 Published Studies

Fish and crab consumption surveys relevant to the 17.4-mile area of the LPRSA were identified based on the criteria outlined in EPA's 2000 Ambient Water Quality Guidance (EPA 2000). The analysis is organized by the following data sources:

(1) use of local data;
(2) use of data reflecting similar geography/population groups;
(3) use of data from national surveys; and
(4) use of EPA's default intake rates.

1. *Local Data.* One survey was identified in the lower six miles of the Passaic River (Ray et al., 2007a,b). A survey of the entire 17.4-mile study area was not found based on a literature review conducted for this document.

2. *Geographic Areas/Population Groups.* Three surveys were identified in the Newark Bay Estuary and the New York Bay Estuary, which are the watersheds encompassing the 17.4-mile LPRSA. Additional surveys in New Jersey were identified including surveys in Barnegat Bay and the 1993 New Jersey Statewide survey. The surveys listed below share similar geography, population groups and climatic conditions, and include:

    - Newark Bay Complex including Newark Bay, tidal portions of the Hackensack River, Passaic River, Arthur Kill, and Kill van Kull (Burger 2002; May and Burger 1996).

    - 1993 New Jersey Household Fish Consumption Study conducted by the Center for the Public Interest Polling (CPIP) and the New Jersey Marine Sciences

Consortium (NJMSC) (1993) and an intercept survey conducted in Barnegat Bay (Burger et al. 1998).

- New York Statewide Angler survey, a statewide mail survey of New York State anglers, with applicability to the New York Bay, conducted in 1991 (Connelly et al. 1992). The survey data was obtained by EPA and analyzed based on type of water body, flowing vs. still water, single waterbody vs. multiple waterbodies, the climate, fishing regulations, and the availability of desired fish species. This analysis was presented in the externally peer-reviewed Human Health Risk Assessment for the Hudson River (TAMS 2000).

In addition, regional data for Mid-Atlantic marine fisheries were collected by the National Marine Fisheries Service (NMFS 1993) and summarized in the 2011 EFH (EPA 2011). The Mid-Atlantic data includes consumption from recreational fishing in Delaware, Maryland, New Jersey, New York, and Virginia.

3. *National Surveys*. The 1997 EFH (EPA 1997) identified a national survey (EPA 1996) that provides daily average per capita fish consumption estimates based on the combined USDA 1989, 1990, and 1991 Continuing Survey of Food Intakes by Individuals (CSFII).

4. *National Default Fish Ingestion Rates*. Recommended fish ingestion rates are available in the following EPA guidance:

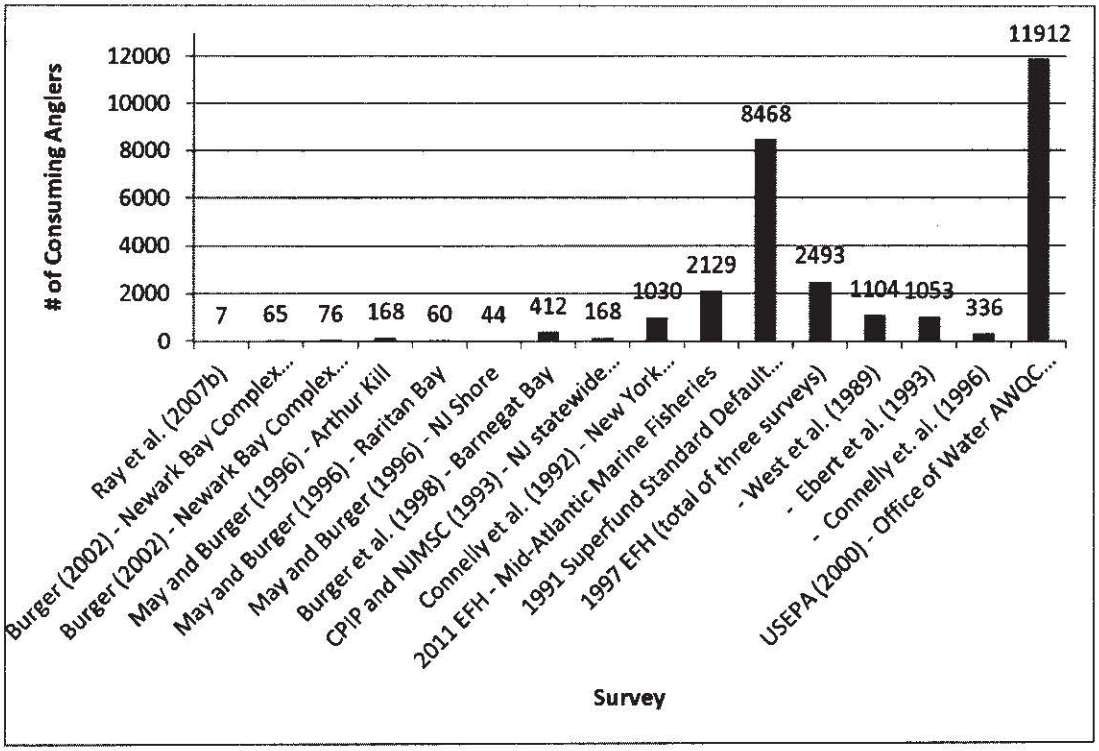
   - 1997 EFH (EPA 1997)
   - 1991 Standard Default Exposure Factors for Superfund (EPA 1991)
   - Office of Water Methodology for Deriving Ambient Water Quality Criteria (EPA 2000).

2.1 Survey Evaluation

a. Number of Survey Individuals

Number of individuals reporting fish consumption for the surveys described above was compiled and illustrated in Figure 1.

Figure 1. Number of Anglers Responding to Surveys Indicating Fish Consumption



As indicated in Figure 1, the one local survey conducted by Ray et al. (2007b) had 7 reported consumers and the lowest number of fish consumers of all of surveys analyzed. Table 6 in Ray et al. (2007b) reported that only 11% of those surveyed reported consuming fish (i.e., 7 out of 61 anglers surveyed). The small number of consumers limits further statistical analyses in that it would result in a large variance around the estimated ingestion rate. Therefore, in accordance with EPA guidance (EPA 1992), the small number of consumers and the minimal consumer-specific data provided by Ray et al. (2007b), limit evaluation of the consumption rate to the maximum reported consumption rate of 28 grams/day, which will be used in further evaluations of the data.

The remaining surveys indicate a range of individuals reporting consumption of fish and/or crabs. Larger numbers of individuals reporting fish consumption provide a more robust dataset that can be used to represent the upper percentile consumption rate.

b. Survey Methodology Review Process

Funding and methodological review procedures for the surveys identified in Section 2.0 vary. All of the papers provided below were published in the peer-reviewed literature or by EPA following an external review process. Following is a summary of the review process and considerations.

The survey methodology for the angler and creel survey conducted in the lower six miles of the LPRSA, described in Ray et al. (2007b), was reviewed by an expert panel (Finley et al. 2003, Kinnell et al. 2007). The survey results were analyzed using a statistical methodology described in a paper published in peer reviewed literature (Ray et al. 2007a,b). However, the work plan for this survey was submitted to EPA for review and specifically disapproved as not being consistent with EPA guidance. In addition, EPA and New Jersey Department of Environmental Protection (NJDEP) reviewed the data reported in Ray et al. (2007b) and identified several concerns with use of the survey data for the LPRSA human health risk assessment (Mugdan 2010, Buchanan 2010).

Surveys in the Newark Bay Complex were conducted by Rutgers University, including the Environmental and Occupational Health Sciences Institute, and NJDEP. Within each of these organizations, procedures exist for detailed reviews of proposed surveys and research before grants are submitted for funding (L. Lurig personal communication with M. Olsen 2011). Upon submission, grants are further evaluated by the funding Agencies listed in the published report: EPA Region 2; NJDEP Division of Science and Research; the Consortium for Risk Evaluation and Stakeholder Participation through the Department of Energy (DOE) Cooperative Agreement and the National Institutes of Environmental Health Sciences. Each organization has established review procedures prior to awarding grants. They include evaluation of budgets and timelines, scientific merit, and whether the grant rules, regulations and guidance are met. Upon funding of grants, typically reports are submitted to the funding Agency and reviewed by the Agency scientists for compliance with the approved grant. Finally, the survey methodologies and results were published in peer reviewed literature (Burger 2002, May and Burger 1996).

The New Jersey Statewide Survey of Fish Consumption was conducted in 1993 by the Center for Public Interest Polling (CPIP), Eagleton Institute of Politics, Rutgers, the State University of New Jersey and the New Jersey Marine Sciences Consortium (NJMSC) for the New Jersey Department of Environmental Protection and Energy. The grant followed State review procedures.

The 1991 New York State Angler survey was conducted under grants from the National Oceanic and Atmospheric Administration, Office of Sea Grant, U.S. Department of Commerce under Grant #NA90AA-D-SG078 to the New York Sea Grant Institute. This research underwent Cornell University reviews before submission to the grant agency and also underwent review by the Department of Commerce.

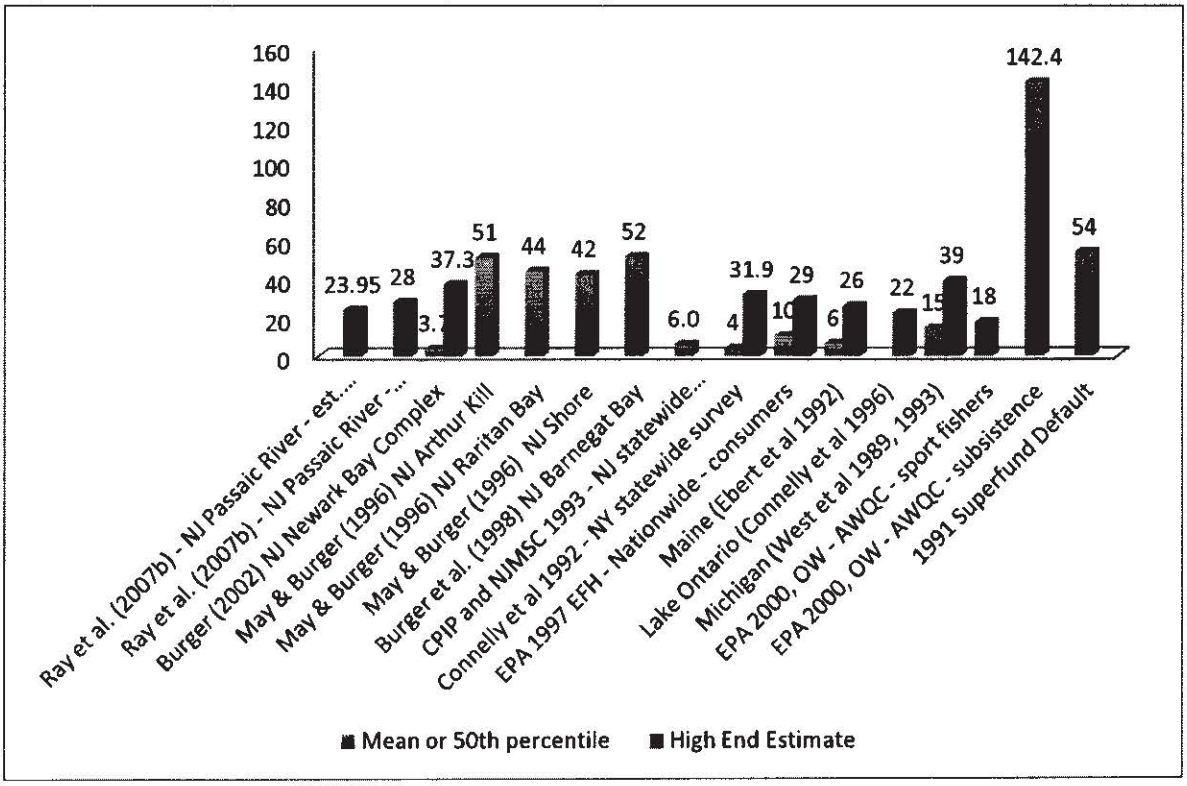
The 1997 and 2011 EFHs (EPA 1997, 2011) were reviewed internally by Agency scientists, made publicly available and then submitted for external review by EPA's Science Advisory Board. In addition, the Office of Water Methodology for Deriving Ambient Water Quality Criteria (EPA 2000) was submitted for public review and appropriate regulatory review. The

1991 Standard Default Exposure Factors for Superfund (EPA 1991) was also reviewed within the Agency (J. Dinan, EPA, personal communication with M. Olsen, 4/13/2011).

c. Ingestion Rate for Fish Among Consuming Anglers

The fish ingestion rates used in this analysis were obtained from the individual reports described above. Figure 2 provides an array of mean and high-end ingestion rates from each study, where available. For two studies, Burger (2002) and Connelly et al. (1992), the value shown as a mean in the figure is actually the 50th percentile. "High-end" ingestion rates are (1) 90th percentiles, in cases where the number could be estimated or was provided, (2) 95th percentiles, for the studies included in the 1997 EFH recommended freshwater angler ingestion rate[3], or (3) a maximum value, as in the case of the limited data provided in the Ray et al. (2007b) survey.

Figure 2. Fish Ingestion Rates for Specific Surveys



Based on the low response rate from the Ray et al. survey (2007b), the rate reported in Figure 2 represents the maximum reported ingestion rate. Ray et al. (2007b) stated that 2 of the 7 anglers consumed more than 20 g/day, with a maximum rate of 28 g/day. An average ingestion rate or

[3] The 1997 EFH recommended rate shown in Figure 2 has been adjusted to exclude non-consumers, as described later in this section.

other statistics (e.g., specific percentiles) for the 7 consumers could not be determined from the summary of data provided in the paper.

EPA evaluated the raw data collected for the Burger (2002) study in the Newark Bay Complex of New Jersey to estimate the 50th percentile and 90th percentile fish ingestion rates shown in Figure 2. For people who only fished (i.e., who did not also go crabbing), 65 of the respondents provided estimates of the self-caught meals per month, serving size, and months per year that they fish.[4] Four of the records were excluded from the ingestion rate estimates because the respondents estimated a serving size greater than 30 ounces per meal (i.e., greater than about 2 pounds of fish per meal). For the remaining 61 consumers of self-caught fish, daily ingestion rates were estimated for each individual by multiplying the serving size (in ounces/day) by a conversion factor for grams/ounce, number of meals per month and months per year of fishing, and by dividing by 365 days per year. The 50th percentile ingestion rate is 3.7 g/day, the mean ingestion rate is 13 g/day, and the 90th percentile ingestion rate is 37.3 g/day. The distribution is highly skewed, increasing to 62.9 g/day at the 95th percentile.

The May and Burger (1996) study in New Jersey's Arthur Kill, Raritan Bay, and the New Jersey shore, and the Burger et al. (1998) study in New Jersey's Barnegat Bay, present the mean number of times fish were eaten per month and mean serving sizes, each with their standard errors. The means were multiplied to estimate the mean fish ingestion rates for each area. Some individuals in these studies reported not eating the fish. It is not known whether the non-consumers were included in the presented summary statistics. Some respondents reported freezing fish to eat during the winter. Mean fish ingestion rates from these studies ranged from 42 to 52 g/day, assuming fish consumption 12 months/year[5]. Upper percentile statistics for fish ingestion could not be estimated with accuracy from the data presented in the papers (i.e., without information about the shapes of the distributions or the degree of independence).

The 1993 New Jersey Household Fish Consumption Study involved interviews with a random probability sample of 1,000 New Jersey residents 18 years of age and older and was conducted between October 26 and November 20, 1993 (CPIP and NJMSC 1993). There were 225 anglers among those interviewed, 168 of whom reported eating fish in the past 7 days. These individuals ate an average of 4.81 pounds/year (or 6 g/day) of fish recreationally caught in New Jersey. Upper percentile statistics could not be calculated from the data presented. The data are based on extrapolation from a one-week period in the fall and the study notes that consumption of recreationally caught fish may vary significantly according to both seasonal and annual preferences and availability. While upper-percentile data are not available, the analysis indicates that the average consumption rate of 6 g/day for anglers consuming New Jersey recreationally

[4] Eight additional people who only fished and said they ate fish were not included in the calculations because they did not provide answers for all three variables.

[5] The assumption of 12 months per year fish consumption was based on the statement in May and Burger (1996) that "some fishermen indicated that they froze their catch to provide fish for the rest of the year."

caught fish is comparable to the 50th percentile from the New York statewide survey of 4 g/day (Connelly et al. 1992, as analyzed by TAMS [2000] for all flowing water bodies, described below).

The Human Health Risk Assessment for the Hudson River (TAMS 2000, Table 3-1) summarized fish ingestion rate percentile values for the 1991 New York angler survey (Connelly et al. 1992), a statewide mail survey that included over 1,000 New York anglers who caught and consumed fish in 1991. The 50th percentile fish ingestion rate for all flowing water bodies was 4.0 g/day and the 90th percentile was 31.9 g/day. This survey was also conducted to determine anglers' awareness and knowledge of fish advisories. About 85% of anglers were aware of fish consumption advisories, and almost half reported that they would eat more sport-caught fish if there were no problems with contaminants.

The 2011 EFH (EPA 2011) recommended values for Atlantic recreational marine fish intake are based on data from the National Marine Fisheries Service (NMFS 1993): mean of 5.6 g/day and 95th percentile of 18 g/day. When the data are narrowed to the Mid-Atlantic states (Table 10-50 in EPA 2011), the mean is 6.3 g/day and the 95th percentile is 18.9 g/day. However, the data include non-consumers: "values represent both individuals who ate recreational fish during the survey period and those that did not, but may eat recreationally caught fish during other periods" (EPA 2011). For this reason, the values are not included in Figure 2. In addition, the NMFS surveys were not designed to estimate individual consumption of fish and did not attempt to estimate the number of individuals consuming the recreational catch. EPA estimated individual intake with the assumption that each angler's catch would be consumed by an average of 2.5 individuals. As noted by EPA (2011), this assumption introduces a relatively low level of uncertainty in the estimated mean, but a higher level of uncertainty in the estimated intake distributions (i.e., 95th percentile). Anglers that do not share their catch would have consumption rates 2.5 times higher than the estimated values.

In the 1997 EFH, EPA's recommended mean and 95th percentile fish ingestion rates for recreational freshwater anglers are 8 g/day and 26 g/day (EPA 1997 and associated errata sheet). These are based on mailed questionnaire surveys of licensed fishermen in Michigan, Maine, and New York (Ebert et al. 1993; West et al. 1989, 1993; Connelly et al. 1992) and based on a survey involving mailed questionnaires, a diary study, and periodic telephone interviews (Connelly et al. 1996) near Lake Ontario in New York. Similar to the Lower Passaic River, the fish ingestion rates from these studies reflect a situation in which fish consumption is advised against for certain water bodies and species and for certain human groups (Connelly et al. 1996).

A closer examination of the 1997 EFH revealed that the recommended mean and 95th percentile for the Lake Ontario study (Connelly et al., 1996) included some non-consumers and discussions with the EFH author confirmed this finding. A recalculation performed for this technical memo

resulted in mean and upper percentile values for consuming recreational freshwater anglers of 10.5 g/day and 29.1 g/day, derived by averaging the consumers-only values from the three populations surveyed in the studies.

- Maine (Ebert et al. 1993) data used in the defaults included non-consumers, but consumer-only percentiles for this survey are shown in Table 10-64 of the EFH. The 95th percentile fish ingestion rate for consuming anglers is 26 g/day.

- Lake Ontario, New York (Connelly et al. 1996) data used in the defaults included 16 percent of anglers who ate no sport caught fish. When non-consumers are excluded from the distribution, the 95th percentile fish ingestion rate for consumers is 22.3 g/day. Over 95% of the participants were aware of the New York State fish consumption advisories, and 32% indicated that they would eat more fish if there were no advisories.

- Michigan data (West et al. 1989, 1993) used in the defaults included consumers only. The 96th percentile fish ingestion rate for consumers is 39 g/day.

EPA's Office of Water identified 17.5 g/day as the average consumption among sport fishers based on averages in the studies reviewed. An upper percentile value for sport fishers is not provided. EPA's Office of Water also recommends a default of 142.4 g/day for subsistence fishers, which falls within the range of averages for this group (EPA 2000).

Thus, as presented in Figure 2, the mean or 50th percentile fish ingestion rates from the surveys examined range from 4 to 142 g/day, and the available high-end estimates of fish ingestion range from approximately 22 to 39 g/day.

Several factors were considered in the identification of the appropriate fish ingestion rate for use in the LPRSA baseline human health risk assessment: watershed in which the survey was conducted, diversity of survey methods, and consistency with local surveys from which high-end values were not available. Of the surveys identified, only the 1997 EFH (EPA 1997), Burger (2002) and Connelly et al. (1992) contain enough information to calculate statistical distributions for the ingestion rates. Only the Burger (2002) and Connelly et al. (1992) (as analyzed and applied in the externally peer-reviewed Human Health Risk Assessment for the Hudson River in TAMS 2000) included data from the New York/New Jersey Harbor Estuary, which encompasses the tidal portion of the Lower Passaic River. Therefore, the fish ingestion rate for the Lower Passaic River RME adult angler (34.6 g/d) is calculated by averaging 90th percentile values from Burger (2002) (37.3 g/d) and Connelly et al. (1992) (31.9 g/d). For the CTE value, the average of the 50th percentile value of 3.7 g/day from Burger (2002) and the 50th percentile value of 4.0 g/day from Connelly et al. (1992) is used (CTE = 3.85 g/d).

From Figure 2, a comparisons of mean fish ingestion rates from other coastal areas of New Jersey (NJ Arthur Kill at 51 g/d, NJ Raritan Bay at 44 g/d and NJ Barnegat Bay at 52 g/d) indicate that the estimated mean rates in these NJ coastal areas tend to be higher than those found in surveys from other geographic areas (i.e., Maine at 6 g/d, Michigan at 15 g/d and NJ-wide at 6 g/d). While the data presented in the other NJ surveys do not provide the information necessary to calculate high end fish ingestion estimates, those surveys present means that indicate that NJ coastal fish ingestion rates tend to be higher than those from other parts of the country. Therefore, we conclude that the fish ingestion rate of 34.6 grams/day does not overestimate the ingestion rate for the Lower Passaic River.

d. Crab Ingestion Rate Among Consuming Anglers

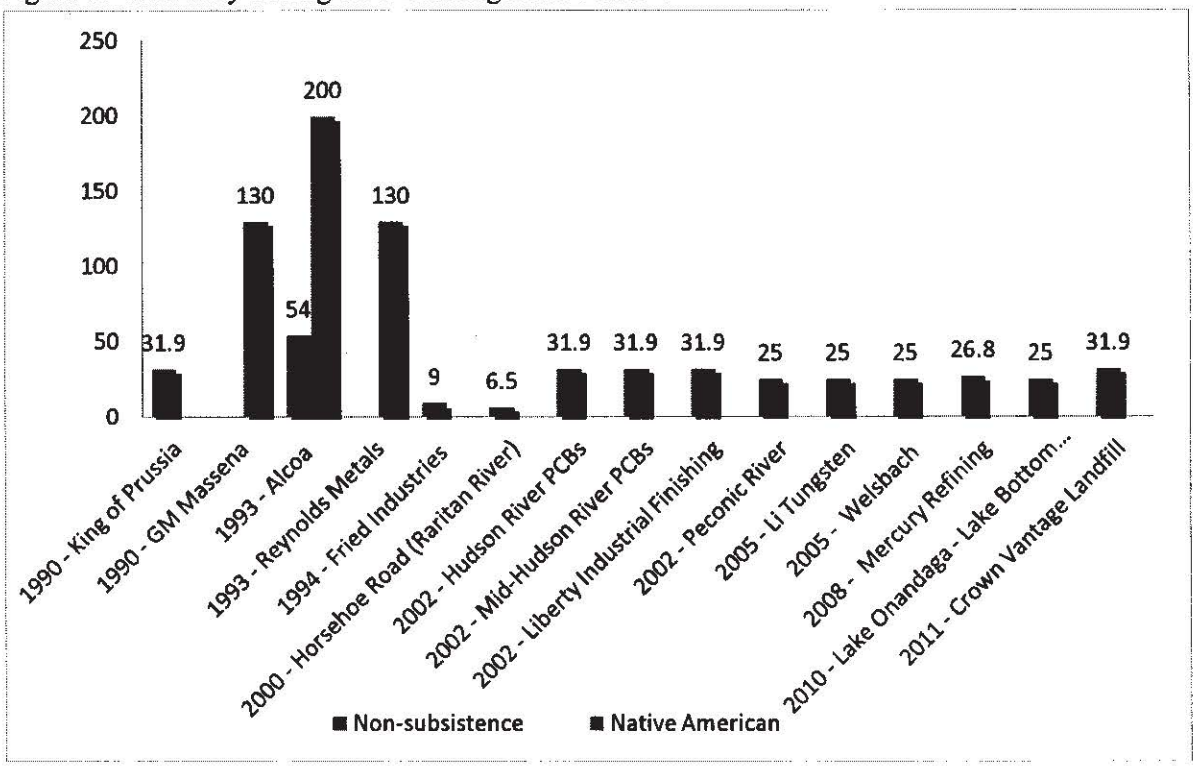
Two studies provided data on crab consumption (Burger 2002; Burger et al. 1998). EPA evaluated the data collected for the Burger (2002) study in the Newark Bay Complex of New Jersey to estimate crab consumption rates. For people who only crabbed (i.e., who did not also fish), 76 of the respondents provided estimates of the number of self-caught crab meals per month, number of crabs per meal, and the number of months per year that they go crabbing. Two records were excluded from the ingestion rate estimates because the responses were considered outliers: one reported eating 48 crabs per meal and the other reported eating 22 crabs per meal 25 times per month. For the remaining 74 consumers of self-caught crabs, daily ingestion rates were estimated for each individual by multiplying the number of crabs per meal by number of meals per month and months per year of crabbing, and by dividing by 365 days per year. In addition, it was assumed that the average edible portion of crab was 45 g per crab, based on the average weight of edible meat (muscle and hepatopancreas) from crabs collected as part of the 17-mile LPRSA Remedial Investigation/Feasibility Study that is currently being conducted. The 50^{th} percentile ingestion rate is 3.0 g/day, the mean ingestion rate is 8.2 g/day, and the 90^{th} percentile ingestion rate is 20.9 g/day. The distribution is highly skewed, with a 95^{th} percentile of 38.4 g/day that is almost double the 90^{th} percentile. The mean crab ingestion rate is about half the mean value of 16.6 g/day from Barnegat Bay (Burger et al. 1998). Burger et al. 1998 did not report enough information to support statistical calculations of high end ingestion rates. Other studies in this area reported crab consumption but an ingestion rate could not be calculated based on the information presented (Burger et al. 1999 and Kirk-Pflugh et al. 1999).

3.0 Consistency with Region 2 Decisions

Figure 3 provides a comparison of the fish ingestion rates used in EPA Region 2 decisions since 1991 (see Appendix A for the list of Superfund Sites for which the decisions were made). As noted in the Figure (in red), several decisions included consideration of fish ingestion rates by Native American Nations found in Massena, New York that were based on a site-specific survey of this population conducted by the New York State Department of Health in 1995 (NYSDOH

1995). This survey yielded an ingestion rate of 142 grams/day at the 90th percentile, which represents a subsistence fishing level. No evidence of subsistence fishing has been observed in the LPRSA. Averaging the other ingestion rates, in the absence of the ingestion rates for the Massena sites, yields an RME ingestion rate of 27.4 grams/day. The RME fish ingestion rate identified for the LPRSA (34.6 g/day) is higher than the average but within the range of ingestion rates used in EPA Region 2 decisions since 1991.

Figure 3. Summary of Region 2 Fish Ingestion Rates Since 1991.



4.0 Fraction Ingested

The CPG recommended applying a Fraction Ingested (FI) rate of < 1 for the Lower Passaic River Study Area. RAGS – Part A includes a term Fraction Ingested that is defined as "Fraction ingested from contaminated source (unitless)" (EPA 1989, p. 6-46). The guidance in the document does not specifically address application of this factor for fish consumption, but rather, on page 6-47, describes the application of this factor to adjust for ingestion rates for vegetables or other produce or ingestion of meat, eggs, and dairy products. The evaluation of various risk assessments conducted within Region 2 indicates the assessments were consistent with the overall directives on fish ingestion recommendations provided on page 6-43 that states "Residents near major commercial or recreational fisheries or shell fisheries are likely to ingest larger quantities of locally caught fish and shellfish than inland residents." Further, the fish

ingestion rate focuses only on the contaminated source; a fraction ingested term would apply only if other sources of fish were included.

Consistent with the recommendations in RAGS Part A (EPA 1989), use of an FI less than one is not appropriate, because of the following:

- The Lower Passaic River has adequate quantity and quality of fish and crabs to support the estimated level of ingestion of fish and crabs for the RME individual, both currently (as found in the fish community survey conducted by the CPG in 2010 [Windward 2011]) and in the future;

- The Lower Passaic River is in a densely populated urban area, with access to the river for fishing and crabbing through parks, boat docks, publicly-accessible parking lots abutting the river and residences on the river banks. Therefore,

    - Anglers have ample opportunities to return to areas where they have successfully caught fish or crab, especially adolescents or lower income families, who have limited means of transportation;
    - Workers have the opportunity to fish and/or crab during the work day or on their way to and from work;
    - There are so many municipalities along the Lower Passaic River that there is the potential that individuals may move within the 17-mile study area, and yet continue to fish and crab, and consume fish/crabs from the Lower Passaic River.

- Many municipalities and counties along the Lower Passaic River have published master plans that call for the expansion and improvement of parks and open space along the Lower Passaic River that, if implemented, will make the area more amenable to fishing and crabbing (City of Newark 2010, City of Newark et al. 2004, Clarke et al. 2004, Clarke et al. 1999, Heyer et al. 2003, Heyer et al. 2002, Borough of Rutherford et al. 2007). As noted in EPA's Land Use in the CERCLA Remedy Selection Process (EPA 1995), comprehensive community master plans are a valuable source of information in determining reasonably anticipated future use for future risk scenarios.

Based on the various lines of evidence, a FI of 1 will be applied in the LPRSA human health risk assessment.

5.0 Conclusion

As shown in the discussion above, the RME fish ingestion rate of 34.6 grams per day and CTE fish ingestion rate of 3.85 g/day, as well as an RME crab ingestion rate of 20.9 grams per day

and CTE crab ingestion rate of 3.0 grams per day, are justified for use in the LPRSA human health risk assessment, because of the following reasons.

- The fish ingestion rate is based on the only two published surveys conducted in the New York/New Jersey Harbor estuary with enough information to calculate statistical distributions of ingestion rates. Those surveys use different sampling methods (i.e., intercept and licensed angler survey), yet result in comparable consumption rates. They also represent large angling populations from coastal New York and New Jersey watersheds.

- The fish ingestion rate is consistent with rates calculated from other surveys conducted within EPA Region 2 and nationally.

- The fish ingestion rate is consistent with rates used in various EPA decisions within Region 2 at sites with sediment contamination where fish ingestion was considered.

- The fish rate is consistent with ingestion rates at other large river bodies in Region 2 where more areas may be accessible for angling, which is anticipated under the future improvements to parks and open space along the Lower Passaic River.

- The crab ingestion rate is based on the only published survey conducted in the New York/New Jersey Harbor estuary with enough information to calculate statistical distributions of crab ingestion rates.

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Appendix A
List of Superfund Sites and Associated Waterbody Used in Evaluation of Fish Ingestion Rates

Year of Record of Decision	Site Name	EPA ID Number	Waterbody
1990	King of Prussia	NJD980505341	Great Egg Harbor River
1990	General Motors (Central Foundry Division) GM Massena	NYD091972554	St. Lawrence and Raquette Rivers
1993	Reynolds Metal Company	NYD002245967	St. Lawrence River
1994	Fried Industries	NJD041828906	Raritan River
1995	Alcoa (Removal Action)	NYD980506232	Grasse River
2000	Horseshoe Road	NJD980663678	Raritan River
2002	Hudson River PCBs	NJ980763841	Hudson River
2002	Liberty Industrial	NYD000337295	Massapequa Creek and Ponds
2002	Brookhaven National Laboratory	NJD00337295	Peconic River
2005	Li Tungsten	NYD986882660	Glen Cove Creek
2005	Welsbach & General Gas Mantle (Camden Radiation)	NJD986620995	Newton Creek and Delaware River
2008	Mercury Refining	NYD00048148175	Unnamed Tributary and Patroon Creek and I-90 Pond
2010	Onondaga Lake	NYD986913580	Onondaga Lake
2011	Crown Vantage Landfill	NJN000204492	Delaware River