Superfund Proposed Plan

U.S. Environmental Protection Agency
Region II

Lower Eight Miles of the Lower Passaic River
Part of the Diamond Alkali Superfund Site

Essex and Hudson Counties, New Jersey

April 2014

EPA ANNOUNCES PROPOSED PLAN

This Proposed Plan describes the remedial alternatives considered for the sediments of the lower eight miles of the Lower Passaic River, part of the Diamond Alkali Superfund Site, and identifies the preferred remedial alternative with the rationale for this preference.

This Proposed Plan was developed by the U.S. Environmental Protection Agency (EPA), the lead agency for the Site, in consultation with the New Jersey Department of Environmental Protection (NJDEP), the support agency. In addition, EPA and NJDEP have consulted with the U.S. Army Corps of Engineers (USACE), National Oceanic and Atmospheric Administration (NOAA) and U.S. Fish and Wildlife Service (USFWS), key federal stakeholders in the Lower Passaic River, Newark Bay and New York-New Jersey Harbor Estuary. EPA is issuing the Proposed Plan as part of its public participation responsibilities under Section 117(a) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended (CERCLA) and Section 300.430(f)(2) of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The nature and extent of the contamination in the lower eight miles of the Lower Passaic River and the remedial alternatives summarized in this Proposed Plan are described in greater detail in two documents: the *Remedial Investigation Report for the Focused Feasibility Study of the Lower Eight Miles of the Lower Passaic River* (RI Report) and the *Focused Feasibility Study Report for the Lower Eight Miles of the Lower Passaic River* (FFS Report). These and other documents are part of the

MARK YOUR CALENDAR

Public Comment Period:

April 21 to June 20, 2014

EPA will accept written comments on the Proposed Plan during the public comment period. Written comments should be addressed to:

Alice Yeh, Remedial Project Manager
Environmental Protection Agency
290 Broadway, 19th Floor
New York, New York 10007-1866

Fax: (212) 637-4439
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PassaicLower8MileComments.Region2@epa.gov

Public Meetings
EPA will hold a series of public meetings to explain the Proposed Plan and all of the alternatives presented in the Focused Feasibility Study. Oral and written comments will also be accepted at the meetings. The meetings will be held at the following locations:

Portuguese Sports Club
55 Prospect Street, Newark, NJ 07105
May 7, 2014 at 7:00 P.M.

Kearny, NJ
May 2014
Specific date and location to be determined

Belleville, NJ
June 2014
Specific date and location to be determined

EPA will announce the dates and locations of the Kearny and Belleville meetings by posting them on ourPassaic.org, issuing news advisories and/or placing ads in local newspapers.

publicly available administrative record file. EPA encourages the public to review these documents to gain a more comprehensive understanding of the Site and the Superfund activities that have been conducted at the Site.

EPA's preferred alternative consists of constructing an engineered cap over the lower 8.3 miles of the Lower Passaic River bank to bank. The engineered cap would consist of approximately two feet of sand and, where needed to prevent erosion of the sand, a layer of armoring stone. Before the engineered cap is installed, the river would be dredged bank to bank (approximately 4.3 million cubic yards) so that the cap can be placed without causing additional flooding and to allow for the continued use of the federally-authorized navigation channel in the 2.2 miles of the river closest to Newark Bay. The final amount to be dredged, thickness of the cap and material to be used for the cap would be determined during remedy design. Mudflats dredged during implementation of the remedy would be replaced with similar material to provide a suitable habitat. Dredged materials removed would be dewatered and transported by rail to off-site permitted incinerators and landfills depending on their characteristics. Institutional controls, such as NJDEP's fish and crab consumption advisories, would remain in place and would be enhanced with additional outreach until the concentrations of contaminants of concern in fish and crab tissue reach protective concentrations that correspond to interim remediation milestones, at which time EPA expects to be able to recommend to NJDEP that advisories gradually be relaxed. Measures to reconstruct habitat impacted by the dredging and capping would also be implemented, including habitat assessment and surveys during remedy design. The design would address placement of habitat recovery material and aquatic vegetation. The preferred alternative includes long-term monitoring and maintenance of the engineered cap to ensure its stability and integrity. Long-term monitoring of fish and sediment would be performed to determine when interim remediation milestones and remediation goals are reached. Other monitoring, such as water column sampling, would also be performed.

While all of the alternatives discussed in this Proposed Plan are subject to public comment, EPA will provide focused public outreach on two aspects of the preferred alternative: dredged material management options (choice of off-site disposal versus a contained aquatic disposal [CAD] site in Newark Bay) and navigational depths (whether shallower depths might accommodate reasonably-anticipated future uses in the lower 2.2 miles of the river). These aspects of the preferred alternative are discussed further below. The focused outreach will occur through facilitated public meetings and information sessions during the public comment period. This will help to ensure that all opinion, views and comments, and new relevant information, are addressed and available in the administrative record to support the selection of the remedy.

Community Role in the Selection Process

This Proposed Plan is being issued to inform the public of EPA's preferred alternative and to solicit public comments pertaining to all of the remedial alternatives evaluated, including the preferred alternative. Changes to the preferred alternative, or a change from the preferred alternative to another alternative, may be made if public comments or additional data indicate that such a change would result in a more appropriate remedial action. The final decision regarding the selected remedy will be made after EPA has taken into consideration all public comments. EPA is soliciting public comment on all of the alternatives considered in the Proposed Plan, because EPA may select a remedy other than the preferred alternative. This Proposed Plan has been made available to the public for a public comment period that concludes on June 20, 2014.

Public meetings will be held during the comment period to provide information regarding the investigations of the lower eight miles of the Lower Passaic River, the alternatives considered and the preferred alternative, as well as to receive public comments. The public meetings will include formal presentations by EPA of the preferred alternative and other cleanup options for the river.

Information on the public meetings and submitting written comments can be found on Page 1.

Comments received at the public meetings, as well as written comments, will be documented in the Responsiveness Summary Section of the Record of Decision (ROD). The ROD is the document that explains which alternative has been selected and the basis for the selection of the remedy.

SITE DESCRIPTION

The Focused Feasibility Study Area (FFS Study Area) is the lower eight miles of the Lower Passaic River in northeastern New Jersey, from the river's confluence with Newark Bay at River Mile (RM) 0 to RM8.3 near the border between the City of Newark and Belleville Township. The FFS Study Area is part of the Lower Passaic River Study Area, which is the 17-mile, tidal portion of the Passaic River, from the river's confluence with Newark Bay (RM0) to Dundee Dam (RM17.4), and its watershed, including the Saddle River (RM15.6), Third River (RM11.3) and Second River (RM8.1) [see Figure 1]. The FFS Study Area, Lower Passaic River and Newark Bay are all part of the Diamond Alkali Superfund Site.

During a comprehensive study of the 17-mile Lower Passaic River, the sediments of the FFS Study Area were found to be a major source of contamination to the rest of the river and Newark Bay. Therefore, EPA completed this FFS to evaluate taking action to address these sediments, while the comprehensive study of the 17-mile Lower Passaic River is on-going.

The sediments of the FFS Study Area pose an unacceptable risk to human health and the environment due to the presence of a variety of contaminants that stay in the environment for a long time and can build up in fish and shellfish. These contaminants include polychlorinated dibenzo-p-dioxins and furans (dioxins and furans), polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), DDT[1] and other pesticides, mercury, lead and other metals.

The FFS Study Area is located in a highly developed urban area, with approximately 1.4 million people living in Essex County (west bank) and Hudson County (east bank). Intensive commercial and industrial uses occur near the mouth of the river (RM0) and around portions of Newark Bay, in part to take advantage of the transportation infrastructure (rail, air and marine). Farther upriver, near RM4, commercial uses continue, but more residential and recreational uses are also included. There are narrow bands of park and open space along the river, surrounded by commercial and dense urban residential development. Near RM7, there are marinas and boat launches along with park lands surrounded by more suburban residential neighborhoods. Hard shorelines, such as bulkhead and riprap (some with overhanging vegetation) make up approximately 95 percent of the banks of the FFS Study Area, while aquatic vegetation predominates along about 5 percent of the banks. Mudflats total approximately 100 acres of the 650-acre FFS Study Area.

The New Jersey Surface Water Quality Standards classify the Lower Passaic River from its mouth to the Second River (RM0 to RM8.1) as saline-estuarine 3 (SE3), with designated uses including secondary contact recreation (activities where the probability of water ingestion is minimal and which include, but are not limited to, boating and fishing). The Lower Passaic River from Second River to Dundee Dam (RM8.1 to RM17.4) is classified as freshwater 2 non-trout (FW2-NT) and saline-estuarine 2 (SE2). Designated uses for FW2-

[1] DDT is a common name that refers to an industrially produced, chlorinated pesticide, dichlorodiphenyl-trichloroethane. DDT breaks down in the environment to form two compounds commonly called DDD and DDE. The term Total DDT used in this Proposed Plan refers to the sum of DDT, DDD and DDE concentrations in a sample.

NT and SE2 include secondary contact recreation. Designated uses for FW2-NT also include primary contact recreation (activities that involve significant ingestion risks and include, but are not limited to, wading, swimming, diving, surfing and water skiing). NJDEP's fish and crab consumption advisories indicate that no species of fish or shellfish from the Lower Passaic River (RM0 to RM17.4) should be eaten due to contamination by PCBs, dioxin and mercury.

The Lower Passaic River has a federally authorized navigation channel which was first constructed, to RM8.1, in the 1880s. It was expanded to its maximum length, to RM 15.4, in 1915, with depths ranging from 30 feet (from RM0 to RM2.6) down to 10 feet at the farthest upstream reaches. After construction, USACE dredged the channel regularly to maintain navigation and prevent infilling with sediments suspended in the water column from storm events and with each tide cycle. The channel below RM2.5 was regularly maintained until 1983. The channel above RM2.5 was dredged periodically through the 1930s (in RM2.5 to RM4.6 and in RM7.1 to RM8.3), through 1950 (in RM4.6 to RM7.1), and through 1976 (in RM8.3 to RM15.4).

As maintenance dredging declined and eventually stopped, this artificially-maintained channel filled with sediments. At the same time, industrial activities along the river grew, and industries and municipalities disposed of wastewaters in the river. The coincidence of chemical disposal in the river and the filling-in of the navigation channel created an ideal situation for the accumulation of contaminated sediments in the Lower Passaic River.

The Lower Passaic River's cross-sectional area declines steadily from RM0 to RM17.4, with a pronounced constriction at RM8.3 (see FFS Report Figure 1-6). At that location, there is also a change in sediment texture. The river bed below RM8.3, from bank to bank, is dominated by fine-grained material (silts) with pockets of coarser materials (sand and gravel). Above RM8.3, the bed is dominated by coarser sediments with smaller areas of silt, often located outside the channel. About 85 percent of the fine-grained surface area in the Lower Passaic River is located below RM8.3 and, by volume, about 90 percent of silts in the Lower Passaic River are located below RM8.3. Due to a combination of a wider cross-section and a deeper navigation channel below RM8.3 (16 to 30 feet) than above RM8.3 (10 feet), thicker and wider beds of contaminated sediments accumulated below RM8.3 than above it.

The contaminants of concern (COCs) shown in Table 1 tend to bind tightly to fine sediment particles (i.e., silts). Therefore, the majority of the contamination tends to be found in areas that are predominantly comprised of silts which, for the Lower Passaic River, are the lower 8.3 miles, the FFS Study Area.

SITE BACKGROUND

The Passaic River was one of the major centers of the American industrial revolution, starting two centuries ago. By the end of the 19th century, a multitude of industrial operations, such as manufactured gas plants, paper manufacturing and recycling facilities, petroleum refineries, pharmaceutical and chemical manufacturers, and others had located along the river's banks as the New Jersey cities of Newark and Paterson grew. Industries and municipalities often discharged wastewater directly to the river. To date, over 100 industrial facilities have been identified as potentially responsible for discharging contaminants to the river, including, but not limited to, dioxins and furans, PCBs, PAHs, DDT and other pesticides, mercury, lead and other metals.

The Lower Passaic River is a part of the Diamond Alkali Superfund Site, a former manufacturing facility located at 80-120 Lister Avenue in Newark, New Jersey, at RM3. Manufacturing of DDT and other products began at this facility in the 1940s. In the 1950s and 1960s, the facility was operated by Diamond Alkali Company (later purchased by and merged into Occidental

Chemical Corporation or OCC), which used the facility for the manufacture of the defoliant chemical known as "Agent Orange," among other products. A byproduct of this manufacturing process was 2,3,7,8-TCDD (2,3,7,8-tetrachlorodibenzo-p-dioxin, the most toxic form of dioxin), which was released into the river.

Superfund History

After investigations by NJDEP and EPA, the Site was placed on the National Priorities List in 1984. After further investigations and several emergency response actions that addressed dioxin found on nearby properties, EPA issued a ROD in 1987 to select an interim containment remedy for the Lister Avenue facility. The remedy consisted of capping, subsurface slurry walls, and a groundwater collection and treatment system that would prevent exposure to contaminated soil (that originated at the facility and that was brought to the facility from neighboring lots), and prevent further releases to the river.

Construction of the remedy at the 80-120 Lister Avenue facility was carried out by OCC and the owner of the facility, Chemical Land Holdings, Inc., now Tierra Solutions, Inc. (Tierra), under EPA oversight. Construction was completed in 2001 and maintenance of the facility is performed by Tierra on OCC's behalf, under EPA oversight. EPA performs periodic reviews of the protectiveness of the remedy.

In 1994, OCC agreed to investigate a six-mile stretch (RM1 to RM7) of the Lower Passaic River, with the work being performed by Tierra on OCC's behalf, under EPA oversight. Results from this investigation indicated that contaminated sediment moved into and out of the six-mile stretch, suggesting that a more comprehensive study was required. In 2002, EPA expanded the

Table 1
Contaminants of Concern in Surface Sediments (top 6 inches)

Surface Sediments, 0-6 inches [a]	Unit [b]	Frequency of Detection	Minimum	Maximum	Mean	Median
2,3,7,8-TCDD [c]	pg/g	363/365	0.09	34,100	951	280
Total TCDD	pg/g	311/312	2.20	37,900	1,193	399
Total PCBs	ug/kg	357/358	0.10	28,600	1,668	1,004
Total DDT	ug/kg	361/361	0.32	10,229	235	102
Dieldrin	ug/kg	269/355	0.01	152	11	5.3
Total PAHs	mg/kg	361/361	0.21	2,806	48	31
Mercury	mg/kg	373/381	0.05	16	2.72	2.20
Copper	mg/kg	382/384	0.21	2,470	183	169
Lead	mg/kg	378/378	4.40	906	259	235

Based on 1995 – 2012 data.

[a] The top six inches of sediment is where most organisms in contact with the sediment are exposed to COCs, because it is where they are most active (e.g., burrowing or feeding).

[b] pg/g = picograms per gram or parts per trillion (ppt); ug/kg = micrograms per kilogram or parts per billion (ppb); mg/kg = milligrams per kilogram or parts per million (ppm).

[c] 2,3,7,8-TCDD = 2,3,7,8-tetrachlorodibenzo-p-dioxin is the most toxic form of dioxin.

investigation to include the entire 17-mile Lower Passaic River.

While working with OCC and Tierra on the Lister Avenue facility and the first studies of the river, EPA also identified other potentially responsible parties (PRPs) for the Lower Passaic River. A number of companies that owned or operated facilities on the river formed the Cooperating Parties Group (CPG). In 2004, EPA signed a settlement agreement with the CPG in which the group agreed to pay for EPA to perform the 17-mile Lower Passaic River RI/FS. The settlement agreement was amended in 2005 and 2007, adding more parties to reach a total of over 70 members. In 2007, the CPG entered into a separate administrative order on consent (AOC) in which the group agreed to take over the performance of the 17-mile Lower Passaic River RI/FS from EPA. This RI/FS is ongoing.

In 2002, at the start of the 17-mile Lower Passaic River RI/FS, EPA also formed a partnership with USACE, the State of New Jersey, NOAA and USFWS to conduct a joint study that would bring each agency’s legal authorities to bear on the complex environmental problems of the Lower Passaic River.

In 2004, EPA and OCC signed an AOC in which OCC agreed to conduct a separate RI/FS of Newark Bay, under EPA oversight. As with the 1994 agreement, Tierra is performing the work on OCC’s behalf. This study of Newark Bay is ongoing.

In June 2008, EPA, OCC and Tierra signed an AOC for a non-time-critical removal action to remove 200,000 cubic yards (cy) of contaminated sediment from the river (from RM3.0 to RM3.8) adjacent to the 80-120 Lister Avenue facility. This action is referred to as the "Tierra Removal." Sediment adjacent to the facility has been found to have the highest levels of 2,3,7,8-TCDD measured in the river. Dredging, dewatering and transport off-site of the first 40,000 cy of sediment (known as Phase 1 of the Tierra Removal) was completed in 2012. The AOC contemplates that Phase 2 (160,000 cy) will undergo a separate engineering study and proposal that will be submitted to the public for review and comment at a later date. Both phases of this removal action are considered source removal projects.

In June 2012, EPA and the CPG signed an AOC for a time-critical removal action to address the risks posed by high concentrations of dioxins, PCBs and other contaminants found at the surface of a mudflat on the east bank of the river at RM10.9 in Lyndhurst, New Jersey. This action is referred to as the "RM10.9 Removal." The action involved placing an engineered cap over contaminated sediments, thereby reducing exposure and preventing migration of the contamination to other parts of the river. In order to ensure that the action did not make flooding worse, a sufficient volume of surface sediments was first dredged from the area to make space for the cap. The work began in 2013 and is on-going in 2014. This time-critical removal action is not a final remedy; a final decision for the RM10.9 Removal area will be made by EPA as part of the 17-mile Lower Passaic River RI/FS ROD.

Concurrent with these river studies and removal actions, EPA concluded that expediting the Superfund process for the lower 8.3 miles of the river, which was known to contain the bulk of the contaminated sediment, would best support the overall protection of human health and the environment. Because the majority of fine-grained (and, therefore, more heavily contaminated) sediment was found below RM8.3, EPA undertook a targeted RI and FFS of the lower eight miles, which has led to this Proposed Plan.

WHAT ARE THE "CONTAMINANTS OF CONCERN"?

EPA has identified many hazardous substances in the FFS Study Area sediments. The following eight are Contaminants of Concern or COCs, which pose the greatest potential risks to human health and the environment in the FFS Study Area.

Dioxins and furans are human health and ecological COCs. They are by-products of chemical manufacturing, combustion (either in natural or industrial settings), metal processing and paper manufacturing. The dioxin compound (or congener) known as 2,3,7,8-TCDD (2,3,7,8-tetrachlorodibenzo-p-dioxin is the most toxic form of dioxin) and others were byproducts in the manufacture of "Agent Orange," a defoliant used in the Vietnam War, and other herbicides. Dioxins stay in the environment for a long time and can build up in fish and shellfish. Toxic effects in humans include reproductive problems, problems in fetal development or early childhood, immune system damage and cancer. In animals, effects include developmental and reproductive problems, hemorrhaging and immune system problems.

PCBs are human health and ecological COCs. They are manmade chemicals that were banned in the late 1970s. PCBs are mixtures of up to 209 compounds (or congeners). Some commercial PCB mixtures are known in the United States by an industrial trade name, Aroclor. Because they do not burn easily and are good insulating materials, PCBs were used widely as coolants and oils, and in the manufacture of paints, caulking and building material. PCBs stay in the environment for a long time and can build up in fish and shellfish. PCBs are classified as probable human carcinogens. Children exposed to PCBs may develop learning and behavioral problems later in life. PCBs are known to impact the immune system and may cause cancer in people who have been exposed to them over a long time. In birds and mammals, PCBs can cause adverse effects such as anemia and injuries to the liver, stomach and thyroid gland. PCBs also can cause problems with the immune system, behavioral problems and impaired reproduction.

Mercury is a human health and ecological COC. It is a metal that comes from a variety of sources, including metals processing, burning of coal, medical and other wastes, industrial effluent and atmospheric deposition. Mercury stays in the environment for a long time and can build up in fish and shellfish. Toxic effects in humans include developmental and reproductive problems, and effects on the brain, nervous system and kidney. In birds and mammals, mercury can cause adverse effects in the central nervous system.

DDT and its primary breakdown products, dichlorodiphenyldichloroethane (DDD) and dichlorodiphenyldichloroethylene (DDE), are ecological COCs. DDT is a pesticide that was banned for use in the United States in 1972. It was used widely to control insects on crops and to control mosquitoes that spread malaria. These compounds can build up in fish and shellfish and can cause adverse reproductive effects such as eggshell thinning in birds.

Copper is an ecological COC. It is a metal that enters the environment through releases from factories that make or use copper metal or compounds, leachate from landfills, combustion of fossil fuels, wood processing, fertilizer production and natural sources such as dust from soils, volcanoes and forest fires. Although copper is an essential element at low levels for all organisms, at higher levels it is highly toxic in aquatic environments and can build up in fish and shellfish. Copper can cause adverse effects in fish, invertebrates and amphibians. Copper also impacts growth, development and causes organ problems in birds and mammals.

Dieldrin is an ecological COC. It is a pesticide that is no longer produced or used, but was once used extensively as an insecticide on crops or to control termites. It can build up in fish and shellfish. Dieldrin is highly toxic to aquatic crustaceans and fish. Dieldrin also causes liver damage, central nervous system effects and suppression of the immune system in mammals and egg shell thinning in birds.

PAHs are ecological COCs. These chemicals are a major component of petroleum products, or are formed during incomplete burning of coal, oil, gas, wood or other substances. PAH molecules are composed of two or more carbon and hydrogen rings. Low molecular weight (LMW) PAHs have two to three rings, while high molecular weight (HMW) PAHs have more than three rings. There are more than 100 different PAHs, which generally occur as complex mixtures. PAHs are toxic to invertebrates and cause inhibited reproduction, delayed emergence, sediment avoidance and mortality. In fish, PAHs cause liver abnormalities and impairment of the immune system. PAHs can cause adverse effects on reproduction, development and immunity in birds and mammals.

Lead is an ecological COC. Lead occurs naturally in the environment, but most of the higher levels found in the environment come from mining or factories that use lead compounds. Lead is also released into the air during burning of coal, oil or waste. Lead can cause muscular and neurological effects in fish. It is also toxic to invertebrates and can cause damage to the nervous system in birds and mammals.

SITE CHARACTERISTICS

Summary of Sampling Results and Other Investigations

The RI and FFS Reports evaluated contamination in the Lower Passaic River and Newark Bay using data from field investigations that have been conducted from the 1990s through 2013 by federal and state agencies, potentially responsible parties under EPA oversight, such as the CPG and OCC, and academic institutions. The investigations that support this Proposed Plan include: bathymetric, geophysical and geotechnical surveys; river flow and sediment transport studies; sediment erosion studies; sediment sampling for contaminants; water quality studies; fish and crab tissue sampling; habitat surveys; a dredging pilot study; and sampling at combined sewer overflows (CSOs) and stormwater outfalls (SWOs). Additional investigations and modeling were conducted to study the fate and transport of the COCs in the FFS Study Area. The FFS has incorporated the following data from the 17-mile Lower Passaic River RI/FS: 2008 low resolution sediment coring program; 2009-2010 benthic and surface sediment program; 2012 low resolution supplemental sediment sampling program; 2009-2010 physical water column monitoring program; 2010 high-flow water column suspended solids sampling; 2011-2012 chemical water column monitoring program; 2009-2010 fish community and tissue collection surveys; 2010 habitat identification survey; 2010 summer/fall avian community survey; 2007 through 2011 single and multi-beam bathymetric surveys; 2011-2012 River Mile 10.9 sampling; and 2012 background benthic sediment sampling. More detail can be found in the RI Report for the FFS Study Area and other documents in the administrative record file.

Sediment Conceptual Site Model

The Lower Passaic River is a two-layer estuary. The tides drive a wedge of denser salt water from Newark Bay north into the river along the bottom part of the water column, under a top layer of fresher water flowing in from the Upper Passaic River over Dundee Dam. Near the upstream limit of the salt wedge, where it meets the freshwater flow, turbulence creates a cloud of suspended sediments resulting in elevated suspended sediment concentrations in part or all of the water column, depending on flow conditions. During low flow conditions, the salt wedge and suspended sediment cloud can reach as far upstream as approximately RM12, while during storm events they may be pushed out to Newark Bay. Under typical flow conditions, the salt wedge and suspended sediment cloud are located between RM2 and RM10 and move back and forth along about 4 miles of the river each tidal cycle (twice a day). The movement of the salt wedge and suspended sediment cloud causes surface sediments in the river to resuspend and redeposit on each tidal cycle, resulting in longitudinal mixing of the surface sediments. This means that, while there is a broad range of concentration values present at the surface (high values more than 100 times low values), there is little or no trend in COC median surface sediment concentrations with river mile from RM2 to RM12 (see RI Report Figures 4-2, 4-11, 4-17a, 4-32a, 4-47a). In addition, data show that, between RM0 and RM8.3, surface sediments in the navigation channel are as highly contaminated as those in the shoals (see RI Report Figures 4-7, 4-14, 4-23, 4-38, 4-57). In other words, data show that elevated concentrations of COCs are ubiquitous in surface sediments of the FFS Study Area, bank-to-bank.

Maintenance of the navigation channel stopped in some reaches in the 1930s and in much of the rest of the river after 1950 (except in the first two miles and in portions dredged in 1976 as described above), at which time the formerly dredged channel began to fill in. Since many industrial discharges were most active in the decades when the navigation channel was first filling in, the highest contaminant concentrations tend to be found deeper in the sediment bed (see Table 2 or RI Report Figure 4-75). The total estimated inventory of contaminated fine-grained sediments in the FFS Study Area is approximately 9.7 million cy.

Sediment erosion studies show that the shear stress (the force exerted by water flowing along the river bed that causes sediment particles to erode) at which erosion is first observed increases with depth, so that shallow sediments are easily erodible, and sediments are less erodible deeper in the river bed. This is due to the consolidation of deeper sediments over time caused by the weight of overlying sediments.

When maintenance dredging was significantly curtailed after 1950, sediment infilling rates in the navigation channel were relatively high (approximately 4 inches per year) and coincided with a period when industrial discharges were most active, so the deepest sediments are the most highly contaminated. Then, in the 1970s and 1980s, industrial discharges declined as a result of Clean Water Act regulations, and the channel began to fill with less contaminated sediment, leading to a slow decline in concentrations over several feet of sediment. Recently (since the 2000s), much of the channel has filled in and the river has begun to reach a quasi-steady state.

As discussed in more detail below, the surface sediments have the most direct consequences on human health and the environment, so understanding current conditions in the surface sediments and predicting future conditions was a central focus of the FFS. As overall patterns of

Table 2
Contaminants of Concern below 6 Inches

Contaminant Concentrations in Sediment with Depth	0.5 - 1.5 feet		1.5 - 2.5 feet		2.5 - 3.5 feet		3.5 feet – end*	
	Min-Max	Mean (Median)	Min-Max	Mean (Median)	Min-Max	Mean (Median)	Min-Max	Mean (Median)
2,3,7,8-TCDD (pg/g or ppt)	0.29 - 50,400	1,900 (400)	0.26 - 77,900	3,620 (520)	0.46 - 932,000	9,900 (470)	0.07 - 5,300,000	19,300 (280)
Total TCDD (pg/g or ppt)	0.032 - 27,700	1,920 (500)	0.11 - 60,200	3,390 (620)	0.021 - 67,900	3,670 (790)	0.021 - 2,760,000	12,400 (380)
Total PCBs (ug/kg or ppb)	0.15 - 33,000	2,940 (1,640)	0.33 - 1,800	3,570 (1,880)	0.0062 - 29,960	4,050 (1,650)	0.00059 - 133,000	3,360 (940)
Total DDT (ug/kg or ppb)	0.024 - 1,800	230 (120)	0.04 - 30,800	580 (130)	0.02 - 7,800	460 (180)	0.0038 - 14,000,000	29,300 (120)
Dieldrin (ug/kg or ppb)	0.019 - 250	15 (3.6)	0.024 - 250	17 (3.9)	0.0014 - 580	25 (3.9)	0.0016 -1,000	27 (3.0)
Total PAHs (mg/kg or ppm)	0.006 - 6,500	73 (30)	0.0013 - 7,750	140 (32)	0.0011 - 720	45 (29)	0.00032 - 1,270	64 (33)
Mercury (mg/kg or ppm)	0.0034 - 28	4.6 (3.7)	0.017 - 29	5.9 (4.4)	0.01 - 28	5.9 (4.8)	0.0016 - 30	6.6 (5.5)
Copper (mg/kg or ppm)	1.5 - 3,020	270 (220)	3.4 - 1,210	290 (270)	2.3 - 1,040	280 (280)	2.1 - 4,700	330 (310)
Lead (mg/kg or ppm)	1.9 - 17,900	460 (340)	1.7 - 1,100	430 (410)	1.7 - 980	410 (420)	1.0 - 7,860	430 (460)

Based on 1990-2012 data
* Depth of cores is highly variable, but averages about 12 to 20 feet.

infilling have slowed considerably and alternated with some scouring during high flow events, this quasi-steady state condition means that the river is no longer steadily filling with "cleaner" sediments from elsewhere. Daily tidal action resuspends and redeposits the contaminated surface sediments, while occasional scouring during high flow events uncovers and resuspends deeper, more highly-contaminated sediments.

The RI and FFS assessed the degree to which filling with newer, "cleaner" sediments from elsewhere, a process called natural recovery, might allow the river to improve on its own. Contaminant concentrations in approximately the top two feet of sediments have declined extremely slowly in recent years. Sampling from 1995 through 2012 confirms that FFS Study Area surface sediment median contaminant concentrations have remained almost unchanged over that 17-year period (see RI Report Figures 4-8, 4-15, 4-26, 4-41, 4-62) even though industrial sources along the river have declined and generally ceased discharging.

Based on analyses discussed in the RI Report for the FFS Study Area, direct atmospheric deposition, groundwater discharge and industrial point sources currently are not significant contributors to the FFS Study Area of sediments and the contaminants bound to them. The Upper Passaic River, Newark Bay, the three main tributaries, and CSOs and SWOs were sampled between 2005 and 2011. A mass balance of suspended sediment and contaminant loads was performed with the data (a mass balance assumes that the sum of contaminants coming into the water column from various sources must equal the sum of contaminants going out of the water column). Results show that the tributaries, CSOs and SWOs are minor contributors of COCs, since they are minor contributors of sediments compared to the Upper Passaic River and Newark Bay, and the concentrations of contaminants bound to those sediments are low compared to the surface sediments of the Lower Passaic River main stem. Contributions from the various sources are summarized in Table 3.

The daily movement of contaminated surface sediment combined with the occasional uncovering and resuspension of deeper, more highly-contaminated sediments in the FFS Study Area are the primary ongoing source of COCs to the water column and surface sediments of the Lower Passaic River.

Fish and Crab Tissue

In the FFS Study Area, contaminant concentrations in fish and crab tissue have similar patterns and

Table 3
Percent Contributions from Various Sources to Recently-Deposited Surface Sediments of Lower Passaic River

	Upper Passaic River	Newark Bay	Tributaries	CSOs-SWOs	Lower Passaic River Resuspension
Solids	32	14	6	1	48
2,3,7,8-TCDD	0	3	0	0	97
Total TCDD	3	5	0	0	92
Total PCBs	11	6	1	0	81
DDE	10	8	3	1	78
Copper	14	12	1	1	72
Mercury	11	14	0	0	75
Lead	19	7	2	2	71
Benzo(a)pyrene	53	7	5	1	33
Fluoranthene	47	5	6	2	40

Notes: All numbers represent percent of total mass for each contaminant.
Benzo(a)pyrene and Fluoranthene are PAHs.

trends to those observed in the surface sediments. Spatially, there is a broad range of contaminant concentrations in fish and crab tissue (high values more than 10 times low values), but there is little or no trend in COC median concentrations with river mile (see Appendix A of the RI and FFS Reports, Data Evaluation Report No. 6, Figures 2-1 through 2-4).

Lipid-normalized contaminant concentrations[2] in fish and crab tissue have not consistently increased or decreased with time from 1999 to 2010, consistent with surface sediment COC concentrations, which also have remained almost unchanged over approximately the same time period. Concentrations of one contaminant may increase over time in one species, while decreasing in another species, or even tissue type (see Appendix A of the RI and FFS Reports, Data Evaluation Report No. 6, Figure 2-12). The lack of consistent trends over time across species and tissue type, as well as the lack of trend with river mile indicate that variations in contaminant concentrations in fish and crab tissue do not represent variations in the sediment COC concentrations to which the fish or crab are exposed, but are probably attributable to factors such as analytical differences among studies, variations in sample types (e.g., variations in number, size, age or tissue type of specimens in a typical sample), seasonal variations in the time of collection or other environmental factors not related to long-term trends in sediment contamination.

SCOPE AND ROLE OF THE ACTION

The Diamond Alkali Site, of which the Lower Passaic River is a part, is being addressed by EPA with phased response activities, including removal actions and operable units. EPA typically addresses sources first, which at this Site includes the interim remedy at the 80-120 Lister Avenue facility, the Tierra Removal and the RM10.9 Removal.

The Operable Units of the Diamond Alkali Superfund Site are the 80-120 Lister Avenue facility, the FFS Study Area, the Lower Passaic River Study Area and the Newark Bay Study Area (Figure 1). This Proposed Plan addresses the risks associated with the contaminated sediments of the lower 8.3 miles of the river (FFS Study Area). EPA expects to select a remedy for the FFS Study Area after considering comments on this Proposed Plan, which will be the final action for the sediments of the FFS Study Area and an interim action for the water column. After completion of the on-going RI/FS for the 17-mile Lower Passaic River Study Area, EPA expects to select a remedy that addresses the entire Lower Passaic River, including the water column. The on-going Newark Bay Study Area RI/FS is expected to be completed subsequently.

EPA has determined that the remedy for the FFS Study Area will be consistent with the expected remedies for the Lower Passaic River and Newark Bay Study Areas for reasons discussed below.

EPA investigated potential COC sources to the Lower Passaic River, including atmospheric deposition, groundwater, industrial point sources, Upper Passaic River, Newark Bay, major tributaries, CSOs and SWOs. Data and screening level analyses show that those sources are minor contributors of most of the COCs when compared to the resuspension of sediments in the FFS Study Area.

The primary objective of this action is to address the contaminated sediments in the FFS Study Area. Addressing these sediments would reduce COC concentrations in biota including fish and crab tissue, thereby significantly reducing potential human health and ecological risks. In addition, remediation of FFS Study Area sediment would reduce this major on-going source of contaminants

[2] Tissue contaminant concentrations were normalized by lipid concentrations (i.e., each tissue contaminant concentration was divided by the lipid concentration of the fish analyzed) in order to focus on changes in tissue contaminant concentrations over time that are not related solely to changes in lipid concentrations over time. Lipid content is a measure of the amount of fats and oils in the fish and crab tissue.

to the rest of the Lower Passaic River, Newark Bay and the New York-New Jersey Harbor Estuary.

The COCs tend to bind tightly to fine sediment particles (*e.g.*, silts). Therefore, the highest concentrations of COCs tend to be found in areas that are predominantly comprised of silts, which, for the Lower Passaic River, are the lower 8.3 miles, i.e., the FFS Study Area. As described in the "Site Characteristics" section above, sediment sampling data show that elevated concentrations of COCs are found throughout the surface sediments of the FFS Study Area, bank-to-bank. Data further show that median concentrations of COCs in surface sediments have remained almost unchanged in the last 17 years (1995-2012). Any remedy for the lower 8.3 miles selected by EPA at the conclusion of the comprehensive study of the 17-mile Lower Passaic River would need to take into account the toxic and persistent nature of the COCs that exist bank-to-bank in the lower 8.3 miles. Given that the proposed FFS Study Area remedy: (1) addresses the part of the 17-mile Lower Passaic River that contains a majority of the sediments to which COCs tend to bind; and (2) is based on the physical characteristics of sediment texture, supported by chemical data on the spatial and temporal extent of contamination, EPA has concluded that a FFS Study Area remedy would be consistent with the remedy likely to be selected for the 17-mile Lower Passaic River.

Given the complexity and uncertainty involved with remediating sediment sites, especially at such a large scale, EPA expects to employ an adaptive management approach during the remedial design and implementation of the remedy. This will allow for appropriate adjustments to ensure efficient and effective remediation. This will ensure that uncertainties are promptly and effectively addressed, inform specific design decisions, and address concerns about how this action will be integrated with the ongoing RI/FS for the 17 miles Lower Passaic River Study Area.

The identification of principal and low level threats is made on a site-specific basis to help streamline and focus waste management options by categorizing the suitability of the waste for treatment or containment. Principal threat wastes include source materials that are considered highly toxic. The NCP states that EPA expects to use treatment to address principal threats posed by a site whenever practicable.

The dioxin, PCB and other COC concentrations in sediments throughout the FFS Study Area are present at levels contributing to 10^{-3} risks for humans consuming fish and crab caught in the FFS Study Area. Although the engineering and sediment transport modeling work done as part of the FFS has determined that the sediment, despite its toxicity, under current conditions, can be reliably contained, EPA nevertheless considers the most highly contaminated sediments as principal threat wastes at the site.

EPA has considered treatment as a component of dredged material management. However, EPA does not believe that additional treatment of all the sediment in the FFS Study Area is practicable or cost effective given the high volume of sediment and the number of COCs that would need to be addressed and lack of applicable in-situ treatment technologies.

SUMMARY OF SITE RISKS

A baseline risk assessment was conducted for the FFS Study Area to estimate the risks associated with current and future site conditions. The baseline risk assessment is detailed in Appendix D of the RI and FFS Reports.

Human Health Risk Assessment

A Human Health Risk Assessment (HHRA) was conducted to assess the cancer risks and non-cancer health hazards associated with exposure to COCs in the FFS Study Area (see "What Is Risk and How Is It Calculated," below). Based on the results of Superfund HHRAs conducted for other river sites with bioaccumulative COCs, such as dioxins and PCBs, consumption of fish and shellfish (e.g., crabs) is anticipated to be associated with the highest cancer risks and non-cancer health hazards compared to ingestion, dermal contact or inhalation of chemicals in surface water or sediment during recreational exposures. Despite NJDEP's fish and crab consumption advisories, and prohibitions on taking blue crabs in the Newark Bay Complex, numerous published studies show that people are catching and eating fish and crab along the banks of the Lower Passaic River and Newark Bay. Therefore, the FFS evaluated the potential risks to the adult angler/sportsman and other family members (i.e., an adolescent aged 7 to 18 years and a child aged 1 to 6 years) who eat self-caught fish and crab from the FFS Study Area.

Exposure pathways other than fish or crab consumption (such as recreational use of the river) are being evaluated in the 17-mile Lower Passaic River RI/FS.

The HHRA evaluated risks to human health under current and future land use scenarios. Consistent with EPA guidance, the HHRA evaluated risks without taking into consideration the current NJDEP fish and crab consumption advisories. Both a reasonable maximum exposure (RME) and a central tendency exposure (CTE) were evaluated to describe the magnitude and range of exposure that might be experienced by the angler and family members. Risk decisions are based on the RME, consistent with the NCP. The HHRA assumed that the angler and family members would eat self-caught fish and crab at the rates shown in the table below. Using the "meals per year" terminology in NJDEP fish and crab consumption advisories, the adult fish consumption rate of 34.6 grams/day is equivalent to 56 eight-ounce fish meals per year, and the adult crab consumption rate of 20.9 grams/day is equivalent to 34 eight-ounce crab meals per year. These rates were based on studies of anglers conducted in the Lower Passaic River, Newark Bay and New York-New Jersey Harbor Estuary. The adult ingestion rates were adjusted to reflect the lower bodyweights of the adolescent and young child. The rates are consistent with

WHAT IS HUMAN HEALTH RISK AND HOW IS IT CALCULATED?

A Superfund baseline human health risk assessment is an analysis of the potential adverse health effects caused by hazardous substance releases from a Site in the absence of any actions to control or mitigate these under current and future land uses. A four-step process is used for assessing site-related human health risks for reasonable maximum exposure scenarios.

Hazard Identification: In this step, the contaminants of potential concern (COPCs) at the Site in various media (*i.e.*, soil, groundwater, surface water, and air) are identified based on such factors as toxicity, frequency of occurrence, and fate and transport of the contaminants in the environment, concentrations of the contaminants in specific media, mobility, persistence, and bioaccumulation.

Exposure Assessment: In this step, the different exposure pathways through which people might be exposed to the contaminants identified in the previous step are evaluated. Examples of exposure pathways include ingestion of contaminated fish or crab, incidental ingestion of and dermal contact with contaminated sediment and ingestion of and dermal contact with contaminated surface or groundwater. Factors relating to the exposure assessment include, but are not limited to, the concentrations in specific media that people might be exposed to and the frequency and duration of that exposure. Using these factors, a "reasonable maximum exposure" (RME) scenario, which portrays the highest level of human exposure that could reasonably be expected to occur, is calculated. A "central tendency exposure" (CTE) scenario is also calculated, which shows an average level of human exposure.

Toxicity Assessment: In this step, the types of adverse health effects associated with chemical exposures and the relationship between magnitude of exposure (dose) and severity of adverse effects (response) are determined. Potential health effects are chemical-specific and may include the risk of developing cancer over a lifetime or other non-cancer health hazards, such as changes in the normal functions of organs within the body (e.g., changes in the effectiveness of the immune system). Some chemicals are capable of causing both cancer and non-cancer health hazards.

Risk Characterization: This step summarizes and combines outputs of the exposure and toxicity assessments to provide a quantitative assessment of site risks for all COPCs. Exposures are evaluated based on the potential risk of developing cancer and the potential for non-cancer health hazards. The likelihood of an individual developing cancer is expressed as a probability. For example, a 10^{-4} cancer risk means a "one in ten thousand excess cancer risk"; or one additional cancer may be seen in a population of 10,000 people as a result of exposure to site contaminants under the conditions identified in the Exposure Assessment. Current Superfund regulations for exposures identify the range for determining whether remedial action is necessary as an individual excess lifetime cancer risk of 10^{-4} to 10^{-6}, corresponding to a one-in-ten-thousand to a one-in-a-million excess cancer risk. For non-cancer health effects, a "hazard index" (HI) is calculated. The key concept for a non-cancer HI is that a threshold (measured as an HI of less than or equal to 1) exists below which non-cancer health hazards are not expected to occur. The goal of protection is 10^{-6} for cancer risk and an HI of 1 for a non-cancer health hazard. Chemicals that exceed a 10^{-4} cancer risk or an HI of 1 are typically those that will require remedial action at a site and are referred to as contaminants of concern (COCs) in the ROD.

those to be used in the 17-mile Lower Passaic River RI/FS.

	Adult [grams/day]		Adolescent [grams/day]		Child [grams/day]	
	Fish	Crab	Fish	Crab	Fish	Crab
RME	34.6	20.9	23.1	13.9	11.5	7.0
CTE	3.9	3.0	2.6	2.0	1.3	1.0

The results for cancer risks from the HHRA are summarized in the table below. For the RME adult and child, a cancer risk of $5x10^{-3}$ for fish or $2x10^{-3}$ for crab means that eating fish or crab from the FFS Study Area may cause five additional cancers in a population of 1,000 people or two additional cancers in 1,000 people, respectively. All of the RME risks are greater than the goal of protection established in the NCP of $1x10^{-6}$ (i.e., one additional cancer in 1,000,000 people). All of the RMEs are also greater than the $1x10^{-4}$ cancer risk that typically would require remedial action at a site.

	Cancer Risk to Adult and Child		Cancer Risk to Adolescent	
	Fish	Crab	Fish	Crab
RME	5×10^{-3}	2×10^{-3}	2×10^{-3}	6×10^{-4}
CTE	1×10^{-4}	1×10^{-4}	5×10^{-5}	4×10^{-5}

The results for non-cancer health hazards from the HHRA are summarized in the table below. For the RME child who eats fish or crab from the FFS Study Area, the health hazard results indicate exposure to contaminant concentrations that are 195 or 67 times higher, respectively, than chemical specific reference doses. All of the RME hazards are much higher than EPA's goal of protection of a HI of less than or equal to 1.

	Non-Cancer Hazard to Adult		Non-Cancer Hazard to Adolescent		Non-Cancer Hazard to Child	
	Fish	Crab	Fish	Crab	Fish	Crab
RME	126	43	113	38	195	67
CTE	8	6	8	5	13	9

Dioxins and furans and PCBs are the primary contributors to the human health cancer risk and non-cancer health hazard for ingestion of fish and crab, with mercury another contributor.

Ecological Risk Assessment (ERA)

Although the FFS Study Area is in a densely-populated urban area, a wide range of ecological receptors may be exposed to COCs, including the following:

- Benthic invertebrates (represented by worms that live in/on the sediment and blue crab);
- Forage fish (represented by mummichog);
- Predatory fish (represented by white perch and American eel);
- Water-dependent birds (represented by great blue heron); and
- Water-dependent mammals (represented by mink).

The receptors listed above were evaluated for exposure to COCs through direct contact with and incidental ingestion of sediments, as well as ingestion of contaminated prey. To assess exposures to early life stages (the most sensitive to dioxin-like effects), fish and herring gull embryo viability was also evaluated. The ERA evaluated potential risks to receptors under current and future use scenarios. An ERA quantifies risk to different potentially exposed ecological receptors as a Hazard Quotient (HQ). If an HQ is calculated to be equal to or less than 1, then no adverse health effects are expected as a result of exposure. If the HQ is greater than 1, then adverse health effects are possible.

Risks to benthic invertebrates were evaluated two ways: first, for worms, by comparing sediment contaminant concentrations to literature values (called sediment benchmarks) that represent health-protective concentrations (one conservative and one less conservative). In the FFS Study Area, sediment concentrations for all COCs exceeded the sediment benchmarks. Based on the magnitude of exceedance of sediment benchmarks, dioxins (HQs of 300), DDT (HQs of 6 to 200), PCBs (HQs of 6 to 60), PAHs (HQs of 5 to 40), dieldrin (HQs of 5 to 20) and mercury (HQs of 5 to 20) contribute most substantially to risks to worms. Second, for crabs, a comparison was made between crab tissue concentrations and literature values called critical body residues, again representing health-protective concentrations. FFS Study Area crab tissue concentrations were higher than critical body residues for copper, mercury, PCBs and dioxins. Based on the magnitude of exceedance of critical body residues, dioxins (HQs of 40 to 400) and PCBs (HQs of 10 to 40) contribute most substantially to risks to crabs.

For fish, FFS Study Area tissue concentrations were higher than critical body residues for copper, PCBs and dioxins. Estimates of fish egg concentrations were greater than egg critical body residues for dioxins.

Risks to water-dependent birds and mammals were evaluated by modeling the potential daily doses of COCs that these receptors might be exposed to from eating food (prey) and from incidental ingestion of sediment. The modeled daily doses were compared to literature values called toxicological reference values that represent health-protective concentrations. For the heron consuming fish, only dioxin-modeled daily doses exceeded the toxicological reference values. The contaminant concentrations in eggs from fish-eating birds substantially exceeded literature values (critical body residues) for PCBs, dioxins and DDT. For the mink, modeled daily doses were higher than toxicological reference values for dioxins (HQs of 30 to 900), PCBs (HQs of 4 to 100) and mercury (HQs of 2 to 4).

WHAT IS *ECOLOGICAL* RISK AND HOW IS IT CALCULATED?

A Superfund baseline ecological risk assessment is an analysis of the potential adverse health effects to biota caused by hazardous substance releases from a site in the absence of any actions to control or mitigate these under current and future land and resource uses. The process used for assessing site-related ecological risks includes:

Problem Formulation: In this step, the contaminants of potential ecological concern (COPECs) at the site are identified. Assessment endpoints are defined to determine what ecological entities are important to protect. Then, the specific attributes of the entities that are potentially at risk and important to protect are determined. This provides a basis for measurement in the risk assessment. Once assessment endpoints are chosen, a conceptual model is developed to provide a visual representation of hypothesized relationships between ecological entities (receptors) and the stressors to which they may be exposed.

Exposure Assessment: In this step, a quantitative evaluation is made of what plants and animals are exposed to and to what degree they are exposed. This estimation of exposure point concentrations includes various parameters to determine the levels of exposure to a chemical contaminant by a selected plant or animal (receptor), such as area use (how much of the site an animal typically uses during normal activities); food ingestion rate (how much food is consumed by an animal over a period of time); bioaccumulation rates (the process by which chemicals are taken up by a plant or animal either directly from exposure to contaminated soil, sediment or water, or by eating contaminated food); bioavailability (how easily a plant or animal can take up a contaminant from the environment); and life stage (e.g., juvenile, adult).

Ecological Effects Assessment: In this step, literature reviews, field studies or toxicity tests are conducted to describe the relationship between chemical contaminant concentrations and their effects on ecological receptors, on a media-, receptor- and chemical-specific basis. In order to provide upper and lower bound estimates of risk, toxicological benchmarks are identified to describe the level of contamination below which adverse effects are unlikely to occur and the level of contamination at which adverse effects are more likely to occur.

Risk Characterization: In this step, the results of the previous steps are used to estimate the risk posed to ecological receptors. Individual risk estimates for a given receptor for each chemical are calculated as a hazard quotient (HQ), which is the ratio of contaminant concentration to a given toxicological benchmark. In general, an HQ above 1 indicates the potential for unacceptable risk. The risk is described, including the overall degree of confidence in the risk estimates, summarizing uncertainties, citing evidence supporting the risk estimates and interpreting the adversity of ecological effects.

Conclusion

Based on the results of the remedial investigation and the risk assessments, EPA has determined that the preferred alternative identified in this Proposed Plan, or one of the other active measures considered in the Proposed Plan, is necessary to protect public health or welfare and the environment from actual or threatened releases of hazardous substances into the environment.

REMEDIAL ACTION OBJECTIVES

Remedial action objectives (RAOs) describe what the proposed site cleanup is expected to accomplish. The following RAOs have been established for the FFS Study Area:

- Reduce cancer risks and non-cancer health hazards for people eating fish and shellfish by reducing the concentrations of COCs in the sediments of the FFS Study Area.

- Reduce the risks to ecological receptors by reducing the concentrations of COCs in the sediments of the FFS Study Area.

- Reduce the migration of COC-contaminated sediments from the FFS Study Area to upstream portions of the Lower Passaic River and to Newark Bay and the New York-New Jersey Harbor Estuary.

According to Superfund guidance, reasonably anticipated future land and waterway uses in the FFS Study Area should be considered during the development of remedial alternatives and remedy selection. Except for the two miles closest to Newark Bay, the federally-authorized navigation channel in the FFS Study Area has not been regularly maintained since 1950. The lowest two miles were last dredged in 1983. Various physical constraints, such as shallow depths and low vertical clearance bridges, limit commercial use of most of the navigation channel. However, the lower two miles of the river are used for commercial navigation by a number of companies. A berth-by-berth analysis for 1997-2006 done by USACE establishes current waterway use, and a 2010 USACE survey of commercial users showed future waterway use objectives in the lower 2.2 miles of the river. In a February 6, 2014 letter, USACE confirmed that “USEPA’s remedial action is critical to restoring the navigation channel for the viability and economic sustainability of the area and its users.”

In addition, the communities along the banks of the FFS Study Area have clearly planned for future increases in recreational access to the river, particularly above RM2.2, through master plans. Increasing recreational access to the FFS Study Area will result in recreational reasonably anticipated future uses above RM2.2.

Preliminary Remediation Goals

There are no federal or State of New Jersey cleanup standards for the COCs in sediment. Therefore, site-specific preliminary remediation goals (PRGs) for FFS Study Area sediments were developed. PRGs are used to define the extent of cleanup needed to achieve RAOs.

Human Health PRGs. Risk-based human health concentrations were developed first as tissue concentrations of COCs (dioxins, PCBs and mercury) that would allow adult anglers to eat self-caught fish or crab from the FFS Study Area without incurring a cancer risk above 10^{-6} and a non-cancer health hazard above 1, which is EPA's goal of protection (see Table 4). Protective concentrations in tissue were also developed for a cancer risk of 10^{-4}, which is typically the level that requires remedial action at a site. Protective concentrations in fish and crab tissue were calculated based on the site-specific adult consumption rates of 34.6 g/day for fish and 20.9 g/day for crab used in the HHRA. These consumption rates are equivalent to 56 eight-ounce fish meals per year and 34 eight-ounce crab meals per year. Additional risk-based tissue concentrations were developed for 12 eight-ounce fish or crab meals per year, for use as interim remediation milestones (Table 4, columns 8-10). Interim remediation milestones are contaminant levels that will be used during monitoring after remedy implementation to evaluate if contaminant concentrations in sediment, fish and crab tissue are decreasing as expected. It is expected that as fish and crab tissue levels decrease, EPA will be able to recommend to NJDEP that institutional controls be adjusted to increase consumption rates.

Then, sediment concentrations needed to meet protective fish and crab tissue concentrations were estimated using site-specific non-linear regressions that showed the relationship between COC concentrations in sediments and co-located fish or crab tissue concentrations. That relationship between sediment and tissue concentrations takes into account the possibility that some of the fish or crab may have been exposed to contamination outside of the FFS Study Area, and is consistent with research showing that tissue concentrations may not be reduced at the same rate as sediment concentrations after sediments are remediated. These are the risk-based sediment PRGs for human health (Table 5, columns 3-8 and 12-13).

Ecological PRGs. While all of the COCs discussed in the "Ecological Risk Assessment" section cause unacceptable risks (HQ greater than 1) to some or all of the receptors evaluated, risk-based PRGs were developed for dioxins, PCBs, mercury and DDT, because they are representative COCs (based on the magnitude of HQs and number of receptors affected) and because there were multiple lines of evidence developed to evaluate how the alternatives would achieve PRGs for these four COCs after remediation. In addition, most active alternatives (i.e., alternatives other than No Action) designed to address these COCs would also address the other COCs.

Table 4
Fish and Crab Tissue Concentrations Protective of the Adult Angler

Contaminant [All Units in ng/g or ppb]	Cancer Risk-Based Tissue Concentrations									Noncancer Hazard-Based Tissue Concentrations		
	56 fish meals per year			34 crab meals per year			12 fish or crab meals per year					
	10^{-6}	10^{-5}	10^{-4}	10^{-6}	10^{-5}	10^{-4}	10^{-6}	10^{-5}	10^{-4}	56 fish meals per year	34 crab meals per year	12 fish or crab meals per year
Mercury	Classification — C; possible human carcinogen; There is no quantitative estimate of carcinogenic risk from oral exposure									200	330	940
Total PCBs	2.9	29	290	4.8	48	480	14	140	1400	40	66	190
2,3,7,8-TCDD	0.000039	0.00039	0.0039	0.000064	0.00064	0.0064	0.00018	0.0018	0.018	0.0014	0.0023	0.0066

All units in ng/g or ppb.

Sediment PRGs that would be protective of benthic invertebrates were developed based on the sediment benchmarks used to evaluate risks in the ERA. The benchmarks are published literature values shown through independent research to be good predictors of toxicity. The overall ecological risk-based PRG for dioxin, one of the risk drivers, is site-specific, in that it is based on reproductive effects data collected in the Newark Bay complex.

Tissue concentrations that would be protective of crab and fish were developed based on the critical body residues used to evaluate risks in the ERA. Tissue concentrations that would be protective of birds and mammals were developed based on the toxicological reference values used to evaluate risks in the ERA. The corresponding sediment concentrations needed for each species to meet the protective tissue concentrations were then estimated using the site-specific non-linear regressions described above (under “Human Health PRGs”).

Table 5 (column 2) presents the overall ecological risk-based sediment PRG for the representative COCs. The overall ecological risk-based PRG for each COC is the lowest of the PRGs developed for each category of receptor, so that all of the organisms, including the most sensitive species, would be protected.

Background Concentrations. The Dundee Dam (RM17.4) physically isolates Dundee Lake and other Upper Passaic River sediments from Lower Passaic River influences. Conditions above Dundee Dam meet EPA’s definition of “background” as constituents or locations that are not influenced by releases from the Site, including both anthropogenic and naturally derived substances. The concentrations of the COCs detected in recently-deposited sediments collected from the Upper Passaic River immediately above Dundee Dam that are representative of current background conditions for the FFS Study Area are as follows (all in ng/g or ppb): mercury 720, PCBs 460, DDT 30, dioxin 0.002, copper 63,000, lead 130,000, LMW PAHs 7,900, HMW PAHs 53,000 and dieldrin 5. While the Superfund program generally does not clean up to concentrations below natural or anthropogenic background levels, in the Lower Passaic River the flow of water and suspended sediment over Dundee Dam is just one of many sources of surface water and sediment into the FFS Study Area. Sediment particles coming from above Dundee Dam make up about one third of particles in the FFS Study Area water column. When those particles flow down to the FFS Study Area, they mix with the other particles in the system (including cleaner particles in the water column that would result from a remediated FFS

Table 5
Human Health and Ecological Risk-Based Sediment PRGs and Remediation Goals

Contaminant [All Units in ng/g]	Overall Eco Sediment PRG	Cancer Threshold Sediment PRG for an Adult									Noncancer Threshold Sediment PRG		
		56 fish meals per year			34 crab meals per year			12 fish or crab meals per year					
		10^{-6}	10^{-5}	10^{-4}	10^{-6}	10^{-5}	10^{-4}	10^{-6}	10^{-5}	10^{-4}	56 fish meals per year	34 crab meals per year	12 fish or crab meals per year
Mercury	**74**	Classification — C; possible human carcinogen; There is no quantitative estimate of carcinogenic risk from oral exposure									550	45,000	67,000
Total PCBs	7.8	3.2	32	320	1.6	51	1600	13	170	2000	**44**	82	230
Total DDT	**0.30**	-	-	-	-	-	-	-	-	-	-	-	-
2,3,7,8-TCDD	0.0011	0.000095	0.0016	0.022	0.00043	0.005	0.058	0.0008	0.012	0.19	**0.0071**	0.019	0.059

All units in ng/g or ppb.
Bolded numbers are remediation goals.

Study Area); after they are deposited, they also mix with the clean material placed on the river bed as part of remediation. So contamination in the top six inches (the bioactive zone) should end up being much less than background concentrations coming over Dundee Dam. Furthermore, future background conditions are expected to continue to improve as a result of source controls and restoration activities under the other operable units and under other local, state and federal authorities.

Selected Remediation Goals

PRGs become final remediation goals when EPA makes a final decision to select a remedy for the FFS Study Area, after taking into consideration all public comments. According to EPA guidance, the starting point for setting remediation goals is a risk level of 10^{-6} and a non-cancer HI equal to one for protection of human health and the lowest ecological PRG set to protect the various ecological receptors evaluated at an HQ equal to one. However, remedial action at a site may achieve remediation goals set anywhere within the range of 10^{-4} to 10^{-6} and HI at or below 1. The remediation goals for the FFS Study Area are summarized in Table 5 (bolded numbers). For the COCs with human health PRGs, the remediation goals are within the risk range and at or below an HI equal to 1, so they are protective of human health. For mercury and DDT, the remediation goals are at an HQ equal to 1, so they are indicators of environmental improvement. EPA's analysis indicates that surface sediment concentrations would fluctuate around or very near the remediation goals under at least two of the active alternatives described below in the "Description of Alternatives" section, in conjunction with natural recovery processes. For dioxins and PCBs, it is unlikely that the ecological PRGs could be met under any of the alternatives within a reasonable time frame, even with natural recovery processes. However, given that bank-to-bank remediation of the FFS Study Area would be necessary to achieve protection of human health (see "Long Term Effectiveness and Permanence" section below), the ecological PRGs would not result in any additional remediation in the FFS Study Area, and those ecological PRGs were not selected as remediation goals.

SUMMARY OF REMEDIAL ALTERNATIVES

CERCLA § 121(b)(1), 42 U.S.C. § 9621(b)(1), mandates that remedial actions must be protective of human health and the environment, be cost-effective, and use permanent solutions and alternative treatment technologies and resource recovery alternatives to the maximum extent practicable. Section 121(b)(1) also establishes a preference for remedial actions which employ, as a principal element, treatment to permanently and significantly reduce the volume, toxicity, or mobility of the hazardous substances, pollutants and contaminants at a site. CERCLA § 121(d), 42 U.S.C. § 9621(d), further specifies that a remedial action must require a level or standard of control of the hazardous substances, pollutants, and contaminants, which at least attains applicable or relevant and appropriate requirements (ARARs) under federal and state laws, unless a waiver can be justified pursuant to CERCLA § 121(d)(4), 42 U.S.C. § 9621(d)(4). Detailed information about the remedial alternatives is provided in the FFS Report.

Common Elements of the Active Alternatives

Four remedial alternatives were evaluated in detail (described in the next section). All of the active alternatives (i.e., alternatives other than "No Action") contain some common elements, as described below. In addition, the cost of each of the active alternatives has been estimated for each of the three dredged material management (DMM) scenarios described below on page 21. Because Alternatives 3 and 4, and Alternative 2 when paired with DMM Scenario A, would result in some contaminants remaining on site above levels that would allow for unrestricted use, five-year reviews would be conducted.

Institutional Controls: NJDEP fish and crab consumption advisories currently in place would continue under all of the alternatives. Each active alternative would include enhanced outreach efforts conducted in every municipality on both shores of the FFS Study Area to educate community members about the NJDEP consumption advisories and to emphasize that advisories will remain in place during and after remediation until remediation goals are reached. For the active alternatives that rely on an engineered cap for protectiveness, additional institutional controls would be necessary to maintain cap integrity in perpetuity. Such controls might include: prohibitions on anchoring vessels within the FFS Study Area to prevent damage to the cap; restrictions on construction and dredging in the FFS Study Area except in the federally-authorized navigation channel; restrictions on construction and dredging below the depths of the federally-authorized navigation channel; and/or bulkhead maintenance agreements or deed restrictions in the FFS Study Area that specify or limit what can be done with regard to bulkhead construction or repair. Additional institutional controls could be developed during remedial design.

Dredging: Dredging is an element of all of the active alternatives. Large debris would be removed first. The FFS assumed that dredging would occur using a mechanical dredge fitted with an environmental clamshell bucket, although costs for a hydraulic dredge were also estimated. Once a remedy has been selected, the most appropriate and effective equipment will be determined during the design phase and used during construction. The FFS assumed use of two primary mechanical dredges equipped with 8-cy environmental clamshell buckets. The production rate for each of the two dredges was conservatively estimated to be 2,000 cy per 24-hour day, based on a test of environmental dredging conducted in the FFS Study Area by USACE and NJDOT in 2005. A secondary dredge would operate at a lower production rate around obstructions such as bridge abutments and bulkheads. Dredging was assumed to occur for 40 weeks per year to account for equipment maintenance, weather and a period during which work may halt to allow for fish migration (known as a fish window). During the remedy design, a fish migration study would be conducted to better define the fish window.

Capping or Backfilling: Capping and/or backfilling are elements of all of the active alternatives. Both capping and backfill material would consist of coarse-grained sand from nearby borrow sources. The term backfill is used for sand placed on the river bed after all contaminated fine-grained sediments have been removed (e.g., in Alternative 2 and in RM0.0 to RM1.2 in Alternative 3, as described below). The sand layer's purpose is to mitigate the impact of any residual[3] fine-grained sediment remaining after dredging. For cost-estimation purposes, the FFS assumed an average 2-foot backfill layer. Backfill would not be maintained after placement, since the intent is not to leave behind any inventory of contaminated sediments that could become mobile.

[3] Dredging residuals are the small amounts of contaminated sediments that are inevitably left behind after dredging.

DREDGED MATERIAL MANAGEMENT (DMM): THREE SCENARIOS

DMM Scenario A: Contained Aquatic Disposal (CAD). CAD cells have been proven to be a viable disposal option at other Superfund sediment sites. They can be a technically viable and cost effective means to dispose of contaminated sediments. The bottom of Newark Bay consists of approximately 60 feet of clay beneath a few feet of silts. In the context of the FFS, CAD cells would be containment pits excavated into the clay bottom that could serve as disposal sites for contaminated sediments dredged out of the FFS Study Area. In this DMM Scenario, multiple CAD cells approximately 50 feet deep would be excavated into the Newark Bay bottom (see FFS Report Figure 4-1). For cost estimation purposes, it was assumed that the clay excavated to create the CAD cells would be disposed of in an ocean disposal area, such as the Historic Area Remediation Site (HARS) in the New York Bight east of Sandy Hook. Final disposal locations would be determined during remedy design. The CAD site would be surrounded by a sheet pile containment system to minimize impacts to Newark Bay during construction and dredged material placement.

The dredged materials would be barged directly to the CAD site in a split hull or bottom dump barge and disposed of in the CAD cells under water. Because Resource Conservation and Recovery Act (RCRA) regulations exclude dredged material that is subject to the requirements of Clean Water Act Section 404 (as this material would be) from the definition of hazardous waste, there is no requirement that FFS Study Area sediments be treated prior to disposal in the CAD cells. After each CAD cell is filled, an engineered cap would be placed over the dredged material as final cover, restoring the Bay bottom.

DMM Scenario B: Off-Site Disposal. Off-Site Disposal includes two components: incinerators and landfills. This is because FFS Study Area sediments have the potential to be characterized as hazardous under RCRA standards. At this time, incineration is the only technology known to be able to treat sediments to the applicable RCRA standards if those sediments are characterized as hazardous under RCRA and contain dioxin as an underlying hazardous constituent at concentrations requiring treatment. Dredged materials characterized as non-hazardous may be disposed of directly in a landfill (for cost assumption purposes, placement in a RCRA Subtitle C landfill was conservatively assumed, since that was the method of disposal for both the Phase 1 Tierra Removal and RM10.9 Removal). The ash generated by incineration can also be disposed of in a RCRA Subtitle C landfill.

The dredged materials would be barged to an upland sediment processing facility in the vicinity of the Lower Passaic River/ Newark Bay shorelines. Debris and sand would be separated for disposal or potential beneficial use. The remaining fine-grained material would be actively dewatered using filter presses or other technology to be determined during remedy design. The contaminated water generated from dewatering would be treated at a water treatment plant at the processing facility to meet NJDEP water quality standards and discharged to the Lower Passaic River or Newark Bay. For cost estimation purposes, it was assumed that the dewatered dredged material would be transported by rail and disposed of as follows: EPA estimates that less than 10 percent (about 30,000 to 790,000 cy depending on the alternative) would require incineration at facilities in the United States or Canada, with the other approximately 90 percent going directly to regulated landfills in the United States or Canada. The ash generated by incineration would be disposed of in a RCRA Subtitle C landfill.

DMM Scenario C: Local Decontamination and Beneficial Use. Local Decontamination and Beneficial Use includes three components: thermal treatment, sediment washing and solidification/stabilization. FFS Study Area sediments have the potential to be characterized as hazardous under RCRA standards. According to pilot tests of the decontamination technologies, only thermal treatment technologies were able to treat sediments to the applicable RCRA standards if those sediments are characterized as hazardous and contain dioxin as an underlying hazardous constituent. Fine-grained dredged materials characterized as non-hazardous could be treated with the sediment washing technology. A small percentage of FFS Study Area sediments may meet New Jersey standards for beneficial use without treatment. It was assumed that this small percentage would be solidified and stabilized with a binding material such as Portland cement, and beneficially used in an industrial setting.

The dredged materials would be barged to an upland sediment processing facility in the vicinity of the Lower Passaic River/ Newark Bay shorelines. Debris and sand would be separated for disposal or potential beneficial use. The portion of the fine-grained material to be decontaminated using thermal treatment and solidification/stabilization would be actively dewatered using filter presses or other technology to be determined during remedy design. The portion of the fine-grained material to be decontaminated using sediment washing would be dewatered after treatment. The contaminated water generated from dewatering would be treated at a water treatment plant at the processing facility to meet NJDEP water quality standards and discharged to the Lower Passaic River or Newark Bay. For cost estimation purposes, it was assumed that 10 percent or less of the dredged materials would require thermal treatment, with beneficial use end-products; approximately 90 percent would undergo sediment washing (and potential solidification/stabilization if necessary) for use as RCRA Subtitle D landfill capping in or out of New Jersey; and the remaining few percent would be expected to pass for industrial beneficial use with only stabilization.

By contrast, the term "capping" is used when an engineered cap is placed over contaminated fine-grained sediments (that have not been dredged) to sequester them (i.e., isolate them from the environment). The engineered cap would consist of sand with varying grain sizes and amounts of organic carbon, whose thickness is designed to provide chemical isolation and to protect against disturbance from bioturbation (mixing of sediment by burrowing organisms), erosion, and consolidation and settling of underlying sediments. Based on modeling results, certain areas of the river may need armoring with stone to reduce the erosion of the sand material particularly after high flow events (exact areas to be determined during remedy design). The engineered cap would need to be monitored and maintained in perpetuity. For cost estimation purposes, the FFS assumed a 2-foot thick engineered cap with 0.5-feet of armor stone in some areas. In the mudflats, the FFS assumed a one-foot thick sand layer with one foot of mudflat reconstruction (habitat) substrate. During remedy design, appropriate enhanced capping technologies, such as additives (e.g., activated carbon or organoclay) to create an active cap or thin-layer capping technologies would be considered in areas where necessary or where conditions are conducive to such approaches. USACE habitat restoration plans for the New York-New Jersey Harbor Estuary could provide additional information on appropriate habitat reconstruction techniques. Re-deposition of fine-grained material in capped and armored areas is anticipated to occur over time, making these areas similar in grain size to non-capped areas. It is anticipated that over time, the re-colonized benthic community would likely be similar to the benthic community currently in the Lower Passaic River.

Removal Actions: All alternatives assume that the Tierra Removal (Phase 1 and 2) and RM10.9 Removal have been implemented, since they are governed by existing agreements. The agreement for Phase 2 of the Tierra Removal contemplates the siting of a confined disposal facility[4] (CDF) as a receptacle for the dredged materials, which has not been done to date. If Phase 2 has not been implemented by the start of the FFS Study Area remediation, then EPA expects that Phase 2 would be implemented in conjunction with the FFS Study Area remedy in a coordinated and consistent manner.

Remedial Alternatives

Alternative 1: No Action

Present Value (PV):	$0
Construction Time:	0 years

The Superfund program requires that the No Action alternative be considered as a baseline for comparison with the other alternatives. The No Action alternative would not include any remedial measures, although the Tierra and RM10.9 Removals are assumed to have been implemented.

Alternative 2: Deep Dredging with Backfill

PV:	
With DMM Scenario A	$1.34 Billion
With DMM Scenario B	$3.25 Billion
With DMM Scenario C	$2.62 Billion
Construction Time:	11 years

Deep Dredging with Backfill evaluates a bank-to-bank remedy that would involve dredging of all contaminated fine-grained sediments throughout the FFS Study Area (9.7 million cy) and placing two feet of backfill over the dredged area to address dredging residuals. This alternative is intended to remove the contaminated sediment inventory causing the current and potential future risks in the FFS Study Area. This alternative would also result in the restoration of the authorized navigation channel, since the contaminated

[4] A confined disposal facility (CDF) is an engineered structure, built on land or in the water (on the sediment bed) to store contaminated dredged material, isolating it from the surrounding environment. An in-water CDF may be constructed with sheet pile walls or other containment structures, either against the shore or as an island. Once an in-water CDF is filled, it would be capped, converting open water to dry land.

sediment inventory is coincident with the authorized navigation channel.

Within the horizontal limits of the authorized navigation channel, the depth of contaminated fine-grained sediment corresponds well with the depth of historical dredging. Therefore, the depth of dredging is assumed to be the authorized channel depth plus an additional three feet to account for historical dredging accuracy and over-dredging. The resulting sediment removal depths (all in mean low water [MLW]) would be:

Channel Dredging Under Alternative 2		
River Mile Section	Dredging Depth (Resulting Channel Depth)	Width
RM0 to RM2.6	33 feet (30-foot deep channel)	300 feet
RM2.6 to RM4.6	23 feet (20-foot deep channel)	300 feet
RM4.6 to RM7.1	19 feet (16-foot deep channel)	300 feet
RM7.1 to RM8.1	19 feet (16-foot deep channel)	200 feet
RM8.1 to RM8.3	13 feet (10-foot deep channel)	150 feet

Outside the horizontal limits of the navigation channel (in the shoals), the depth of contaminated fine-grained sediment to be dredged varies from 3 feet to 20 feet below the sediment surface. Final dredging depths would be refined in the remedy design. Mudflats dredged during implementation of Alternative 2 would be reconstructed to their original grade and would include one foot of mudflat reconstruction (habitat) substrate.

Dredging and backfilling would be approximately concurrent tasks. As soon as practicable after dredging, two feet of backfill material would be placed to mitigate residuals, inside and outside of the channel.

Institutional controls (such as NJDEP's fish and crab consumption advisories with enhanced outreach) would be implemented until all remediation goals are met. Monitoring and reporting in five-year reviews would also be required until all remediation goals are met. In addition, because Alternative 2 with DMM Scenario A would result in some contaminants remaining on-site above levels that would allow for unrestricted use (in Newark Bay CAD cells), CERCLA would require that five-year reviews be conducted.

Dredged materials removed would be managed in accordance with one of three DMM scenarios described on page 21.

The construction duration for the alternative is not dependent on the DMM scenario, because DMM facilities were assumed to be sized according to the dredged material throughput for the alternative. Construction duration for DMM Scenario C is more uncertain than for the other two scenarios, because the decontamination technologies evaluated in DMM Scenario C have not been constructed and operated in the United States on a scale approaching the capacity needed for this alternative. The construction time estimate includes time for dredging, backfilling and dredged material disposal.

Alternative 3: Capping with Dredging for Flooding and Navigation

PV:

With DMM Scenario A	$0.95 Billion
With DMM Scenario B	$1.73 Billion
With DMM Scenario C	$1.59 Billion
Construction Time:	5 years

Capping with Dredging for Flooding and Navigation evaluates a bank-to-bank remedy that would place an engineered cap (or backfill where appropriate, as described below) bank-to-bank over the FFS Study Area. Before placement of the cap, enough contaminated fine-grained sediment (4.3 million cy, based on a potential cap thickness of two feet) would be dredged so that the cap could be placed without causing additional flooding and to allow for the continued use of the federal navigation channel between RM0 and RM2.2. This alternative includes dredging the 300-foot wide federally-authorized navigation channel at the reasonably-anticipated future use depths from RM0 to RM2.2, as supported by a 2010 USACE survey of commercial users. To ensure that the public is fully informed about the depths of the navigation channel that will result from this alternative and the associated costs, EPA will provide for further facilitated discussions focused on this issue during the public comment period. If information developed during this process shows and supports that shallower post-remedy navigation depths could accommodate the reasonably-anticipated future use, this may be considered in the Agency's remedy decision.

Where dredging depths coincide with the federally-authorized navigation channel (RM0 to RM1.2), an additional three feet would be dredged to account for historical dredging accuracy and over-dredging. Because this is expected to dredge all contaminated fine-grained sediments within this channel, a cap would not be required; this area would be backfilled with a 2-foot sand layer to address dredging residuals. Where dredging depths are shallower than the federally authorized channel (RM1.2 to RM2.2), an additional 5.5 feet of sediment would be dredged to accommodate an engineered cap (to provide a cap protection buffer and allowance for future maintenance dredging). Resulting dredging depths would be as follows (all in MLW):

Channel Dredging Under Alternative 3		
River Mile Section	Dredging Depth (Resulting Channel Depth)	Width
RM0 to RM1.2	33 feet (30-foot deep channel)	300 feet
RM1.2 to RM1.7	30.5 feet (25-foot deep channel)	300 feet
RM1.7 to RM2.2	25.5 feet (20-foot deep channel)	300 feet

Between RM2.2 and RM8.3, dredging would be performed to prevent the engineered cap from causing additional flooding and to provide a depth of at least 10 feet below MLW over a 200-foot width (except between RM8.1 and RM8.3, where dredging would be over a 150-foot width) to accommodate reasonably anticipated recreational future uses above RM2.2, discussed under the "Remedial Action Objectives" section above. This means dredging approximately 2.5 feet below the sediment surface (most of the dredging would be to accommodate the engineered cap). Final dredging depths may be refined in the remedy design, and would include enough dredging to ensure cap stability and integrity.

Mudflats dredged during implementation of Alternative 3 would be reconstructed to their original grade. The engineered cap over the mudflats would consist of one foot of sand and one foot of mudflat reconstruction (habitat) substrate. USACE habitat restoration plans for the New York-New Jersey Harbor Estuary could provide additional information on appropriate habitat reconstruction techniques.

Institutional controls and monitoring would be implemented after construction until remediation goals are met. Institutional controls might include NJDEP's fish and crab consumption advisories with enhanced outreach and restrictions on activities that might disturb the engineered cap, such as limitations on dredging in the FFS Study Area except in the navigation channel in RM0 to RM2.2, restrictions on anchoring vessels within the FFS Study Area or bulkhead maintenance restrictions (as discussed in the "Common Elements of the Active Alternatives" section above). Since the depths after remediation in RM1.2 to RM8.3 would be shallower than the federally authorized channel depths, modification of the authorized federal navigation channel in RM1.2 to RM2.2 and deauthorization of the navigation channel in RM2.2 to RM8.3 under the federal Rivers and Harbors Act, through USACE administrative procedures and Congressional action would be pursued. Because Alternative 3 (under all DMM scenarios) would result in some contaminants remaining on-site above levels that would allow for unrestricted use, CERCLA would require that five-year reviews be conducted.

Dredged materials removed would be managed in accordance with one of three DMM scenarios described on page 21.

The construction duration for the alternative is not dependent on the DMM scenario, because DMM facilities were sized according to the dredged material throughput for the alternative. Construction duration for DMM Scenario C is more uncertain than for the other two scenarios, because the decontamination technologies evaluated in DMM Scenario C have not been constructed and operated in the United States on a scale approaching the capacity needed for this alternative. The construction time estimate includes time for dredging, capping and backfilling, and dredged material disposal.

Alternative 4: Focused Capping with Dredging for Flooding

PV:	
With DMM Scenario A	$0.37 Billion
With DMM Scenario B	$0.61 Billion
With DMM Scenario C	$0.61 Billion
Construction Time:	2 years

This alternative evaluates a remedy that is less than bank to bank in scope. It focuses on discrete areas of the FFS Study Area sediments that release the most contaminants into the water column. Focused Capping with Dredging for Flooding includes dredging of contaminated fine-grained sediments (1 million cy) in selected portions of the FFS Study Area (adding up to 220 acres or about one third of the FFS Study Area surface) with the highest gross and net fluxes of COCs. Dredging would occur to a depth of 2.5 feet to allow an engineered cap to be placed over those portions dredged without causing additional flooding (see Figure 2). Alternative 4 would not include any dredging to accommodate the continued use of the channel for navigation. Mudflats dredged during implementation of Alternative 4 would be reconstructed to their original grade. The engineered cap over the mudflats would consist of one foot of sand and one foot of mudflat reconstruction (habitat) substrate.

Institutional controls and monitoring would be implemented after construction until remediation goals are met. Institutional controls might include NJDEP's fish and crab consumption advisories with enhanced outreach and restrictions on activities that might disturb the engineered caps, as discussed in the "Common Elements of the Active Alternatives" section above. Since the depths after remediation would be shallower than the federally-authorized channel depth from RM0 to RM8.3, de-authorization of the federal navigation channel under the federal River and Harbors Act through USACE procedures and Congressional action would be pursued. Because Alternative 4 (under all DMM scenarios) would result in some contaminants remaining on-site above levels that would allow for unrestricted use, CERCLA would require that five-year reviews be conducted.

Dredged materials removed would be managed in accordance with one of three DMM scenarios described on page 21.

The construction duration for the alternative is not dependent on the DMM scenario, because DMM facilities were sized according to the dredged material throughput for the alternative. Construction duration for DMM Scenario C is more uncertain than for the other two scenarios, because the decontamination technologies evaluated in DMM Scenario C have not been constructed and operated in the United States on a scale approaching the capacity needed for this alternative. The construction time estimate includes time for dredging, capping and dredged material disposal.

THE NINE SUPERFUND EVALUATION CRITERIA

1. Overall Protection of Human Health and the Environment evaluates whether an alternative eliminates, reduces, or controls threats to public health and the environment through institutional controls, engineering controls, or treatment.

2. Compliance with Applicable or Relevant and Appropriate Requirements (ARARs) evaluates whether the alternative meets federal and state environmental statutes, regulations, and other requirements that pertain to the site, or whether a waiver is justified.

3. Long-term Effectiveness and Permanence considers the ability of an alternative to maintain protection of human health and the environment over time.

4. Reduction of Toxicity, Mobility, or Volume of Contaminants through Treatment evaluates an alternative's use of treatment to reduce the harmful effects of principal contaminants, their ability to move in the environment, and the amount of contamination present.

5. Short-term Effectiveness considers the length of time needed to implement an alternative and the risks the alternative poses to workers, the community, and the environment during implementation.

6. Implementability considers the technical and administrative feasibility of implementing the alternative, including factors such as the relative availability of goods and services.

7. Cost includes estimated capital and annual operations and maintenance costs, as well as present value cost. Present value cost is the total cost of an alternative over time in terms of today's dollar value. Cost estimates are expected to be accurate within a range of +50 to -30 percent.

8. State/Support Agency Acceptance considers whether the State agrees with the EPA's analyses and recommendations, as described in the RI/FS and Proposed Plan.

9. Community Acceptance considers whether the local community agrees with EPA's analyses and preferred alternative. Comments received on the Proposed Plan are an important indicator of community acceptance.

COMPARATIVE ANALYSIS OF ALTERNATIVES

In this section, the alternatives are evaluated in detail to determine which would be the most effective in achieving the goals of CERCLA and the RAOs for the FFS Study Area. The alternatives are compared to each other based on the nine criteria set forth in the NCP at 40 CFR 300.430(e)(9)(iii) (see box above).

Overall Protection of Human Health and the Environment

A primary requirement of CERCLA is that the selected remedial action be protective of human health and the environment. An alternative is protective if it reduces current and potential future risks associated with each exposure pathway at a site to acceptable levels.

Alternative 1 (No Action) would not be protective of human health and the environment. Under Alternative 1, the resuspension of contaminated sediments in the FFS Study Area would continue to contaminate surface sediments and biota, so that the unacceptable risks to humans and the environment calculated in the baseline risk assessments would continue for the foreseeable future. Sediment data show some decline in surface sediment concentrations over time due to natural recovery processes, although these processes have slowed considerably over approximately the past 15 years as the navigation channel has filled in and the river has begun to reach a quasi-steady state. Computer modeling results for Alternative 1 show that the decline in concentrations is extremely slow, so that in the period of 2019 to 2048 (30-year period chosen to allow comparison to the 30-year period after construction for the active alternatives), human health total cancer risk (sum for the adult and child for all COCs) would be $4x10^{-3}$ and $2x10^{-3}$ for fish and crab consumption, respectively. The total non-cancer health hazards for the adult would be 90 and 40 for fish and crab consumption, respectively, and for the child would be 163 and 71 for fish and crab consumption, respectively. By the end of that 30-year period, total ecological hazards for benthic invertebrates would range from 40 to 300, for fish would range from 10 to 200 and for wildlife would range from 2 to 700. Since, under Alternative 1, risk levels would remain 10 to several hundred times above protective goals 30 years into the future, it would not be reasonable to expect natural recovery processes to achieve these levels in the foreseeable future beyond the modeling simulation period.

Alternative 2 (Deep Dredging with Backfill) and Alternative 3 (Capping with Dredging) would both protect human health and the environment to approximately the same degree.

Alternative 2 would address the unacceptable risks due to COCs in FFS Study Area sediments by removing the extensive inventory of contaminated fine-grained sediments from RM0 to RM8.3 (approximately 9.7 million cy). Dredging residuals that remain in the FFS Study Area after construction would be covered by a two-foot layer of backfill. The extent to which the surface sediments in the FFS Study Area would be re-contaminated would be determined by the influx, mixing and deposition of sediment that enters from above Dundee Dam, from between the dam and RM8.3, and from Newark Bay. The FFS Study Area is the major source of COCs to the river above RM8.3 and to Newark Bay; so removing those sediments would reduce that source of contamination to those areas, thereby reducing the contamination brought back into the FFS Study Area from those areas over time. Overall contamination levels in the Lower Passaic River and Newark Bay watersheds would be reduced even further by any additional remedial actions EPA might take following completion of the 17-mile Lower Passaic River RI/FS and Newark Bay RI/FS.

Computer models predict that Alternative 2 would reduce risks by ten times after remedial construction, so that in the 30-year period after construction, the human health total cancer risk (for the adult and child for all COCs) would be $5x10^{-4}$ and $4x10^{-4}$ for fish and crab consumption, respectively. The upper boundary of EPA's acceptable risk range is not a discrete line at $1x10^{-4}$. This specific risk estimate for Alternative 2, which is around 10^{-4}, is within the acceptable range. The non-cancer health hazard for the adult would be 10 and 7 for fish and crab consumption, respectively, and for the child would be 22 and 15 for fish and crab consumption, respectively. The non-cancer health hazards would be above EPA's goal of an HI of one, so Alternative 2 would incorporate institutional controls such as fish and crab consumption advisories enhanced by additional outreach to ensure protectiveness. However, Alternative 2 is expected to reduce risks low enough that the stringency of the consumption advisories might be reduced over time, as discussed in the "Long Term Effectiveness and Permanence" section below. Thirty years after construction, total ecological hazards for benthic invertebrates would range from 4 to 30, for fish would range from 2 to 20 and for wildlife would range from 0.8 to 40.

Alternative 3 (Capping with Dredging) would address the unacceptable risks due to COCs in FFS Study Area sediments by sequestering the extensive inventory of contaminated sediments in the FFS Study Area under a bank-to-bank engineered cap. The extent to which the surface sediment in the FFS Study Area would be re-contaminated would be determined by the influx, mixing and deposition of sediment that enters from above Dundee Dam, from between the dam and RM8.3, and from Newark Bay. The FFS Study Area is the major source of COCs to the river above RM8.3 and to Newark Bay; so capping those sediments would reduce that source of contamination to those areas, thereby reducing the contamination brought back into the FFS Study Area from those areas over time. Overall contamination levels in the Lower Passaic River and Newark Bay watersheds would be reduced even further by any additional remedial actions EPA might take following completion of the 17-mile Lower Passaic River RI/FS and Newark Bay RI/FS.

Computer models predict that Alternative 3 would reduce risks by more than ten times after remedial construction, so that in the 30-year period after construction, human health total cancer risk (for the adult and child for all COCs) would be $4x10^{-4}$ and $3x10^{-4}$ for fish and crab consumption, respectively. The upper boundary of EPA's acceptable risk range is not a discrete line at $1x10^{-4}$. This specific risk estimate for Alternative 3, which is around 10^{-4}, is within the acceptable range. The non-cancer health hazard for the adult would be 8 and 6 for fish and crab consumption, respectively, and for the child would be 18 and 13 for fish and crab consumption, respectively. The non-cancer health hazards would be above EPA's goal of an HI of one, so Alternative 3 would incorporate institutional controls such as fish and crab consumption advisories enhanced by additional outreach to ensure protectiveness. However, Alternative 3 is expected to reduce risks low enough that the stringency of the consumption advisories might be reduced over time, as discussed in the "Long Term Effectiveness and Permanence" section below. Thirty years after construction, total ecological hazards for benthic invertebrates would range from 3 to 30, for fish would range from 2 to 20 and for wildlife would range from 0.8 to 30.

Alternative 4 (Focused Capping with Dredging) would address the unacceptable risks due to COCs in FFS Study Area sediments to some extent by capping the sediment areas that contribute the most contaminant flux to the water column; the discrete areas of sediments to be capped would add up to about one-third of the FFS Study Area surface. However, computer models predict that Alternative 4 would not come close to achieving protectiveness of human health and the environment in the 30 years after construction (duration of model simulation). Alternative 4 would reduce risks by about half after remedial construction, so that in the 30-year period after construction, human health total cancer risk (for adult and child for all COCs) would still be $2x10^{-3}$ and $1x10^{-3}$ for fish and crab consumption, respectively. The non-cancer health hazard for the adult would be 55 and 27 for fish and crab consumption, respectively, and for the child would be 97 and 47 for fish and crab consumption, respectively. Thirty years after construction, total ecological hazards for benthic invertebrates would range from 30 to 200, for fish would range from 10 to 100 and for wildlife would range from 2 to 400. Since, under Alternative 4, risk levels would remain up to 100 times above protective goals 30 years after construction, it would not be reasonable to expect natural recovery processes to result in achieving protective goals in the foreseeable future beyond the model simulation period. Since cancer risks remain outside EPA's risk range and non-cancer health hazards are above EPA's goal of an HI of 1, Alternative 4 would incorporate institutional controls such as fish and crab consumption advisories enhanced by additional outreach to ensure protectiveness. Unlike Alternatives 2 and 3, Alternative 4 would primarily rely on fish and crab consumption advisories for protectiveness in perpetuity, since they would remain in place in the foreseeable future without any change in stringency. These computer model predictions are consistent with the body of data collected over the past 17 years and the conceptual understanding of the river system presented under the "Site Characteristics" section, above. The data show that FFS Study Area surface sediments have average COC concentrations that are almost 100 times higher than the remediation goals. Given the ubiquitous nature of highly contaminated sediments in the FFS Study Area, capping discrete areas that only add up to about one-third of the FFS Study Area is unlikely to lead to substantial decreases in COC concentrations. The contaminated sediments in the two-thirds of the FFS Study Area not addressed by Alternative 4 would move with the tide or in storm events to re-contaminate the adjacent capped areas.

Under Alternatives 2, 3 and 4, for DMM Scenario A (CAD), an engineered cap would be placed over the CAD cells in Newark Bay and the cap would be monitored and maintained in perpetuity.

In recent correspondence, the State of New Jersey, NOAA and USFWS have expressed serious concerns about the disposal of highly contaminated sediment from the Lower Passaic River into a CAD cell in Newark Bay, which they note is unprecedented in terms of its scale and footprint, and the coincident potential impacts to the aquatic environment.

These concerns are discussed further in the "Short-Term Effectiveness" section below, because EPA has analyzed the impacts as short-term, temporary impacts during remedy construction. However, NOAA estimates that CAD cells that would be open in Newark Bay for two to eleven years under the three active alternatives could have long-term impacts on some species that are dependent on limited bay bottom habitat for critical life stages. In contrast, DMM Scenarios B (Off-Site) and C (Local Decontamination) have no environmental impact on the aquatic environment of Newark Bay.

Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)

Any alternative considered by EPA must comply with all federal and state environmental standards, requirements, criteria or limitations, unless they are waived under certain specific conditions.

Alternative 1 (No Action) would not contribute significantly toward eventual achievement of federal and state surface water ARARs. Since there is no active remediation associated with this alternative, action-specific and location-specific ARARs do not apply.

Compliance with surface water quality ARARs is both a short-term requirement during remediation and a long-term requirement after the remediation is completed. In the short term, actions would be taken during the implementation of Alternatives 2 (Deep Dredging with Backfill), 3 (Capping with Dredging) and 4 (Focused Capping with Dredging) to reduce construction-related surface water quality impacts. Alternatives 2, 3 and 4 are designed to address sediment contamination in the FFS Study Area. Although remediation of contaminated sediment would contribute to improved water quality, implementation of one of these alternatives, by itself, would be unlikely to achieve compliance with ARARs in the water column. However, because this FFS only addresses the sediments portion of the lower 8.3 miles and is an interim action for the water column, and is only part of the remedial activities under consideration for the 17-mile Lower Passaic River and Newark Bay, compliance with surface water ARARs would more likely be achieved after additional response actions have been implemented. Alternatives 2, 3 and 4 would satisfy the location-specific and action-specific ARARs, such as the requirements of the Clean Water Act that would apply to dredging and the RCRA requirements that would apply to management of dredged materials.

Long-Term Effectiveness and Permanence

This evaluation takes into account the residual risk remaining at the conclusion of remedial activities, and the adequacy and reliability of containment systems and institutional controls.

Alternative 1 (No Action) would not be effective in addressing the contaminated sediments that are causing the unacceptable risks identified in the baseline risk assessments. Natural recovery processes would cause some decline in surface sediment concentrations over time, but computer modeling results (see FFS Report Figure 4-3) for Alternative 1 show that, by the late 2050s (end of the model simulation period), FFS Study Area surface sediment concentrations would remain far above any of the remediation goals or background levels for any COC.

- For dioxin, by the late 2050s, FFS Study Area surface sediment concentrations would remain well over ten times higher than the remediation goal.
- For PCBs, DDT and mercury, by the late 2050s, surface sediment concentrations would remain almost twice as high as background concentrations and over ten times (for PCBs and mercury) or 100 times (for DDT) higher than the remediation goals.

Alternative 1 (No Action) would not include any containment systems or institutional controls to address COC contamination in FFS Study Area sediments.

Modeling has predicted that in order for any alternatives to achieve protectiveness of human health (i.e., not only be within the risk range of $1x10^{-4}$ to $1x10^{-6}$, but also be at or below an HI equal to 1), bank-to-bank remediation in the FFS Study Area would be necessary. Modeling results also predicted that bank-to-bank alternatives would reduce surface sediment concentrations for some of the COCs to below background levels in the future. This is because particles coming over Dundee Dam (background for the FFS Study Area) make up about one third of particles in the FFS Study Area water column. When those particles flow down to the FFS Study Area, they mix with the other particles in the system (including cleaner particles in the water column that would result from a remediated FFS Study Area) and also the clean material placed on the river bed as part of remediation. So contamination in the top six inches (the bioactive zone) should end up being much less than background concentrations coming over Dundee Dam.

Under Alternative 2 (Deep Dredging with Backfill), approximately 9.7 million cy of contaminated sediments covering approximately 650 acres of river bottom between RM0 and RM8.3 would be permanently removed from the ecosystem of the Lower Passaic River after construction is completed. Dredging residuals remaining in the FFS Study Area would be covered by a two-foot layer of backfill. Under Alternative 3 (Capping with Dredging), approximately 4.3 million cy of contaminated sediments covering approximately 650 acres of river bottom between RM0 and RM8.3 would be permanently removed from the ecosystem of the Lower Passaic River, followed by construction of a two-foot engineered cap (or backfill where appropriate) over the entire FFS Study Area. After construction is completed, the resuspension of contaminated sediments within the FFS Study Area would no longer continue to contaminate surface sediments and biota or pose unacceptable risks to humans and the environment. A significant decline in surface sediment concentrations in the FFS Study Area is predicted for COCs under both alternatives (see FFS Report Figure 4-3).

- For dioxin, in the 30-year period after construction, surface sediment concentrations are predicted to decline tenfold and end up fluctuating around the remediation goal. The fluctuations depend on the magnitude and frequency of storm events, which are programmed into the model at 15 year intervals, although in reality the sequence of storm events cannot be predicted with any degree of certainty.
- For PCBs, in the 30-year period after construction, surface sediment concentrations are predicted to decline over tenfold and end up fluctuating around the remediation goal depending on the magnitude and frequency of storm events.
- For mercury, during the 30-year period after construction, surface sediment concentrations are predicted to decline over tenfold and end up fluctuating around the remediation goal, depending on the magnitude and frequency of storm events.
- For DDT, during the 30-year period after construction, surface sediment concentrations are predicted to decline over tenfold, to fluctuate at a level about ten times higher the remediation goal.

Alternatives 2 and 3 would incorporate fish and crab consumption advisories to ensure protectiveness of human health. For dioxin and PCBs, approximately 10 years after construction, surface sediment concentrations are expected to reach the interim remediation milestones that correspond to interim protective fish and crab tissue concentrations, potentially allowing NJDEP to consider relaxing the stringency of fish and crab consumption advisories (e.g., allowing one fish meal per month, as opposed to the current advisory that recommends no consumption of fish or shellfish from the Lower Passaic River).

Alternative 2 would not rely on a containment system to maintain protectiveness in the FFS Study Area over the long term, since the contaminated fine-grained sediments would be removed. Note that a containment system might be incorporated as part of the dredged material management option selected for this alternative (see below).

Alternative 3 would be effective in the long term in limiting exposure to risks posed by COCs in the FFS Study Area sediments provided the integrity of the engineered cap is maintained. Therefore, the cap would need to be monitored and maintained in perpetuity. Engineered caps have been demonstrated to be effective in the long term in sequestering contaminated sediments at other Superfund sites, when they are properly designed and maintained. For FFS cost-estimation purposes, the engineered cap for the FFS Study Area was assumed to consist of sand with a grain size large enough to withstand a 100-year storm with less than 3 inches of erosion (a fraction of the cap's thickness), thus minimizing the likelihood that cap integrity would be compromised during a storm event or season. Based on modeling results, certain areas of the river were assumed to need armor stone for further protection against erosion. The FFS cost estimate also assumed cap inspection and any necessary maintenance at regular intervals and after storm events.

For Alternative 4, approximately 1.0 million cy of contaminated sediments in discrete areas totaling approximately 220 acres of river bottom between RM0 to RM8.3, would be permanently removed, followed by placement of a two-foot engineered cap over those areas dredged. As discussed above, Alternative 4 would not achieve much risk reduction, because the contaminated surface sediments in the two-thirds of the FFS Study Area that remain unaddressed would re-contaminate the adjacent capped areas. Computer modeling results (see FFS Report Figure 4-3) show that, by the late 2050s (end of the model simulation period), FFS Study Area surface sediment concentrations would remain far above any of the remediation goals, although some background levels might be reached.

- For dioxin, in the 30-year period after construction, surface sediment concentrations are predicted to remain well over ten times higher than the remediation goal.
- For PCBs and DDT, in the 30-year period after construction, surface sediment concentrations are predicted to be 25 percent higher than background concentrations and ten times (for PCBs) or 100 times (for DDT) higher than the remediation goals.
- For mercury, in the 30-year period after construction, surface sediment concentrations are predicted to just meet background concentrations and to be ten times higher than the remediation goal.

For dioxin and PCBs, under Alternative 4, surface sediment concentrations are not expected to be reduced enough to reach interim remediation milestones. Therefore, unlike Alternatives 2 and 3, Alternative 4 would primarily rely on fish and crab consumption advisories for protectiveness in perpetuity, since they would remain in place in the foreseeable future without any change in stringency.

For Alternatives 2, 3 and 4, under DMM Scenario A (CAD), the engineered caps over the CAD cells would have to be monitored and maintained in perpetuity in order to ensure that the alternatives are protective of human health and the environment over time. In contrast, there is no such requirement for DMM Scenario B (Off-Site Disposal) and DMM Scenario C (Local Decontamination), because existing landfills already have provisions for long-term monitoring and maintenance by landfill owners and operators.

DMM Scenario B relies on off-site incinerators and landfills which are in operation and have proven to be reliable technologies. The reliability of local decontamination technologies (DMM Scenario C), such as thermal treatment and sediment washing, is more uncertain, since they have not been built and operated in the United States on a scale approaching the capacity needed for this project. In addition, sediment washing may be less effective when the matrix contains multiple contaminants and consists of a large proportion of finer particles like silts and clays. Multiple treatment passes, which would increase cost, may be needed under such conditions.

Reduction in Toxicity, Mobility, or Volume Through Treatment

This criterion addresses the statutory preference for selecting remedial actions that employ treatment technologies that permanently and/or significantly reduce the toxicity, mobility or volume of hazardous substances as their principal element.

For Alternative 1 (No Action), only natural recovery processes would potentially reduce COC concentrations in sediments and surface water. Under Alternative 1, there would be no reduction of toxicity, mobility or volume through treatment.

For the active alternatives, reduction of mobility and volume of contaminated sediments in the FFS Study Area would be achieved by dredging and capping, not through treatment. The ultimate reduction of toxicity, mobility and volume of the sediments removed from the FFS Study Area would depend on the DMM Scenario selected.

Under Alternative 2 (Deep Dredging with Backfill), reduction of mobility and volume in the FFS Study Area would be achieved by the removal of 9.7 million cy of contaminated sediments by dredging, including elimination of approximately 24 kilograms (kg) of 2,3,7,8-TCDD, 41,000 kg of mercury, 23,000 kg of PCBs and 4,200 kg of DDT. For Alternative 3 (Capping with Dredging), reduction of mobility and volume in the FFS Study Area would be achieved by the removal of 4.3 million cy of contaminated sediments by dredging, including elimination of approximately 8 kg of 2,3,7,8-TCDD, 16,000 kg of mercury, 7,000 kg of PCBs and 800 kg of DDT. The remaining 5.4 million cy of contaminated sediments would be sequestered in the river under an engineered cap, so that mobility would be effectively eliminated, but there would be no reduction of toxicity for the contaminants that remain under the cap. Under Alternative 4 (Focused Capping with Dredging), reduction of mobility and volume in the FFS Study Area would be achieved by the removal of 1.0 million cy of contaminated sediments by dredging, including elimination of approximately 1 kg of 2,3,7,8-TCDD, 2300 kg of mercury, 1300 kg of PCBs and 100 kg of DDT. The remaining 8.7 million cy of contaminated sediments would not be addressed, so there would be no additional reduction in toxicity, mobility or volume through treatment.

For Alternatives 2, 3 and 4, under DMM Scenario A (CAD), the mobility of the COCs removed from the FFS Study Area would be effectively eliminated, not through treatment, but by sequestering the dredged sediments in the CAD cells under an engineered cap that would need to be monitored and maintained in perpetuity. There would be no reduction in the toxicity or volume of the COCs.

Under DMM Scenario B (Off-Site Disposal), the toxicity, mobility, and volume of the COCs removed from the FFS Study Area are estimated to be reduced as follows:

Alternative	Dredged Material Incinerated[a] (CY)	Dredged Material Landfilled[b] (CY)
2	790,000	7,130,000
3	250,000	3,310,000
4	30,000	800,000

Notes: Numbers are in-situ cubic yards and exclude volume of reclaimed materials (sand) and some debris separated in the mechanical dewatering process.
[a] Incineration would reduce toxicity, mobility and volume through treatment. Actual amount incinerated would depend on results of characterization for disposal.
[b] Landfilling would reduce mobility without any reduction in toxicity or volume, through sequestration not treatment.

Under DMM Scenario C (Local Decontamination), the toxicity, mobility, and volume of the COCs removed from the FFS Study Area are estimated to be reduced as follows:

Alternative	Dredged Material Undergoing:		
	Thermal Treatment[a] (CY)	Sediment Washing[b] (CY)	Stabilization[c] (CY)
2	790,000	6,970,000	160,000
3	250,000	3,270,000	40,000
4	30,000	780,000	17,000

[a] Thermal treatment would reduce toxicity, mobility and volume (achieving 99% reduction in toxicity) through treatment.
[b] Sediment washing would reduce toxicity, mobility and volume (achieving 10-80% reduction in toxicity, depending on the contaminant) through treatment.
[c] Stabilization would reduce mobility through treatment, without any reduction in toxicity or volume.

Short-Term Effectiveness

This criterion addresses the effects of each alternative during construction and implementation until RAOs are met. It considers risks to the community, on-site workers and the environment, available mitigation measures and time frame for achieving the response objectives.

Short-Term Effectiveness: Potential Adverse Impacts on Communities and Workers During In-River Construction. The impacts due to construction in the river are mainly driven by the volume dredged and duration of construction for each alternative. Alternative 1 would not involve any construction that could present a risk to the community or workers. Implementation of Alternative 2 would have larger impacts on the community and workers than Alternative 3, because construction would last longer (11 years) and would involve handling of a higher volume of contaminated sediments (9.7 million cy). Implementation of Alternative 3 would have less of an impact on the community, workers and the environment than Alternative 2, although those impacts would still be important to mitigate, since the construction period would last five years and would involve handling of 4.3 million cy of contaminated sediments. Alternative 4 would also cause adverse impacts on the community, workers and the environment during construction, but those impacts would be smaller than those caused by Alternatives 2 and 3, because of the relatively short construction period (2 years) and smaller volume of contaminated sediments handled (1.0 million cy) relative to Alternatives 2 and 3.

Impacts to communities from construction of Alternatives 2, 3 and 4 would include temporary noise, light, odors, blocked views, potential air quality impacts and disruptions to commercial and recreational river users in the FFS Study Area (operating for a few months at a given location). These impacts could be lessened through use of best management practices documented in community health and safety plans, but disruptions would still be significant, since dredging and backfilling or capping is expected to proceed 24 hours a day, six days per week and 40 weeks per year. Potential occupational risks to site workers from construction of Alternatives 2, 3 and 4 could include direct contact, ingestion and inhalation of COCs from the surface water and sediments and routine physical hazards associated with construction work and working on water. Measures to minimize and mitigate such risks would be addressed in worker health and safety plans, by the use of best management practices and by following properly approved health and safety procedures.

Short-Term Effectiveness: Potential Adverse Impacts on the Environment During In-River Construction. Under Alternatives 2, 3 and 4, dredging would result in resuspension of contaminated sediments, which would cause fish and other organisms in the water to be exposed to higher concentrations of contaminants than usually present in the water column. Studies have shown that dredging can result in resuspension loss of 1 to 3 percent of the material removed. The volume dredged under each alternative and the concentrations of contaminants on the resuspended sediments drive this adverse impact. Alternative 2 would have the most impact on the environment when compared to Alternatives 3 and 4, because Alternative 2 would have the largest volume dredged and the deepest dredging into the sediment bed, where contaminant concentrations are highest. Alternative 3 would have less impact on the environment than Alternative 2, but more than Alternative 4. Risks due to resuspension could be minimized through the control of sediment removal rates (through careful operation of the dredging equipment). Environmental impacts from construction would include temporary loss of benthos and habitat for the ecological community in dredged areas and in areas affected by resuspension of contaminated sediments during dredging. Habitat replacement measures would be implemented to mitigate these impacts. Since the remedial action would improve and replace existing open water, mudflat and intertidal habitat, no additional compensatory mitigation measures would be necessary for this aspect of the remediation. Natural benthic re-colonization following a disturbance is usually fairly rapid, and can begin within days after perturbation. In some cases, full recovery to pre-disturbance species composition and abundance can occur within one to five years.

Short-Term Effectiveness: Impacts on Communities, Workers and the Environment from Disposal Options. The impacts associated with the disposal options are mainly driven by the mode of transportation for the dredged materials and amount of local processing of dredged materials.

For Alternatives 2, 3 and 4, under DMM Scenario A (CAD), it was assumed that the CAD cells would be sited in the part of Newark Bay where the thickest layer of clay (approximately 60 feet) is likely to be found. Dredged materials from the FFS Study Area would be barged to the Newark Bay CAD site so that an upland sediment processing facility on the banks of the Lower Passaic River or Newark Bay would not be necessary. This would minimize on-land impacts to the community, but increase traffic in the bay. Since major container terminals are located in Newark Bay near the CAD sites that EPA considered in the FFS, increased barge traffic to and from the CAD site may interfere with existing port commercial traffic and increase the potential for waterborne commerce accidents. While dredged materials would also have to be barged to an upland processing facility under DMM Scenarios B (Off-Site) or C (Local Decontamination), an FFS-level survey of land along the FFS Study Area shoreline showed a number of locations suitable for an upland processing facility, so that the impact of increased in-water traffic associated with DMM Scenarios B and C could be minimized and interference with the major container terminals in Newark Bay could be avoided as much as possible.

DMM Scenarios B (Off-Site) and C (Local Decontamination) would cause more on-land impacts to the local community and workers. These disposal options would require the siting of a 26- to 40-acre (depending on the alternative and scenario) upland sediment processing facility on the banks of the Lower Passaic River or Newark Bay. For FFS cost and scheduling estimation purposes, the facility was assumed to operate for 24 hours a day, 6 days a week, 40 weeks each year for 2 to 11 years (depending on the alternative). Best efforts to minimize impacts on the local community and workers would be implemented; however, operation of the facility would still result in more odors, noise, light pollution, potential air quality impacts, greater risk of accidents from equipment operation and increased traffic on local roads than DMM Scenario A, which does not need an upland sediment processing facility. DMM Scenario B would have less impact on the local community and workers than DMM Scenario C, because DMM Scenario B involves less processing of dredged materials at the upland processing facility than DMM Scenario C. For DMM Scenario B, only coarse material separation and dewatering would be performed at the upland processing facility before materials are loaded onto rail cars and shipped off site. For DMM Scenario C, material separation, dewatering, thermal treatment, sediment washing and solidification/stabilization would occur at the upland processing facility before the beneficial use end-products are loaded into trucks or railcars to be sent to their final destination. Less processing of dredged materials at the upland processing facility means less equipment operating for the duration of the project and a smaller footprint for the upland processing facility. Measures to minimize and mitigate impacts on the community would be addressed in community health and safety plans, and by the use of best management practices.

Under DMM Scenario A, construction and operation of the CAD site could have substantial impacts on the aquatic environment, some of which could be lessened through engineering controls. Computer simulations of CAD cells placed in Newark Bay and operated without any dissolved- and particulate-phase controls were modeled over short time periods. Modeling results indicated contaminant losses from the CAD cells of approximately one percent of the mass placed, even after the short time period modeled (seven days), and assuming placement of small amounts of dredged materials in the CAD site (approximately 38,400 cy). Based on these modeled results, the CAD site conceptual design used for developing DMM Scenario A in the FFS includes sheet pile walls on all sides and a silt curtain across the entrance channel, intended to lessen the migration of dissolved and particulate-phase contaminants out of the CAD cells during construction and operation. Even with the use of sheet pile walls and a silt curtain, some of the dissolved-phase contamination could still escape during dredged material disposal.

Intertidal and subtidal shallows, such as those where CAD cells would be located, provide valuable habitat for various aquatic species, including areas designated by NOAA as Essential Fish Habitat.

In a recent letter, the Federal Trustees urged EPA not to consider alternatives that include disposal of contaminated sediment into the waters of Newark Bay. They explained that a CAD cell in this situation would be unprecedented in terms of the potential for adverse implications to aquatic habitat, the high concentrations of contaminants, the volume of sediment and the footprint (acres) of the CAD cell, and observed that some species (particularly winter flounder) use the Bay bottom to lay their eggs and will not spawn if those areas are disturbed or not accessible. The Trustees distinguished Newark Bay in this regard from the species and locations involved in Superfund CAD cells at Puget Sound and New Bedford Harbor. The Trustees also concluded that other species that use the Bay (such as juvenile *Alosines*, bay anchovy and silverside) are prey species for federally managed species such as bluefish, summer flounder and windowpane. Therefore, adverse impacts on the prey species would result in reduction in prey and would be considered an adverse impact to Essential Fish Habitat. In addition, the trustees observed that several species in Newark Bay have special status, including Atlantic sturgeon, which is federally listed as an endangered species.

The State of New Jersey has expressed similar concerns, most recently in a letter dated March 12, 2014 from NJDEP Commissioner Bob Martin to EPA Administrator Gina McCarthy. The Commissioner noted that use of a CAD cell for disposal of the required volume and concentration of dioxin-contaminated dredged material is unprecedented. He noted that dioxins are highly persistent, bio-accumulative and toxic chemicals that are highly resistant to degradation from biotic or abiotic processes. Consequently, NJDEP is not willing to support disposal of contaminated sediment in Newark Bay as it is unlikely to degrade to any appreciable extent in a reasonable timeframe.

Based on their November 30, 2012 letter, the USACE believes that CAD cells can be constructed and utilized with only localized short-term impacts and with the least impacts to the surrounding communities. CAD cells have been implemented all over the country including the construction, utilization and recent capping of the Newark Bay Confined Disposal Facility. They note that conditions in Newark Bay are favorable based on natural presence of a thick impermeable red-clay shelf over bedrock in a Bay with a well-established, already impacted, depositional environment (i.e., very low potential for erosion due to storm events) ensuring the secured and consolidated disposal of contaminated sediment in the long-term.

Operation of the CAD site would involve discharging dredged materials into waters of the United States for 11 years under Alternative 2, 5 years under Alternative 3 and 2 years under Alternative 4. The area of the open waters subject to temporary impacts from construction and operation of the CAD site would be approximately 171 acres for Alternative 2, 80 acres for Alternative 3 and 19 acres for Alternative 4. In addition to restoring the bay bottom at the completion of the project, compensatory mitigation for the CAD site would be required; that is, provision of a separate mitigation site to offset the temporal ecological losses to habitat and their functional value. For FFS cost estimation purposes, local mitigation banks have been tentatively identified to provide the mitigation necessary to offset the temporal losses associated with the Alternatives 3 and 4 CAD site. Existing mitigation banks could only provide about 55 percent of the total mitigation acreage necessary to offset the temporal losses associated with the Alternative 2 CAD site. Additional acres could be provided through restoration of sites identified in USACE's Hudson-Raritan Estuary Comprehensive Restoration Plan and Lower Passaic River Ecosystem Restoration Plan. The cost of mitigation is included in the cost of the alternatives that include DMM Scenario A. Furthermore, in addition to habitat loss, there is the potential for fish and semi-aquatic birds moving into the open CAD cells during their 2- to 11-year operation and being exposed to highly concentrated contamination by direct contact or ingestion of prey.

DMM Scenarios B and C would have much less impact on the aquatic environment than DMM Scenario A, because they would not involve discharge of contaminated sediments through the water column and into CAD cells. While DMM Scenarios B and C have greater on-land impacts (discussed above) due to the need for an upland processing facility, those impacts can be mitigated through proven technologies such as air pollution control technology and buffer zones around construction sites.

Short-Term Effectiveness: Time Until Remedial Response Objectives are Achieved. See FFS Report Figure 4-3 for modeling results for Alternatives 1 through 4. Under Alternative 1 (No Action), surface sediment concentrations would still be ten to 100 times higher than any of the remediation goals by the late 2050s (end of the model simulation period). Under Alternative 4 (Focused Capping with Dredging), surface sediment concentrations would still be ten to 100 times higher than any of the remediation goals by the late 2050s. Under Alternative 4, fish and crab consumption advisories would remain in place in the foreseeable future, without any change in stringency.

For Alternatives 2 (Deep Dredging with Backfill) and 3 (Capping with Dredging), during the 30-year period after construction, dioxin, PCB and mercury surface sediment concentrations are predicted to fluctuate around the remediation goals, depending on magnitude and frequency of storm events. DDT surface sediment concentrations are predicted to fluctuate at a level about ten times higher than the remediation goal, depending on magnitude and frequency of storm events. For dioxin and PCBs, approximately 10 years after construction, surface sediment concentrations are expected to reach the interim remediation milestones that correspond to interim protective fish and crab tissue concentrations, potentially allowing NJDEP to consider relaxing the stringency of fish and crab consumption advisories. Alternative 3 would achieve significant reductions in surface sediment concentrations sooner than Alternative 2 because of the shorter construction period (5 versus 11 years).

Implementability

This criterion considers the technical and administrative feasibility of implementing each alternative, including availability of services and materials needed during construction.

There are no implementability issues for Alternative 1 (No Action), which does not involve any active remediation.

For Alternatives 2 (Deep Dredging with Backfill) and 3 (Capping with Dredging), every step of the in-river construction (debris removal, dredging, backfilling, engineered capping and dredged material transport) would be technically implementable, although careful planning would be needed to overcome the substantial challenges involved in the handling of such large volumes of dredged materials. Equipment and technical expertise for dredging and backfill/cap placement are available through several commercial firms. While a large amount of backfill and cap material would be needed, adequate resources have been preliminarily identified at several local borrow sources.

The FFS Study Area river bed is crossed by utilities of various sizes and depths, in a number of locations. During the RM10.9 Removal, concerns were raised by the Jersey City Municipal Utilities Authority about any dredging within 30 feet on either side of the two water lines that cross below the river near Lyndhurst. Dredging for Alternative 2 would affect more utilities than dredging for Alternative 3, because Alternative 2 would involve much deeper dredging than Alternative 3. It is expected that remedy design would include procedures to more precisely locate utilities in the FFS Study Area and determine appropriate dredging off-sets, if necessary. The FFS cost estimates include costs of side-scan sonar to locate utilities and construction safeguards such as coffer dams to protect utilities during dredging.

The FFS Study Area is crossed by 14 bridges of various heights. During the RM10.9 Removal, the opening of bridges to allow construction equipment and dredged materials through was a challenge that involved coordination with the various owners and operators of the bridges. All of the active alternatives would be equally affected by the need to open the bridges. The FFS incorporates the assumption that the necessary coordination, which may include assisting bridge authorities with engineering evaluations and maintenance of the bridges, would occur during the remedial design phase of the project.

In-river construction of Alternative 4 (Focused Capping with Dredging) could be seen as more easily implementable than Alternatives 2 and 3, because smaller volumes of dredged materials would need to be handled and less capping material would be involved. However, under Alternative 4, the process of reliably identifying discrete areas that release the most contaminants into the water column would involve a great degree of uncertainty given the complex estuarine environment of the FFS Study Area. The river bottom changes constantly as the tides move back and forth twice a day and unpredictably as storm events scour different areas depending on intensity, location and direction of travel.

For the in-river work of Alternatives 2, 3 and 4, no insurmountable administrative difficulties are anticipated in getting the necessary regulatory approvals for sediment removal or engineered cap and backfill placement. Since a large number of the activities are expected to occur on site (as defined under CERCLA Section 121(e)(1) and 40 CFR 300.5), federal, state and local permits would not be required. Permits are expected to be obtained from the appropriate local, state and federal agencies for actions that occur off site.

Alternative 4 may face an administrative implementability hurdle with respect to obtaining deauthorization of the federally-authorized navigation channel in the lower 2.2 miles of the river. To obtain deauthorization, a request would need to be submitted to the USACE. After a public comment period, the USACE regional office would make a recommendation to USACE headquarters, which would forward its report to Congress for action. However, the USACE berth-by-berth analysis and survey of commercial users showed clear future waterway use objectives in the lower 2.2 miles of the river. Thus, USACE and Congressional support for deauthorization of the lower 2.2 miles of the federal navigation channel is highly uncertain.

The technical and administrative implementability of the DMM Scenarios vary from one to the next. Every step involved in DMM Scenarios A (dredged material placement in CAD cells) and B (dewatering, dredged material transport and off-site disposal) is technically implementable with proper planning. The technologies have been successfully implemented at other Superfund Sites. Depending on the processing sites that are eventually selected, dewatering, water treatment, and transfer facilities with good rail access and suitable wharf facilities are expected to be available or could be developed. The large volume of sediments to be handled would need significant logistical coordination. For DMM Scenario B, several incinerators and landfills have been identified as potentially having capacity to receive FFS Study Area dredged material by rail.

The decontamination technologies involved in DMM Scenario C (thermal treatment and sediment washing) have not been constructed and operated in the United States on a scale approaching the capacity needed for this project, so their technical ability to handle large volumes of highly contaminated sediments is more uncertain.

- At least four thermal treatment technologies were identified as potentially able to treat FFS Study Area dredged sediments. Pilot demonstrations were conducted by USACE for three of these technologies with Passaic River-Newark Bay sediments and for one technology with Lower Fox River (Wisconsin) sediments. All achieved over 99 percent removal efficiencies for a variety of COCs, including dioxins, PCBs, PAHs and metals, although the demonstrations involved relatively small volumes and short durations.

- At least four vendors have developed sediment washing technologies. In 2005-2006, one conducted a pilot demonstration with Passaic River-Newark Bay sediments that involved high enough processing rates to be considered equivalent to commercial scale operation. The technology achieved variable removal efficiencies (ranging from less than 10 to 80 percent depending on the contaminant) for dioxins and furans, PCBs, PAHs and metals. While data from the demonstration did not conclusively establish that the system would be effective in treating all contaminants to New Jersey standards so as to allow the end product to be used beneficially without restrictions, it is possible that sediment washing, combined with solidification and stabilization technology, would enable the end product to be used as RCRA Subtitle D landfill cover. However, most recently, in mid-2012, bench-scale studies by two sediment washing technology vendors showed that their technologies were unable to reduce Lower Passaic River sediment contamination to levels low enough for beneficial use.

DMM Scenario A (CAD) is a technically viable, cost effective solution that has been constructed and maintained in a protective manner in other locations, including Newark Bay, and Superfund sites such as New Bedford Harbor and Puget Sound Naval Shipyard. In 1997-2012, a CAD cell with a capacity of 1.5 million cubic yards was operated in Newark Bay by the Port Authority of New York and New Jersey and USACE for the disposal of navigational dredged material from the Newark Bay watershed (not for disposal of sediment dredged for environmental cleanup).

However, in this case, DMM Scenario A (CAD) will face significant administrative and legal impediments, because the State of New Jersey has asserted ownership of the bay bottom and strongly opposes construction of a CAD site in Newark Bay, citing the high toxicity and unprecedented volume of contaminated sediment as a primary reason it should not be handled in the aquatic environment. The State's position is clearly articulated in letters dated November 28, 2012 from Governor Chris Christie to former EPA Administrator Lisa Jackson and March 10, 2014 from NJDEP Commissioner Martin to EPA Administrator Gina McCarthy.

Unless the State were to change its position, its opposition is likely to make DMM Scenario A administratively infeasible. Given the State's current position, DMM Scenario A (CAD) is unlikely to satisfy the NCP balancing criterion of implementability and the modifying criterion of state acceptance.

For DMM Scenario B (Off Site Disposal), administrative feasibility is less of a concern, although siting a 26- to 28-acre (depending on the alternative) upland processing facility may be challenging in the dense urban areas around the Lower Passaic River and Newark Bay. For DMM Scenario C, administrative feasibility is less of a concern than for DMM Scenario A but more of a concern than for DMM Scenario B, because Scenario C involves more upland area for dredged material processing (36 to 40 acres depending on the alternative). It also involves the construction of a thermal treatment plant, which may be subject to more stringent limitations on air emissions. In Governor Christie's November 28, 2012 letter, the State of New Jersey also expressed opposition to siting a thermal treatment facility near densely populated urban areas that are already burdened with environmental impacts, particularly from air pollutants. However, the letter acknowledged that decontamination technologies such as those described in DMM Scenario C should be considered in conjunction with off-site disposal.

Cost

Cost estimates are summarized in Table 6. A discount rate of 7 percent was used in the present value calculations, consistent with EPA guidance.

All Alternative 2 capital costs are greater than Alternative 3 capital costs, which in turn are greater than Alternative 4 capital costs, because Alternative 2 involves dredging and managing the largest volume of contaminated sediments, while Alternative 4 involves dredging and managing the least. All Alternative 3 and 4 operation and maintenance (O&M) costs are greater than Alternative 2 O&M costs, because Alternatives 3 and 4 would involve long-term monitoring and maintenance of an engineered cap, while Alternative 2 does not involve any maintenance of the backfill (because there is no contaminated inventory left behind). Annual O&M costs for Alternative 3 and 4 are comparable, estimated at present values of approximately $1.7 to $1.8 million for Alternative 3 and $1.6 to $1.7 million for Alternative 4.

State Acceptance

NJDEP concurs with the preferred alternative. New Jersey has indicated its preference for DMM

Scenario B, and its strong opposition to DMM Scenario A (CAD).

Community Acceptance

Community acceptance of the preferred alternative will be addressed in the ROD following review of the public comments received on the Proposed Plan. However, EPA is aware of opposition to the CAD cells in Newark Bay by many of the community and environmental groups that are actively engaged with the Lower Passaic River.

PREFERRED ALTERNATIVE

EPA's preferred alternative is Alternative 3 (Capping with Dredging for Flooding and Navigation) with DMM Scenario B (Off-Site Disposal). This bank-to-bank alternative includes the following components:

- Installing an engineered cap bank-to-bank from RM1.2 to RM8.3, and in areas outside of the navigation channel from RM0 to RM1.2.
- Dredging the 300-foot wide federal navigation channel from RM0 to RM2.2 to the following depths (all in MLW) to accommodate continued and reasonably anticipated future use:
    - RM0 to RM1.2 = 33 feet (resulting in a 30-foot deep navigation channel);
    - RM1.2 to RM1.7 = 30.5 feet (resulting in a 25-foot deep navigation channel); and
    - RM1.7 to RM2.2 = 25.5 feet (resulting in a 20-foot deep navigation channel).
- Backfilling the dredged channel in RM0 to RM1.2 with 2 feet of sand.
- Prior to installing the cap in RM2.2 to RM8.3, dredging approximately 2.5 feet below the sediment surface to prevent the engineered cap from causing additional flooding and to provide for at least 10 feet below MLW over a 200-foot width in RM2.2 to RM8.1, and over a 150-foot width in RM8.1 to RM8.3, to accommodate reasonably anticipated future recreational uses.

Table 6
Present Value[1] Cost Estimates

Alternative	Disposal Scenario	Capital Costs	Average Annual Long-Term Operation and Maintenance Costs[2]	Total
1) No Action	--	$0	$0	$0
2) Deep Dredging with Backfill	with CAD	$1,318,000,000	$750,000	$1,341,000,000
	with Off-Site	$3,229,000,000	$520,000	$3,245,000,000
	with Decontamination	$2,605,000,000	$520,000	$2,621,000,000
3) Capping with Dredging for Flooding and Navigation	with CAD	$898,000,000	$1,830,000	$953,000,000
	with Off-Site	$1,681,000,000	$1,680,000	$1,731,000,000
	with Decontamination	$1,534,000,000	$1,680,000	$1,585,000,000
4) Focused Capping with Dredging for Flooding	with CAD	$315,000,000	$1,660,000	$365,000,000
	with Off-Site	$566,000,000	$1,600,000	$614,000,000
	with Decontamination	$557,000,000	$1,600,000	$606,000,000

Notes:
1. Present value costs calculated using a seven percent discount rate. Values are rounded to the nearest million (capital costs) and nearest ten-thousand (annual average O&M costs).
2. Total annual and periodic O&M costs averaged over the 30-years post-construction monitoring period to estimate the average annual long-term O&M costs.
3. Total costs may not add due to rounding.

- Reconstructing dredged mudflats to their original grade, with an engineered cap that would consist of one foot of sand and one foot of mudflat reconstruction (habitat) substrate.

This alternative would involve dredging of approximately 4.3 million cy of contaminated sediments, which would be disposed of in the following way:

- Dredged materials would be barged to an upland sediment processing facility in the vicinity of the Lower Passaic River/Newark Bay shorelines for debris screening, sand separation and active dewatering using filter presses.
- Non-hazardous coarse-grained materials (sand) separated during processing would be disposed of at a local landfill, or be beneficially used.
- Dewatered dredged materials would be transported by rail to permitted incinerators and landfills in the United States or Canada for treatment and disposal.
- Water generated by the dewatering would be processed through a water treatment plant to meet NJDEP water quality standards and discharged to the Lower Passaic River or Newark Bay.

During construction, water, air and biota monitoring would be conducted to evaluate whether the project is being managed efficiently to mitigate releases of contaminants to the environment. In instances where water or air quality standards are exceeded, the construction activity that caused the exceedance would be evaluated and additional mitigation measures would be implemented. After construction, frequent monitoring of fish and sediment would be conducted to determine when interim remediation milestones and remediation goals are reached. During and after construction, NJDEP's fish and crab consumption advisories with enhanced community outreach to improve awareness and compliance, would be implemented until remediation goals are met. After construction, monitoring and maintenance of the engineered cap would be required both on a regular basis and after significant storm events. Institutional controls prohibiting disturbance of the engineered cap would be necessary to maintain cap integrity. A review of site conditions would be conducted at least once every five years, as required by CERCLA.

Given the stakeholder interest with respect to the dredged material management options, EPA will provide focused public outreach on this topic through facilitated public meetings and information sessions during the public comment period. These meetings and information sessions will include a discussion of the navigational depths that will result from the remedy, since this issue is also of great interest to stakeholders. If, as a result of comments received or new relevant information, EPA concludes that the record supports making changes to the preferred alternative, the Record of Decision will include a discussion of the significant changes and the reason for such changes.

RATIONALE FOR SELECTION OF PREFERRED ALTERNATIVE

The selection of the preferred alternative is accomplished through the evaluation of the nine criteria as specified in the NCP.

Alternative 3 with DMM Scenario B meets the threshold criteria of Overall Protection of Human Health and the Environment and Compliance with ARARs. This alternative, which relies on an engineered cap bank-to-bank over the entire FFS Study Area and remediates all of the contaminated sediment in the FFS Study Area, achieves substantial risk reduction and controls the major source of contamination to the rest of the river and Newark Bay. Within a reasonable time frame after construction completion, EPA expects to be able to recommend to NJDEP that fish and crab consumption advisories, incorporated to ensure protection of human health, be relaxed as interim remediation milestones are achieved. The preferred alternative fulfills all of the RAOs for the FFS Study Area and would accommodate the reasonably-anticipated future waterway use in the federally-authorized navigation channel identified by USACE's survey of commercial users. Following are the key factors that led EPA to propose this alternative-DMM scenario combination over the others:

- Alternative 3 achieves substantial risk reduction and controls the major source of contamination to the rest of the river and Newark Bay by sequestering all of the contaminated sediments remaining in the FFS Study Area at the completion of the remedy under a bank-to-bank engineered cap. While engineered caps must be monitored and maintained in perpetuity, they have been demonstrated to be effective in the long-term at multiple Superfund sites around the country.
- DMM Scenario B relies on permitted incinerators and landfills that are proven to be reliable technologies and already have provisions for long-term monitoring and maintenance by their owners and operators. In contrast, the local decontamination technologies in DMM Scenario C have never been built and operated in the United States to handle as much as 4.3 million cy of dredged materials.
- Alternative 3 reduces volume in the FFS Study Area by removing 4.3 million cy of contaminated sediments, including 8 kg of 2,3,7,8-TCDD, 16,000 kg of mercury, 7,000 kg of PCBs and 800 kg of DDT among others. Alternative 3 reduces mobility in the FFS Study Area by sequestering the remaining 5.4 million cy of contaminated sediments under an engineered cap that would be maintained in perpetuity. Overall toxicity and volume are reduced by incinerating the 7 percent of dredged materials estimated to be characterized as hazardous under RCRA, while overall mobility is effectively eliminated by disposing of the remaining volume (and the ash from incineration) into a landfill.
- While both Alternatives 2 and 3 meet the threshold criterion of protectiveness, Alternative 3 does so in half the construction duration of Alternative 2 and a smaller volume dredged than Alternative 2. This means that there would be significantly less short-term impact on the community, workers and the environment.
- DMM Scenario B has less of an on-land impact than DMM Scenario C, since off-site disposal would involve fewer acres for, and less processing at, the upland processing facility than local decontamination. DMM Scenario B has significantly less impact on the aquatic environment than DMM Scenario A, since CAD cells, unlike off-site disposal, would involve managing the placement of dredged materials on 80 acres of Newark Bay bottom over 5 years, potentially impacting species that are dependent on limited bay bottom habitat for critical life stages. In addition, CAD cells could increase the potential that fish and birds could be exposed to highly concentrated contamination in the CAD cells, and increase the potential for waterborne commerce accidents in the busy port.
- The dredging and engineered cap components in Alternative 3 have been demonstrated to be technically and administratively feasible at various other Superfund sites. Alternative 3 is more implementable than Alternative 2, because Alternative 3 involves a significantly smaller dredging volume and shallower dredging depths than Alternative 2, which means less challenging logistics for sediment handling and fewer utilities to be located and evaluated. Alternative 3 is more implementable than Alternative 4, because Alternative 3 does not rely on identifying discrete areas of the river that release high fluxes of contaminants into the

water column, and Alternative 3 does not face the administrative implementability hurdle that Alternative 4 faces with respect to obtaining deauthorization of the federally-authorized navigation channel in the lower 2.2 miles of the river.

- The incinerators and landfills included in DMM Scenario B are existing facilities that have the ability to handle FFS Study Area materials. In contrast, because the State of New Jersey strongly opposes construction of a CAD site in Newark Bay, that scenario is likely to face such severe legal and administrative impediments as to make DMM Scenario A administratively infeasible. In DMM Scenario C, sediment washing technologies failed to demonstrate the ability to reduce Lower Passaic River sediment contamination to levels low enough for beneficial re-use, and thermal treatment technology vendors have not sited or constructed commercial-scale facilities with the demonstrated ability to process the large volumes of sediment that would be dredged under Alternative 3.
- At a present value of $1.73 billion, Alternative 3-DMM Scenario B is less costly than the two most costly alternative-DMM scenario combinations, although more costly than three others (excluding costs for Alternatives 1 and 4, which do not meet the protectiveness threshold criterion).
- The State of New Jersey has expressed support for the combination of Alternative 3 and DMM Scenario B.
- Community Acceptance will be evaluated in the ROD following review of the public comments received on the Proposed Plan.

DMM Scenario C does offer some advantages in terms of permanence, reduction of toxicity, mobility and volume through treatment, as well as future sustainability (although this last point is not one of the nine criteria). However, none of the decontamination technologies tested during the FFS development period proved implementable on a commercial scale, particularly with the large volumes contemplated by any FFS Study Area active alternative. Several sediment decontamination vendors are continuing to develop their technologies and continue to express interest in handling Lower Passaic River sediments. It is possible that one or more vendors might succeed in demonstrating that their technology could decontaminate Lower Passaic River sediments and might be able to site and construct a decontamination technology facility in the New York-New Jersey Harbor Estuary. Should this happen during the remedy design phase, EPA could modify the selected remedy through a ROD amendment or Explanation of Significant Differences in such a way as to allow for local decontamination and beneficial use (DMM Scenario C) of all or a portion of the sediment.

Based on information currently available, EPA believes the preferred alternative meets the threshold criteria and provides the best balance of tradeoffs among the alternatives with respect to the balancing and modifying criteria. The preferred alternative would satisfy the statutory requirements of CERCLA §121(b) by being protective of human health and the environment; complying with ARARs; and being cost-effective. Although CERCLA 121(b) also expresses a preference for selection of remedial actions that use permanent solutions and treatment technologies to the maximum extent practicable, there are situations that may limit the use of treatment, including when treatment technologies are not technically feasible or when the extraordinary size or complexity of a site makes implementation of treatment technologies impracticable. The preferred alternative would generate approximately 4.3 million cy of contaminated sediments, which is clearly an extraordinary volume of materials; and the sediment treatment technologies investigated under DMM Scenario C have not been constructed or operated in the United States on a scale approaching the capacity needed for this project, so their technical ability to handle such an extraordinary volume of highly contaminated sediments is uncertain. The preferred alternative is expected to provide treatment of approximately

250,000 cy of contaminated sediment through incineration off-site to comply with applicable RCRA standards.

In its 2007 report on sediment dredging at Superfund sites, the National Research Council (NRC) noted the "difficulty in predicting dredging effectiveness and the limited number of available alternative technologies" (p. 244). The NRC also noted that environmental responses to remediation are complex and difficult to predict (p. 252). The NRC recommended an "adaptive management approach which it defined as "[t]he use of a structured process of selecting a management action, monitoring the effects of the action, and applying those lessons to optimize a management action…" (p.244). The NRC noted it is "context-specific" and involves an active learning process. The NRC also noted that this adaptive management is not a means to permit or sanction a less rigorous cleanup or avoid public input, and stressed the importance of working in concert with site stakeholders so they can contribute to adapting the remedy if necessary. The NRC also stated it is important not only to evaluate new information as it becomes available, but also to document those circumstances that might require deviations from the plan.

Given the complexity and uncertainty involved with remediating sediment sites, especially at such a large scale, as recommended by the NRC, EPA expects to employ an adaptive management approach during the remedial design and implementation of the remedy. This will allow for appropriate adjustments to ensure efficient and effective remediation. Information critical to the successful implementation of the remedy can be evaluated, models may be reviewed and updated and new projections made which will provide the opportunity for the remedial action to be modified, if appropriate. Any remedy modifications will be made and documented in accordance with the CERCLA process, through an Explanation of Significant Differences or an Amendment to the ROD.

Furthermore, EPA will evaluate remedy performance and modify operations to more efficiently attain RAOs. This ensures that uncertainties are promptly and effectively addressed, informs specific design decisions, and addresses concerns about how this action will be integrated with the ongoing RI/FS for the 17 miles Lower Passaic River Study Area being carried out by the CPG under EPA oversight.

FOR FURTHER INFORMATION

The administrative record file, which contains copies of the Proposed Plan and supporting documentation, is available at the following locations:

Newark Public Library
5 Washington Street, Newark, NJ 07101
(973) 733-7784
Hours: Mon, Fri, Sat, 9:00 AM - 5:15 PM
Tues, Wed, Thurs, 9:00 AM – 8:15 PM

Elizabeth Public Library
11 South Broad Street, Elizabeth, NJ 07202
(908) 354-6060
Hours: Mon – Thurs, 9:00 AM – 9:00 PM
Fri, 10:00 AM – 9:00 PM
Sat, 9:00 AM – 5:00 PM

EPA Region 2, Superfund Records Center
290 Broadway, 18th Floor, New York, NY 10007
(212) 637-4308
Hours: Mon - Fri, 9:00 AM - 5:00 PM

In addition, select documents from the administrative record are available online at:

http://www.OurPassaic.org
http://www.epa.gov/region02/superfund/npl/diamondalkali

Additional information about Newark Bay can be found at:

http://www.OurNewarkBay.org

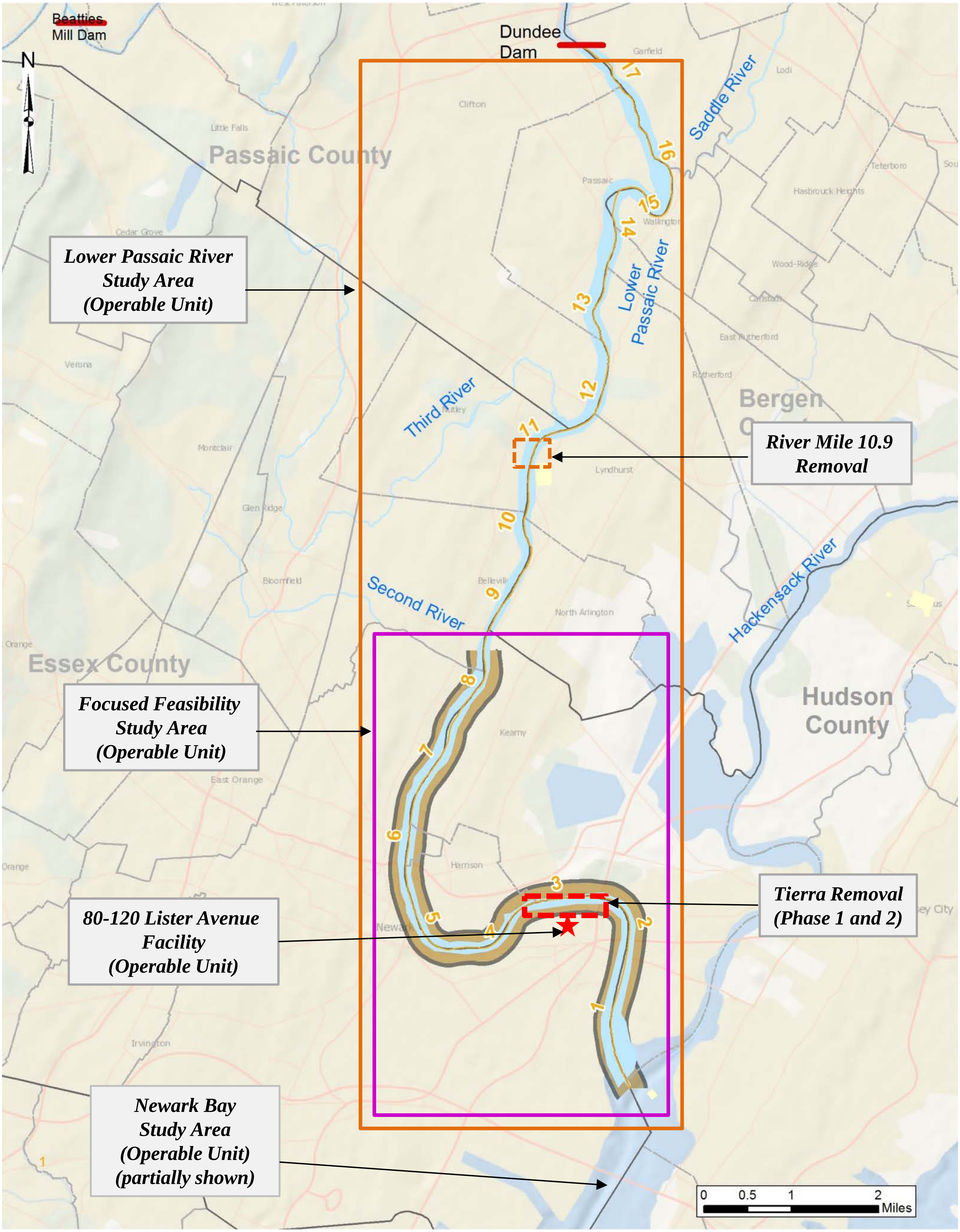
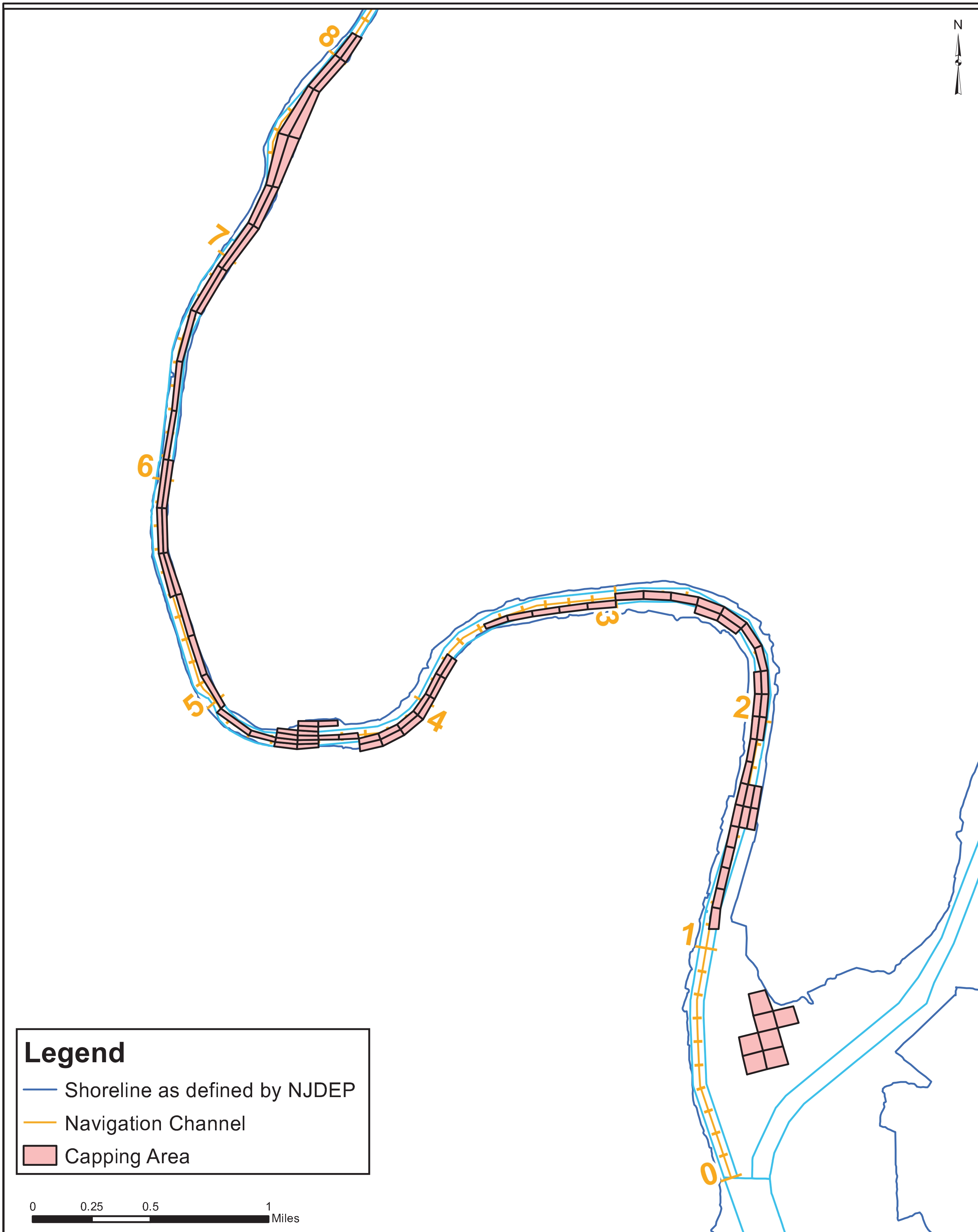


Figure 1 – Map of Diamond Alkali Superfund Site Operable Units and Removal Actions



Capping Area for Alternative 4

Lower Eight Miles of the Lower Passaic River

Figure 2

2014