Appendix B

Sediment TBCs

Development of Preliminary Remediation Goals

Sediment TBCs

Table B-1: Bibliography of Chemical-Specific TBCs for Sediment
Focused Feasibility Study
Lower Passaic River Restoration Project

Screening Value	Source	Document	URL for Document	Date	Comment
TBC	USEPA Region 4, 2001	USEPA Region 4 Waste Management Division Sediment Screening Values for Hazardous Waste Sites	http://www.epa.gov/region4/waste/ots/ecolbul.htm, accessed September 11, 2006	November, 2001	Ecological screening values are based on contaminant levels associated with a low probability of unacceptable risks to ecological receptors. The Office of Technical Services (OTS) has developed the screening values for surface water, sediment, and soil for use at Region 4 hazardous waste sites. Since these numbers are based on conservative endpoints and sensitive ecological effects data, they represent a preliminary screening of site contaminant levels to determine if there is a need to conduct further investigations at the site. Ecological screening values should not be used as remediation levels. For sediments, these are the higher of two values, the EPA Contract Laboratory Program Practical Quantitation Limit and the Effects Value, which is the lower of the Effects Range – Low and the TEL. These are possible effects benchmarks.
TBC	USEPA Region 5, 2003	RCRA Ecological Screening Levels	http://www.epa.gov/reg5rcra/ca/ESL.pdf, accessed September 11, 2006	August, 2003	Environmental Data Quality Levels/Ecological Screening Levels (EDQLs/ESLs): EDQLs are media-specific (soil, water, sediment, and air) values that can be used for initial screening levels to use in ecological risk assessments; values are included for organics, pesticides, PCBs, and inorganics.
PRG	U.S. EPA Region 9 PRGs	USEPA Region 9 PRGs 2004 Table	http://www.epa.gov/region9/waste/sfund/prg/files/04prgtable.pdf, accessed September 11, 2006	October, 2004	This was not added to our table since an agency decision is required to determine whether or not soil PRGs are applicable to sediment. The study area is an estuary with characteristics that may be very different from a soil environment. Therefore, the soil PRGs may not apply to this site.
TBC	NJDEP 1998	Freshwater Sediment Screening Guidelines (Persaud et al., 1993)	http://www.state.nj.us/dep/srp/regs/sediment/sediment.pdf, accessed September 11, 2006	November, 1998	"The values presented ... are extracted from references cited in N.J.A.C. 7:26E-3.11 and are used by USEPA Region II BTAG for EPA Screening Level Ecological Risk Assessments. Freshwater sediment screening values used for the BEE are the Ontario Lowest Effects Levels (LEL) (Persaud et al., 1993), and marine/estuarine sediment screening values used for the BEE are the Effects Range-Low (ER-L) values (Long et al., 1995)."
TBC	NJDEP 1998	Marine/Estuarine Sediment Screening Guidelines (Long et al., 1995)	http://www.state.nj.us/dep/srp/regs/sediment/sediment.pdf, accessed September 11, 2006	November, 1998	"The values presented ... are extracted from references cited in N.J.A.C. 7:26E-3.11 and are used by USEPA Region II BTAG for EPA Screening Level Ecological Risk Assessments. Freshwater sediment screening values used for the BEE are the Ontario Lowest Effects Levels (LEL) (Persaud et al., 1993), and marine/estuarine sediment screening values used for the BEE are the Effects Range-Low (ER-L) values (Long et al., 1995)."
TBC	NJDEP 1998	Volatile Organic Sediment Screening Guidelines, Freshwater and Estuarine/Marine Systems (MacDonald et al., 1992)	http://www.state.nj.us/dep/srp/regs/sediment/sediment.pdf, accessed September 11, 2006	November, 1998	For volatile organics, "the values indicated … are to be used as sediment screening criteria. The values were obtained from Environment Canada's The Development of Canadian Marine Environmental Quality Guidelines (MacDonald et al., 1992)."
TBC	Selected Integrative Sediment Quality Benchmarks for Marine and Estuarine Sediments: NOAA: ER-L, ER-M	Jones, D.S., G.W. Suter II, R.N. Hull. November 1997. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment-Associated Biota: 1997 Revision. ES/ER/TM-95/R4	http://www.hsrd.ornl.gov/ecorisk/tm95r4.pdf, accessed September 11, 2006	November, 1997	"The National Oceanic and Atmospheric Administration (NOAA) annually collects and chemically analyzes sediment samples from sites located in coastal marine and estuarine environments throughout the United States. These data were used to evaluate three basic approaches to the establishment of effects-based criteria: the EqP approach, the spiked-sediment toxicity test approach, and various methods of evaluating synoptically collected biological and chemical data in field surveys (Long and Morgan 1991). Chemical concentrations observed or predicted by these methods to be associated with biological effects were ranked, and the lower 10th percentile [Effects Range–Low (ER-L)] and median [Effects Range–Median (ER-M)] concentrations were identified.The ER-L and ER-M values were recalculated by Long et al. (1995) after omitting a small amount of freshwater data included in the Long and Morgan (1991) calculations and adding more recent data."
TBC	Selected Integrative Sediment Quality Benchmarks for Marine and Estuarine Sediments: FL DEP: TEL, PEL	Florida Department of Environmental Protection. Source is: MacDonald, D.D. 1994. Approach to the Assessment of Sediment Quality in Florida Coastal Waters. Florida Department of Environmental Protection.	http://www.hsrd.ornl.gov/ecorisk/tm95r4.pdf, accessed September 11, 2006	November, 1997	"The National Oceanic and Atmospheric Administration (NOAA) annually collects and chemically analyzes sediment samples from sites located in coastal marine and estuarine environments throughout the United States. These data were used to evaluate three basic approaches to the establishment of effects-based criteria: the EqP approach, the spiked-sediment toxicity test approach, and various methods of evaluating synoptically collected biological and chemical data in field surveys (Long and Morgan 1991). Chemical concentrations observed or predicted by these methods to be associated with biological effects were ranked, and the lower 10th percentile [Effects Range–Low (ER-L)] and median [Effects Range–Median (ER-M)] concentrations were identified."
TBC	Selected Integrative Sediment Quality Benchmarks for Marine and Estuarine Sediments: NAWQC: Chronic, Subchronic; Fish, Daphnid, Nondaphnid invertebrates	Jones, D.S., G.W. Suter II, R.N. Hull. November 1997. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment-Associated Biota: 1997 Revision. ES/ER/TM-95/R4	http://www.hsrd.ornl.gov/ecorisk/tm95r4.pdf, accessed September 11, 2006	November, 1997	"The EqP approach requires a WQB, a K value, and a measured or assumed site-specific total organic carbon (TOC) value. Because many chemicals do not have National Ambient Water Quality Criteria (NAWQC), sets of WQBs of varying conservatism have been developed at ORNL (Suter and Tsao 1996); consult this publication, or its most recent revision, for a complete discussion of the aquatic benchmarks and their uses. Secondary chronic values are intended to be conservative predictors of effects. If concentrations exceed benchmarks that used the NAWQC, the chemicals must be contaminants of concern because the NAWQC are applicable or relevant and appropriate requirements. Concentrations that exceed Lowest Chronic Value benchmarks indicate a risk of real effects."

Table B-1: Bibliography of Chemical-Specific TBCs for Sediment
Focused Feasibility Study
Lower Passaic River Restoration Project

Screening Value	Source	Document	URL for Document	Date	Comment
TBC	Summary of Selected Toxicity Test- and Screening Level Concentration-Based Sediment Quality Benchmarks for Freshwater Sediments: ARCS TEC, PEC, NEC	Jones, D.S., G.W. Suter II, R.N. Hull. November 1997. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment-Associated Biota: 1997 Revision. ES/ER/TM-95/R4. Assessment and Remediation of Contaminated Sediments Program. Source is: USEPA, 1996. *Calculation and Evaluation of Sediment Effect Concentrations for the Amphipod Hyalella azteca and the Midge Chironomus riparius*, EPA 905-R96-008, Great Lakes National Program Office, Chicago, IL.	http://www.hsrd.ornl.gov/ecorisk/tm95r4.pdf, accessed February 27, 2004	November, 1997	This was not added to our table since an agency decision is required to determine whether or not soil PRGs are applicable to sediment. The study area is an estuary with characteristics that may be very different from a soil environment. Therefore, the soil PRGs may not apply to this site.
TBC	Summary of Selected Toxicity Test- and Screening Level Concentration-Based Sediment Quality Benchmarks for Freshwater Sediments: Ontario MOE	Jones, D.S., G.W. Suter II, R.N. Hull. November 1997. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment-Associated Biota: 1997 Revision. ES/ER/TM-95/R4. Ontario Ministry of the Environment. Source is Persaud et al. (1993).	http://www.hsrd.ornl.gov/ecorisk/tm95r4.pdf, accessed September 11, 2006	November, 1997	"The Ontario Ministry of the Environment (Ontario MOE) has prepared provincial sediment quality guidelines using the SLC approach. These values are based on Ontario sediments and benthic species from a wide range of geographical areas within the province (Persaud et al. 1993). The lowest effect level (Low) is the level at which actual ecotoxic effects become apparent. The severe effect level (Severe) represents contaminant levels that could potentially eliminate most of the benthic organisms (Persaud et al. 1993). These “Low” and “Severe” effect values are potential SQBs and are presented in Table 4. Although SLC-derived values are based on biological effects and are suitable for all classes of chemicals and most types of sediment, the endpoint used to derive them (species absence) is considered insensitive (MacDonald 1994). Therefore, the SLC values may not be adequately protective."
TBC	Sediment Screening Values	Jones, D.S., G.W. Suter II, R.N. Hull. November 1997. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment-Associated Biota: 1997 Revision. ES/ER/TM-95/R4. Office of Solid Waste and Emergency Response (OSWER). 1996. "Ecotox Thresholds," *ECO Update* 3(2):1-12.	http://www.hsrd.ornl.gov/ecorisk/tm95r4.pdf, accessed September 11, 2006	November, 1997	"EPA's OSWER has published Ecotox Thresholds (ETs) intended to be used for screening contaminants at CERCLA sites (OSWER 1996) for 8 metals and 41 organics in sediments. The preferred method for determining sediment ETs is to use the proposed SQC values, which are derived using the EqP method. Superfund has elected to use the lower limit of the 95% confidence interval as the ET, rather than the central tendency value, to maintain an appropriate level of conservatism for screening purposes (OSWER 1996). The SQC ETs in Table 5 are normalized to 1% TOC. SQBs are used when SQCs are not available. The SQB is calculated in the same manner as the SQC except that a Tier II Secondary Chronic Value is used. Four of these are from the Great Lakes Water Quality Initiative, 12 are from Suter and Mabrey (1994), and 17 were calculated by OSWER (1996). Three chemicals with OSWER-derived Secondary Chronic Values (endosulfan, methoxyclor, and malathion) had NAWQCs, but the criteria were judged to be old and unreliable. Tier II values were not derived if no daphnia acute values were available. The SQB ETs in Table 5 are normalized to 1% TOC. The ER-L value is used if neither an SQC nor an SQB was available. OSWER noted that there is relatively low correlation between the incidence of effects and the ER-Ls for mercury, nickel, total PCBs, and DDT (Long et al. 1995) and that the ETs for these four chemicals should be used cautiously."
TBC	Canadian Sediment Quality	Canadian Sediment Quality Guidelines for the Protection of Aquatic Life. (Canadian Council of Ministers of the Environment) 1999. updated 2001.	http://www.ec.gc.ca/ceqg-rcqe/English/PDF/sediment_summary_table.pdf, accessed September 11, 2006	2001	Dioxin and furan values given in the units of ng TEQ/kg, or Toxicity Equivalence Quotient.

Table B-2: Sediment Screening Values
Focused Feasibility Study
Lower Passaic River Restoration Project

ARAR: Applicable or Relevant and Appropriate Requirement
PRG: Preliminary Remediation Goal
TBC: To Be Considered

CAS No.	Description	Class	TBC (1) USEPA Region 4, 2001			TBC (2) USEPA Region 5, 2003	TBC (3) NJDEP 1998		TBC (3) NJDEP 1998		TBC (3) NJDEP 1998
			Region 4 Waste Management Division Sediment Screening Values for Hazardous Waste Sites (note: also given in ARCS)			RCRA Ecological Screening Levels (f)	Freshwater Sediment Screening Guidelines (Persaud et al., 1993) (k)		Marine/Estuarine Sediment Screening Guidelines (Long et al., 1995) (k)		Volatile Organic Sediment Screening Guidelines, Freshwater and Estuarine/Marine Systems (MacDonald et al., 1992)
TOC (used for NJDEP 1998, SEL)	**0.01**		Effects Value	CLP PQL (a)	Screening Value		Lowest Effects Level (LEL)	Severe Effects Level (SEL)	Effects Range - Low (ER-L)	Effects Range - Median (ER-M)	Chronic Value
			Inorg: (mg/kg); Org: (ug/kg)	Inorg: (mg/kg); Org: (ug/kg)	Inorg: (mg/kg); Org: (ug/kg); Dioxin (ng/kg)	(ug/kg)	(mg/kg, dry weight)	Inorg: (mg/kg dry wt); Org: (mg/kg OC, dry wt)	(mg/kg, dry weight)	(mg/kg, dry weight)	(mg/kg dry weight at 1% TOC)
591-78-6	2-HEXANONE (Historical)	VOA				58.2 (j)					
108-10-1	4-METHYL-2-PENTANONE (Historical)	VOA				25.1 (j)					
67-64-1	ACETONE	VOA				9.9 (j)					
71-43-2	BENZENE	VOA				142					0.34
75-25-2	BROMOFORM	VOA				492 (j)					
75-15-0	CARBON DISULFIDE	VOA				23.9 (j)					
108-90-7	CHLOROBENZENE	VOA				291					
67-66-3	CHLOROFORM	VOA				121					
75-27-4	DICHLOROBROMOMETHANE	VOA				--					
100-41-4	ETHYLBENZENE	VOA				175					1.4
74-87-3	METHYL CHLORIDE	VOA				--					
78-93-3	METHYL ETHYL KETONE	VOA				42.4 (j)					
75-09-2	METHYLENE CHLORIDE	VOA				159 (j)					
108-88-3	TOLUENE	VOA				1220 (j)					
127-18-4	Tetrachloroethene	VOA				990					0.45
79-01-6	TRICHLOROETHYLENE	VOA				112(j)					1.6
1330-20-7	XYLENE (Historical) (total)	VOA				433 (j)					>0.12
95-94-3	1,2,4,5-TETRACHLOROBENZENE	SV				1252 (j)					
120-82-1	1,2,4-TRICHLOROBENZENE	SV				5062 (j)					
105-67-9	2,4-DIMETHYLPHENOL	SV				304					
51-28-5	2,4-DINITROPHENOL	SV				6.21					
606-20-2	2,6-DINITROTOLUENE	SV				39.8					
95-57-8	2-CHLOROPHENOL	SV				31.9					
99-09-2	3-NITROANILINE	SV				--					
59-50-7	4-CHLORO-3-METHYLPHENOL	SV				388					
106-44-5	4-METHYLPHENOL	SV				20.2					
100-02-7	4-NITROPHENOL	SV				13.3					
117-81-7	BIS(2-ETHYLHEXYL)PHTHALATE	SV	182 (c)	3.6	182	182 (g)					
85-68-7	BUTYL BENZYL PHTHALATE	SV				1970 (j)					
510-15-6	CHLOROBENZILATE	SV				860					
132-64-9	DIBENZOFURAN	SV				449 (j)					
84-74-2	DI-N-BUTYL PHTHALATE	SV				1114					
117-84-0	DI-N-OCTYL PHTHALATE	SV				40600					
87-68-3	HEXACHLOROBUTADIENE	SV				26.5 (j)					
541-73-1	M-DICHLOROBENZENE (1,3-DCB)	SV				1315 (j)					
86-30-6	N-NITROSO-DI-PHENYLAMINE	SV				--					
621-64-7	N-NITROSO-DI-PROPYLAMINE	SV				--					
95-48-7	O-CRESOL (2-Methylphenol)	SV				55.4					
95-50-1	O-DICHLOROBENZENE (1,2-DCB)	SV				294					
1825-21-4	PENTACHLOROANISOLE	SV									
608-93-5	PENTACHLOROBENZENE	SV				24 (j)					
82-68-8	PENTACHLORONITROBENZENE	SV				--					
108-95-2	PHENOL	SV				49.1					
106-46-7	1,4-Dichlorobenzene	PAH				318 (j)					
90-12-0	1-Methylnaphthalene	PAH									
91-57-6	2-Methylnaphthalene	PAH	20.2 (c)	330	330	20.2 (g)	See Marine/Estuarine	--	0.07	0.67	
83-32-9	Acenaphthene	PAH	6.71 (c)	330	330	6.71 (g)	See Marine/Estuarine	--	0.016	0.5	

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Lower Passaic River Restoration Project

ARAR: Applicable or Relevant and Appropriate Requirement
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TBC: To Be Considered

CAS No.	Description	Class	NOAA: TBC, FL DEP: TBC (4) Jones et al. (1997) Selected Integrative Sediment Quality Benchmarks for Marine and Estuarine Sediments				TBC (5) Jones et al. (1997) Selected Integrative Sediment Quality Benchmarks for Marine and Estuarine Sediments (p)				
TOC (used for NJDEP 1998, SEL)	**0.01**		NOAA (l): ER-L	NOAA (l): ER-M	FL DEP (l): TEL	FL DEP (l): PEL	NAWQC Chronic	Secondary Chronic Value	Fish	Daphnids	Nondaphnid invertebrates
			Inorg: (mg/kg dry wt); Org: (ug/kg dry wt)	Inorg: (mg/kg dry wt); Org: (ug/kg dry wt)	Inorg: (mg/kg dry wt); Org: (ug/kg dry wt)	Inorg: (mg/kg dry wt); Org: (ug/kg dry wt)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)
591-78-6	2-HEXANONE (Historical)	VOA					-- (r)	22 (r)	7,400 (r)	-- (r)	-- (r)
108-10-1	4-METHYL-2-PENTANONE (Historical)	VOA					-- (r)	33 (r)	15,000 (r)	-- (r)	-- (r)
67-64-1	ACETONE	VOA					-- (r)	8.7 (r)	3,000 (r)	9.1 (r)	-- (r)
71-43-2	BENZENE	VOA					--	160	--	> 120,000	--
75-25-2	BROMOFORM	VOA									
75-15-0	CARBON DISULFIDE	VOA					--	0.85	8800	230	--
108-90-7	CHLOROBENZENE	VOA					--	410	7800	97,000	--
67-66-3	CHLOROFORM	VOA					--	22	960	3500	--
75-27-4	DICHLOROBROMOMETHANE	VOA									
100-41-4	ETHYLBENZENE	VOA					--	89	> 5400	160,000	--
74-87-3	METHYL CHLORIDE	VOA									
78-93-3	METHYL ETHYL KETONE	VOA					-- (r)	270 (r)	5,400 (r)	27,000 (r)	-- (r)
75-09-2	METHYLENE CHLORIDE	VOA					--	370	18,000	7200	--
108-88-3	TOLUENE	VOA					--	50	6400	130,000	--
127-18-4	Tetrachloroethene	VOA					--	410	3500	3200	--
79-01-6	TRICHLOROETHYLENE	VOA					--	220	51,000	33,000	--
1330-20-7	XYLENE (Historical) (total)	VOA					--	160	740,000	--	--
95-94-3	1,2,4,5-TETRACHLOROBENZENE	SV									
120-82-1	1,2,4-TRICHLOROBENZENE	SV					--	9600	--	--	--
105-67-9	2,4-DIMETHYLPHENOL	SV									
51-28-5	2,4-DINITROPHENOL	SV									
606-20-2	2,6-DINITROTOLUENE	SV									
95-57-8	2-CHLOROPHENOL	SV									
99-09-2	3-NITROANILINE	SV									
59-50-7	4-CHLORO-3-METHYLPHENOL	SV									
106-44-5	4-METHYLPHENOL	SV									
100-02-7	4-NITROPHENOL	SV									
117-81-7	BIS(2-ETHYLHEXYL)PHTHALATE	SV	--	--	182	2647	--	890,000	--	--	--
85-68-7	BUTYL BENZYL PHTHALATE	SV					--	11,000	--	--	--
510-15-6	CHLOROBENZILATE	SV									
132-64-9	DIBENZOFURAN	SV					--	420	--	110,000	--
84-74-2	DI-N-BUTYL PHTHALATE	SV					--	11,000	240,000	240,000	--
117-84-0	DI-N-OCTYL PHTHALATE	SV									
87-68-3	HEXACHLOROBUTADIENE	SV									
541-73-1	M-DICHLOROBENZENE (1,3-DCB)	SV					--	1700	-	--	--
86-30-6	N-NITROSO-DI-PHENYLAMINE	SV									
621-64-7	N-NITROSO-DI-PROPYLAMINE	SV									
95-48-7	O-CRESOL (2-Methylphenol)	SV					-- (r)	12 (r)	440 (r)	1200 (r)	-- (r)
95-50-1	O-DICHLOROBENZENE (1,2-DCB)	SV					--	330	--	--	--
1825-21-4	PENTACHLOROANISOLE	SV									
608-93-5	PENTACHLOROBENZENE	SV					--	700	--	--	--
82-68-8	PENTACHLORONITROBENZENE	SV									
108-95-2	PHENOL	SV					31	--	< 57	570	--
106-46-7	1,4-Dichlorobenzene	PAH					--	340	--	--	--
90-12-0	1-Methylnaphthalene	PAH					--	130	34000	--	--
91-57-6	2-Methylnaphthalene	PAH	70	670	20.2	201					
83-32-9	Acenaphthene	PAH	16	500	6.71	88.9	1300 (q)	--	5300	470,000	16,000

Table B-2: Sediment Screening Values
Focused Feasibility Study
Lower Passaic River Restoration Project

ARAR: Applicable or Relevant and Appropriate Requirement
PRG: Preliminary Remediation Goal
TBC: To Be Considered

CAS No.	Description	Class	TBC (6) Jones et al. (1997) Summary of Selected Toxicity Test- and Screening Level Concentration-Based Sediment Quality Benchmarks for Freshwater Sediments					TBC (7) Jones et al. (1997) Sediment Screening Values (aa)		TBC (8) Canadian Sediment Guidelines			
										Interim Freshwater Sediment Quality Guidelines (dd)		Interim Marine Sediment Quality Guidelines (dd)	
TOC (used for NJDEP 1998, SEL)	**0.01**		ARCS (b) - TEC	ARCS (u) - PEC	ARCS (u) - NEC	Ontario MOE (v) - Low	Ontario MOE (v) - Severe	OSWER (bb)		ISQG (dd)	PEL (dd)	ISQG (dd)	PEL (dd)
			Inorg: (mg/kg dry wt); Org: (ug/kg dry wt)	Inorg: (mg/kg dry wt); Org: (ug/kg dry wt)	Inorg: (mg/kg dry wt); Org: (ug/kg dry wt)	Inorg: (mg/kg dry wt); Org: (ug/kg dry wt)	Inorg: (mg/kg dry wt); Org: (ug/kg dry wt)	Inorg: (mg/kg dry wt); Org: (ug/kg dry wt)	Type (cc)	ug/kg	ug/kg	ug/kg	ug/kg
591-78-6	2-HEXANONE (Historical)	VOA											
108-10-1	4-METHYL-2-PENTANONE (Historical)	VOA											
67-64-1	ACETONE	VOA											
71-43-2	BENZENE	VOA						57	SQB				
75-25-2	BROMOFORM	VOA											
75-15-0	CARBON DISULFIDE	VOA											
108-90-7	CHLOROBENZENE	VOA						820	SQB				
67-66-3	CHLOROFORM	VOA											
75-27-4	DICHLOROBROMOMETHANE	VOA											
100-41-4	ETHYLBENZENE	VOA						3600	SQB				
74-87-3	METHYL CHLORIDE	VOA											
78-93-3	METHYL ETHYL KETONE	VOA											
75-09-2	METHYLENE CHLORIDE	VOA											
108-88-3	TOLUENE	VOA						670	SQB				
127-18-4	Tetrachloroethene	VOA						530	SQB				
79-01-6	TRICHLOROETHYLENE	VOA						1600	SQB				
1330-20-7	XYLENE (Historical) (total)	VOA						25	SQB				
95-94-3	1,2,4,5-TETRACHLOROBENZENE	SV											
120-82-1	1,2,4-TRICHLOROBENZENE	SV						9200	SQB				
105-67-9	2,4-DIMETHYLPHENOL	SV											
51-28-5	2,4-DINITROPHENOL	SV											
606-20-2	2,6-DINITROTOLUENE	SV											
95-57-8	2-CHLOROPHENOL	SV											
99-09-2	3-NITROANILINE	SV											
59-50-7	4-CHLORO-3-METHYLPHENOL	SV											
106-44-5	4-METHYLPHENOL	SV											
100-02-7	4-NITROPHENOL	SV											
117-81-7	BIS(2-ETHYLHEXYL)PHTHALATE	SV						--					
85-68-7	BUTYL BENZYL PHTHALATE	SV						11,000	SQB				
510-15-6	CHLOROBENZILATE	SV											
132-64-9	DIBENZOFURAN	SV						2000	SQB				
84-74-2	DI-N-BUTYL PHTHALATE	SV						11,000	SQB				
117-84-0	DI-N-OCTYL PHTHALATE	SV											
87-68-3	HEXACHLOROBUTADIENE	SV											
541-73-1	M-DICHLOROBENZENE (1,3-DCB)	SV						1700	SQB				
86-30-6	N-NITROSO-DI-PHENYLAMINE	SV											
621-64-7	N-NITROSO-DI-PROPYLAMINE	SV											
95-48-7	O-CRESOL (2-Methylphenol)	SV											
95-50-1	O-DICHLOROBENZENE (1,2-DCB)	SV						340	SQB				
1825-21-4	PENTACHLOROANISOLE	SV											
608-93-5	PENTACHLOROBENZENE	SV											
82-68-8	PENTACHLORONITROBENZENE	SV											
108-95-2	PHENOL	SV											
106-46-7	1,4-Dichlorobenzene	PAH						350	SQB				
90-12-0	1-Methylnaphthalene	PAH											
91-57-6	2-Methylnaphthalene	PAH						--		20.2	201	20.2	201
83-32-9	Acenaphthene	PAH						620	SQC	6.71	88.9	6.71	88.9

Table B-2: Sediment Screening Values
Focused Feasibility Study
Lower Passaic River Restoration Project

CAS No.	Description	Class	(1) USEPA Region 4, 2001			(2) USEPA Region 5, 2003	(3) NJDEP 1998		(3) NJDEP 1998		(3) NJDEP 1998
			Region 4 Waste Management Division Sediment Screening Values for Hazardous Waste Sites (note: also given in ARCS)			RCRA Ecological Screening Levels (f)	Freshwater Sediment Screening Guidelines (Persaud et al., 1993) (k)		Marine/Estuarine Sediment Screening Guidelines (Long et al., 1995) (k)		Volatile Organic Sediment Screening Guidelines, Freshwater and Estuarine/Marine Systems (MacDonald et al., 1992)
TOC (used for NJDEP 1998, SEL)	**0.01**		Effects Value	CLP PQL (a)	Screening Value		Lowest Effects Level (LEL)	Severe Effects Level (SEL)	Effects Range - Low (ER-L)	Effects Range - Median (ER-M)	Chronic Value
			Inorg: (mg/kg); Org: (ug/kg)	Inorg: (mg/kg); Org: (ug/kg)	Inorg: (mg/kg); Org: (ug/kg); Dioxin (ng/kg)	(ug/kg)	(mg/kg, dry weight)	Inorg: (mg/kg dry wt); Org: (mg/kg OC, dry wt)	(mg/kg, dry weight)	(mg/kg, dry weight)	(mg/kg dry weight at 1% TOC)
208-96-8	Acenaphthylene	PAH	5.87 (c)	330	330	5.87 (g)	See Marine/Estuarine	--	0.044	0.64	
120-12-7	Anthracene	PAH	46.9 (c)	330	330	57.2 (i)	0.22	370	0.085	1.1	
56-55-3	Benzo[a]anthracene	PAH	74.8 (c)	330	330	108 (i)	0.32	1480	0.261	1.6	
50-32-8	Benzo[a]pyrene	PAH	88.8 (c)	330	330	150 (i)	0.37	1440	0.43	1.6	
205-99-2	Benzo[b]fluoranthene	PAH				10400					
192-97-2	Benzo[e]pyrene	PAH					0.37	1440			
191-24-2	Benzo[g,h,i]perylene	PAH				170 (h)	0.17	320	See Freshwater	--	
207-08-9	Benzo[k]fluoranthene	PAH				240 (h)	0.24	1340	See Freshwater	--	
92-52-4	biphenyl	PAH									
218-01-9	Chrysene	PAH	108 (c)	330	330	166 (i)	0.34	460	0.384	2.8	
53-70-3	Dibenz[a,h]anthracene	PAH	6.22 (c)	330	330	33 (i)	0.06	130	0.063	0.26	
206-44-0	Fluoranthene	PAH	113 (c)	330	330	423 (i)	0.75	1020	0.6	5.1	
86-73-7	Fluorene	PAH	21.2 (c)	330	330	77.4 (i)	0.19	160	0.019	0.54	
T_HMW_PAH	High molecular weight PAHs, total (Historical)	PAH	655 (c)	330	655						
193-39-5	Indeno[1,2,3-c,d]-pyrene	PAH				200 (h)	0.2	320	See Freshwater	--	
T_LMW_PAH	Low molecular weight PAHs, total (Historical)	PAH	312 (c)	330	330						
91-20-3	Naphthalene	PAH	34.6 (c)	330	330	176 (i)	See Marine/Estuarine	--	0.16	2.1	
T_PAH	PAHs, total (Historical)	PAH									
85-01-8	Phenanthrene	PAH	86.7 (c)	330	330	204 (i)	0.56	950	0.24	1.5	
129-00-0	Pyrene	PAH	153 (c)	330	330	195 (i)	0.49	850	0.665	2.6	
CARP407	Total PAH	PAH	1684 (c)	330	1684		4	10000	4	45	
7429-90-5	ALUMINUM	MET									
7440-36-0	ANTIMONY	MET	2 (b)	12	12						
7440-38-2	Arsenic	MET	7.24 (c)	2	7.24	9790 (i)	6	33	8.2	70	
7440-43-9	Cadmium	MET	0.676 (c)	1	1	990 (i)	0.6	10	1.2	9.6	
7440-47-3	Chromium	MET	52.3 (c)	2	52.3	43400 (i)	26	110	81	370	
7440-48-4	COBALT	MET				50000 (h)					
7440-50-8	Copper	MET	18.7 (c)	5	18.7	31600 (i)	16	110	34	270	
57-12-5	CYANIDE	MET				0.1 (h)					
7439-89-6	IRON	MET									
7439-92-1	Lead	MET	30.2 (c)	0.6	30.2	35800 (i)	31	250	47	218	
7439-96-5	MANGANESE	MET									
7439-97-6	Mercury	MET	0.13 (c)	0.02	0.13	174 (g)	0.2	2	0.15	0.71	
7440-02-0	Nickel	MET	15.9 (d)	8	15.9	22700 (i)	16	75	21	52	
7782-49-2	SELENIUM	MET				--					
7440-22-4	Silver	MET	0.733 (c)	2	2	500 (h)	See Marine/Estuarine	--	1	3.7	
7440-28-0	Thallium	MET				--					
7440-31-5	TIN	MET				--					
7440-62-2	VANADIUM	MET				--					
7440-66-6	Zinc	MET	124 (c)	4	124	121000 (i)	120	820	150	410	
	2,3,7,8-TCDD (toxic equivalent)										
1746-01-6	2,3,7,8-TCDD	DIOX/F				1.2E-04 (j)					
51207-31-9	2,3,7,8-TCDF	DIOX/F				--					
	Dioxin (ng/kg - Region 4 entry)				2.5 (e)						
PCDD-S	Polychlorinated dibenzo-p-dioxins (ug/kg - Region 5 entry)					0.011					
87-86-5	2,3,4,5,6-PENTACHLOROPHENOL	PCB				23000 (j)					

Table B-2: Sediment Screening Values
Focused Feasibility Study
Lower Passaic River Restoration Project

CAS No.	Description	Class	(4) Jones et al. (1997)				(5) Jones et al. (1997)				
			Selected Integrative Sediment Quality Benchmarks for Marine and Estuarine Sediments				Selected Integrative Sediment Quality Benchmarks for Marine and Estuarine Sediments (p)				
TOC (used for NJDEP 1998, SEL)	**0.01**		NOAA (l): ER-L	NOAA (l): ER-M	FL DEP (l): TEL	FL DEP (l): PEL	NAWQC Chronic	Secondary Chronic Value	Fish	Daphnids	Nondaphnid invertebrates
			Inorg: (mg/kg dry wt); Org: (ug/kg dry wt)	Inorg: (mg/kg dry wt); Org: (ug/kg dry wt)	Inorg: (mg/kg dry wt); Org: (ug/kg dry wt)	Inorg: (mg/kg dry wt); Org: (ug/kg dry wt)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)
208-96-8	Acenaphthylene	PAH	44	640	5.87	128					
120-12-7	Anthracene	PAH	85.3	1100	46.9	245	--	220	27	<620	--
56-55-3	Benzo[a]anthracene	PAH	261	1600	74.8	693	--	110	--	2600	--
50-32-8	Benzo[a]pyrene	PAH	430	1600	88.8	763	--	140	--	3000	--
205-99-2	Benzo[b]fluoranthene	PAH									
192-97-2	Benzo[e]pyrene	PAH									
191-24-2	Benzo[g,h,i]perylene	PAH									
207-08-9	Benzo[k]fluoranthene	PAH									
92-52-4	biphenyl	PAH					--	1100	--	--	--
218-01-9	Chrysene	PAH	384	2800	108	846					
53-70-3	Dibenz[a,h]anthracene	PAH	63.4	260	6.22	135					
206-44-0	Fluoranthene	PAH	600	5100	113	1494	6200 (q)	--	32,000	16,000	--
86-73-7	Fluorene	PAH	19	540	21.2	144	--	540	--	--	--
T_HMW_PAH	High molecular weight PAHs, total (Historical)	PAH	1700 (o)	9600 (o)	655 (o)	6676 (o)					
193-39-5	Indeno[1,2,3-c,d]-pyrene	PAH									
T_LMW_PAH	Low molecular weight PAHs, total (Historical)	PAH	552 (o)	3160 (o)	312 (o)	1442 (o)					
91-20-3	Naphthalene	PAH	160	2100	34.6	391	--	240	12,000	23,000	--
T_PAH	PAHs, total (Historical)	PAH	4022 (o)	44792 (o)	1684 (o)	16770 (o)					
85-01-8	Phenanthrene	PAH	240	1500	86.7	544	1800 (q)	--	--	59,000	--
129-00-0	Pyrene	PAH	665	2600	153	1398					
CARP407	Total PAH	PAH									
7429-90-5	ALUMINUM	MET									
7440-36-0	ANTIMONY	MET	2 (m)	25 (m)	--	--					
7440-38-2	Arsenic	MET	8.2	70	7.24	41.6					
7440-43-9	Cadmium	MET	1.2	9.6	0.68	4.21					
7440-47-3	Chromium	MET	81	370	52.3	160					
7440-48-4	COBALT	MET									
7440-50-8	Copper	MET	34	270	18.7	108					
57-12-5	CYANIDE	MET									
7439-89-6	IRON	MET									
7439-92-1	Lead	MET	46.7	218	30.2	112					
7439-96-5	MANGANESE	MET									
7439-97-6	Mercury	MET	0.15	0.71	0.13	0.7					
7440-02-0	Nickel	MET	20.9	51.6	15.9	42.8					
7782-49-2	SELENIUM	MET									
7440-22-4	Silver	MET	1	3.7	0.73	1.77					
7440-28-0	Thallium	MET									
7440-31-5	TIN	MET									
7440-62-2	VANADIUM	MET									
7440-66-6	Zinc	MET	150	410	124	271					
	2,3,7,8-TCDD (toxic equivalent)										
1746-01-6	2,3,7,8-TCDD	DIOX/F									
51207-31-9	2,3,7,8-TCDF	DIOX/F									
	Dioxin (ng/kg - Region 4 entry)										
PCDD-S	Polychlorinated dibenzo-p-dioxins (ug/kg - Region 5 entry)										
87-86-5	2,3,4,5,6-PENTACHLOROPHENOL	PCB									

Table B-2: Sediment Screening Values
Focused Feasibility Study
Lower Passaic River Restoration Project

CAS No.	Description	Class	(6) Jones et al. (1997)					(7) Jones et al. (1997)		(8) Canadian Sediment Guidelines			
			Summary of Selected Toxicity Test- and Screening Level Concentration-Based Sediment Quality Benchmarks for Freshwater Sediments					Sediment Screening Values (aa)		Interim Freshwater Sediment Quality Guidelines (dd)		Interim Marine Sediment Quality Guidelines (dd)	
TOC (used for NJDEP 1998, SEL)	**0.01**		ARCS (b) - TEC	ARCS (u) - PEC	ARCS (u) - NEC	Ontario MOE (v) - Low	Ontario MOE (v) - Severe	OSWER (bb)		ISQG (dd)	PEL (dd)	ISQG (dd)	PEL (dd)
			Inorg: (mg/kg dry wt); Org: (ug/kg dry wt)	Inorg: (mg/kg dry wt); Org: (ug/kg dry wt)	Inorg: (mg/kg dry wt); Org: (ug/kg dry wt)	Inorg: (mg/kg dry wt); Org: (ug/kg dry wt)	Inorg: (mg/kg dry wt); Org: (ug/kg dry wt)	Inorg: (mg/kg dry wt); Org: (ug/kg dry wt)	Type (cc)	ug/kg	ug/kg	ug/kg	ug/kg
208-96-8	Acenaphthylene	PAH						--		5.87	128	5.87	128
120-12-7	Anthracene	PAH	31.62	547.72	1700	220	3700	--		46.9	245	46.9	245
56-55-3	Benzo[a]anthracene	PAH	260	4200	3500	320	14,800	--		31.7	385	74.8	693
50-32-8	Benzo[a]pyrene	PAH	350	393.7	440	370	14,400	430	ER-L	31.9	782	88.8	763
205-99-2	Benzo[b]fluoranthene	PAH											
192-97-2	Benzo[e]pyrene	PAH											
191-24-2	Benzo[g,h,i]perylene	PAH	290	6300	3800	170	3200						
207-08-9	Benzo[k]fluoranthene	PAH	--	--	--	240	13,400						
92-52-4	biphenyl	PAH						1100	SQB				
218-01-9	Chrysene	PAH	500	5200	4000	340	4600	--		57.1	862	108	846
53-70-3	Dibenz[a,h]anthracene	PAH	--	28.2	870	60	1300	--		6.22	135	6.22	135
206-44-0	Fluoranthene	PAH	64.23	834.27	7500	750	10,200	2900	SQC	111	2355	113	1494
86-73-7	Fluorene	PAH	34.64	651.92	1800	190	1600	--		21.2	144	21.2	144
T_HMW_PAH	High molecular weight PAHs, total (Historical)	PAH	2900	4353.82	51,000	--	--	--					
193-39-5	Indeno[1,2,3-c,d]-pyrene	PAH	78	836.66	3800	200	3200						
T_LMW_PAH	Low molecular weight PAHs, total (Historical)	PAH	786	3369	3040	--	--	--					
91-20-3	Naphthalene	PAH	32.75	687.39	290	--	--	480	SQB	34.6	391	34.6	391
T_PAH	PAHs, total (Historical)	PAH	3553	13,660	84,600	4000	100,000						
85-01-8	Phenanthrene	PAH	--	--	--	560	9500	850	SQC	41.9	515	86.7	544
129-00-0	Pyrene	PAH	570	3225	6100	490	8500	660	ER-L	53	875	153	1398
CARP407	Total PAH	PAH						4000	ER-L				
7429-90-5	ALUMINUM	MET	--	58,030	73,160	--	--						
7440-36-0	ANTIMONY	MET						--					
7440-38-2	Arsenic	MET	12.1	57	92.9	6	33	8.2	ER-L	5900	17,000	7240	4160
7440-43-9	Cadmium	MET	0.592	11.7	41.1	0.6	10	1.2	ER-L	600	3500	700	4200
7440-47-3	Chromium	MET	56	159	312	26	110	81	ER-L	37,000	90,000	52,300	160,000
7440-48-4	COBALT	MET											
7440-50-8	Copper	MET	28	77.7	54.8	16	110	34	ER-L	35,700	197,000	18,700	108,000
57-12-5	CYANIDE	MET											
7439-89-6	IRON	MET	--	--	--	2%	4%						
7439-92-1	Lead	MET	34.2	396	68.7	31	250	47	ER-L	35,000	91,300	30,200	112,000
7439-96-5	MANGANESE	MET	1673	1081	819	460	1110						
7439-97-6	Mercury	MET	--	--	--	0.2	2	0.15	ER-L	170	486	130	700
7440-02-0	Nickel	MET	39.6	38.5	37.9	16	75	21	ER-L				
7782-49-2	SELENIUM	MET											
7440-22-4	Silver	MET						--					
7440-28-0	Thallium	MET											
7440-31-5	TIN	MET											
7440-62-2	VANADIUM	MET											
7440-66-6	Zinc	MET	159	1532	541	120	820	150	ER-L	123,000	315,000	124,000	271,000
	2,3,7,8-TCDD (toxic equivalent)												
1746-01-6	2,3,7,8-TCDD	DIOX/F											
51207-31-9	2,3,7,8-TCDF	DIOX/F											
	Dioxin (ng/kg - Region 4 entry)												
PCDD-S	Polychlorinated dibenzo-p-dioxins (ug/kg - Region 5 entry)									0.85 (ee)	21.5 (ee)	0.85 (ee)	21.5 (ee)
87-86-5	2,3,4,5,6-PENTACHLOROPHENOL	PCB											

Table B-2: Sediment Screening Values
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CAS No.	Description	Class	(1) USEPA Region 4, 2001			(2) USEPA Region 5, 2003	(3) NJDEP 1998		(3) NJDEP 1998		(3) NJDEP 1998
			Region 4 Waste Management Division Sediment Screening Values for Hazardous Waste Sites (note: also given in ARCS)			RCRA Ecological Screening Levels (f)	Freshwater Sediment Screening Guidelines (Persaud et al., 1993) (k)		Marine/Estuarine Sediment Screening Guidelines (Long et al., 1995) (k)		Volatile Organic Sediment Screening Guidelines, Freshwater and Estuarine/Marine Systems (MacDonald et al., 1992)
TOC (used for NJDEP 1998, SEL)	**0.01**		Effects Value	CLP PQL (a)	Screening Value		Lowest Effects Level (LEL)	Severe Effects Level (SEL)	Effects Range - Low (ER-L)	Effects Range - Median (ER-M)	Chronic Value
			Inorg: (mg/kg); Org: (ug/kg)	Inorg: (mg/kg); Org: (ug/kg)	Inorg: (mg/kg); Org: (ug/kg); Dioxin (ng/kg)	(ug/kg)	(mg/kg, dry weight)	Inorg: (mg/kg dry wt); Org: (mg/kg OC, dry wt)	(mg/kg, dry weight)	(mg/kg, dry weight)	(mg/kg dry weight at 1% TOC)
1336-36-3	PCB, TOTAL	PCB_SUM	21.6 (c)	33 (67 for Aroclor 1221)	33 (67 for Aroclor 1221)	59.8 (i)	0.07	530	0.023	0.18	
11096-82-5	Aroclor 1260	PCB-AROCLOR					0.005	24	See Freshwater	--	
11097-69-1	Aroclor 1254	PCB-AROCLOR					0.06	34	See Freshwater	--	
11104-28-2	Aroclor 1221	PCB-AROCLOR		67	67						
11141-16-5	Aroclor 1232	PCB-AROCLOR									
12672-29-6	Aroclor 1248	PCB-AROCLOR					0.03	150	See Freshwater	--	
12674-11-2	Aroclor 1016	PCB-AROCLOR					0.007	53	See Freshwater	--	
53469-21-9	Aroclor 1242	PCB-AROCLOR									
	DDD		2 (b)	3.3	3.3						
	DDE		2 (b)	3.3	3.3						
	DDT		1 (b)	3.3	3.3						
72-54-8	4,4'-DDD	PEST	1.22 (c)	3.3	3.3	4.88 (i,j)	0.008	0.06			
72-55-9	4,4'-DDE	PEST	2.07 (c)	3.3	3.3	3.16 (i)	0.005	0.19	0.0022	0.027	
50-29-3	4,4'-DDT	PEST	1.19 (c)	3.3	3.3	4.16 (i)					
	2,4'-DDD + 4,4'-DDD	PEST									
	2,4'-DDT + 4,4'-DDT	PEST					0.008	0.71			
	DDT, Total	PEST									
309-00-2	Aldrin	PEST				2 (h)	0.002	8	See Freshwater	--	
319-84-6	BHC, alpha	PEST				6 (h)	0.006	10			
319-85-7	BHC, beta	PEST				5 (h)	0.005	21			
319-86-8	BHC, delta	PEST				71500					
58-89-9	BHC, gamma (Lindane)	PEST	0.32 (c)	3.3	3.3	2.37 (i)	0.003	1			
BHC_TOTAL	BHCs, total (Historical)	PEST					0.003	12	See Freshwater	--	
57-74-9	CHLORDANE	PEST	0.5 (b)	1.7	1.7	3.24 (i,j)	0.007	6	See Freshwater	--	
DDT_TOTAL	DDTS, total of 6 isomers (Historical)	PEST					0.007	12	0.0016	0.046	
60-57-1	Dieldrin	PEST	0.02 (b)	3.3	3.3	1.9 (i,j)	0.002	91	See Freshwater	--	
1031-07-8	Endosulfan sulfate	PEST				34.6					
959-98-8	Endosulfan, alpha	PEST				3.26					
33213-65-9	Endosulfan, beta	PEST				1.94					
72-20-8	Endrin	PEST	0.02 (b)	3.3	3.3	2.22 (i,j)	0.003	130	See Freshwater	--	
7421-93-4	Endrin aldehyde	PEST				480 (j)					
76-44-8	Heptachlor	PEST				0.6 (g)					
1024-57-3	Heptachlor epoxide	PEST				2.47 (i)	0.005	5	See Freshwater	--	
118-74-1	Hexachlorobenzene	PEST				20 (h)	0.02	24	See Freshwater	--	
72-43-5	Methoxychlor	PEST				13.6					
2385-85-5	Mirex	PEST					0.007	130	See Freshwater	--	
CARP406	Total DDT	PEST	1.58 (d)	3.3	3.3						
8001-35-2	Toxaphene	PEST				0.077 (j)					
CARP409	TPH	TPH									

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CAS No.	Description	Class	(4) Jones et al. (1997)				(5) Jones et al. (1997)				
			Selected Integrative Sediment Quality Benchmarks for Marine and Estuarine Sediments				Selected Integrative Sediment Quality Benchmarks for Marine and Estuarine Sediments (p)				
TOC (used for NJDEP 1998, SEL)	**0.01**		NOAA (l): ER-L	NOAA (l): ER-M	FL DEP (l): TEL	FL DEP (l): PEL	NAWQC Chronic	Secondary Chronic Value	Fish	Daphnids	Nondaphnid invertebrates
			Inorg: (mg/kg dry wt); Org: (ug/kg dry wt)	Inorg: (mg/kg dry wt); Org: (ug/kg dry wt)	Inorg: (mg/kg dry wt); Org: (ug/kg dry wt)	Inorg: (mg/kg dry wt); Org: (ug/kg dry wt)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)
1336-36-3	PCB, TOTAL	PCB_SUM	22.7	180	21.6	189					
11096-82-5	Aroclor 1260	PCB-AROCLOR					--	4,500,000	< 63,000	--	--
11097-69-1	Aroclor 1254	PCB-AROCLOR					--	810	--	71,000	--
11104-28-2	Aroclor 1221	PCB-AROCLOR					--	120	25,000	--	--
11141-16-5	Aroclor 1232	PCB-AROCLOR					--	600	130,000	--	--
12672-29-6	Aroclor 1248	PCB-AROCLOR					--	1000	--	--	--
12674-11-2	Aroclor 1016	PCB-AROCLOR									
53469-21-9	Aroclor 1242	PCB-AROCLOR					--	170	29,000	--	16,000
	DDD										
	DDE										
	DDT						--	340 (t)	19,000	420	--
72-54-8	4,4'-DDD	PEST	--	--	1.22	7.81	--	110	17,000	--	--
72-55-9	4,4'-DDE	PEST	2.2	27	2.07	374					
50-29-3	4,4'-DDT	PEST	--	--	1.19	4.77					
	2,4'-DDD + 4,4'-DDD	PEST	2 (m)	20 (m)	--	--					
	2,4'-DDT + 4,4'-DDT	PEST	1 (m)	7 (m)	--	--					
	DDT, Total	PEST	1.58 (n)	46.1 (n)	3.89 (n)	51.7 (n)					
309-00-2	Aldrin	PEST									
319-84-6	BHC, alpha	PEST	--	--	--	--	-- (s)	120 (s)	-- (s)	5200 (s)	-- (s)
319-85-7	BHC, beta	PEST	--	--	--	--	-- (s)	120 (s)	-- (s)	5200 (s)	-- (s)
319-86-8	BHC, delta	PEST					-- (s)	120 (s)	-- (s)	5200 (s)	-- (s)
58-89-9	BHC, gamma (Lindane)	PEST	--	--	0.32	0.99	3.7	--	680	670	150
BHC_TOTAL	BHCs, total (Historical)	PEST	--	--	--	--					
57-74-9	CHLORDANE	PEST	0.5 (m)	6 (m)	2.26	4.79	2800	--	26,000	260,000	18,000
DDT_TOTAL	DDTS, total of 6 isomers (Historical)	PEST									
60-57-1	Dieldrin	PEST	0.02 (m)	8 (m)	0.72	4.3	110 (q)	--	--	--	--
1031-07-8	Endosulfan sulfate	PEST									
959-98-8	Endosulfan, alpha	PEST					--	5.5	--	--	--
33213-65-9	Endosulfan, beta	PEST					--	5.5	--	--	--
72-20-8	Endrin	PEST	0.02 (m)	45 (m)	--	--	42 (q)	--	--	--	--
7421-93-4	Endrin aldehyde	PEST									
76-44-8	Heptachlor	PEST					--	68	12,000	31,000	--
1024-57-3	Heptachlor epoxide	PEST									
118-74-1	Hexachlorobenzene	PEST									
72-43-5	Methoxychlor	PEST					--	19	--	--	--
2385-85-5	Mirex	PEST									
CARP406	Total DDT	PEST									
8001-35-2	Toxaphene	PEST									
CARP409	TPH	TPH									

Table B-2: Sediment Screening Values
Focused Feasibility Study
Lower Passaic River Restoration Project

CAS No.	Description	Class	(6) Jones et al. (1997)					(7) Jones et al. (1997)		(8) Canadian Sediment Guidelines			
			Summary of Selected Toxicity Test- and Screening Level Concentration-Based Sediment Quality Benchmarks for Freshwater Sediments					Sediment Screening Values (aa)		Interim Freshwater Sediment Quality Guidelines (dd)		Interim Marine Sediment Quality Guidelines (dd)	
TOC (used for NJDEP 1998, SEL)	**0.01**		ARCS (b) - TEC	ARCS (u) - PEC	ARCS (u) - NEC	Ontario MOE (v) - Low	Ontario MOE (v) - Severe	OSWER (bb)		ISQG (dd)	PEL (dd)	ISQG (dd)	PEL (dd)
			Inorg: (mg/kg dry wt); Org: (ug/kg dry wt)	Inorg: (mg/kg dry wt); Org: (ug/kg dry wt)	Inorg: (mg/kg dry wt); Org: (ug/kg dry wt)	Inorg: (mg/kg dry wt); Org: (ug/kg dry wt)	Inorg: (mg/kg dry wt); Org: (ug/kg dry wt)	Inorg: (mg/kg dry wt); Org: (ug/kg dry wt)	Type (cc)	ug/kg	ug/kg	ug/kg	ug/kg
1336-36-3	PCB, TOTAL	PCB_SUM	31.62	244.66	194	70 (a)	5300 (z)	23	ER-L	34.1	277	21.5	189
11096-82-5	Aroclor 1260	PCB-AROCLOR	--	--	--	5 (x,z)	240 (y,z)						
11097-69-1	Aroclor 1254	PCB-AROCLOR	--	--	--	60 (x,z)	340 (y,z)			60	340	63.3	709
11104-28-2	Aroclor 1221	PCB-AROCLOR											
11141-16-5	Aroclor 1232	PCB-AROCLOR											
12672-29-6	Aroclor 1248	PCB-AROCLOR	--	--	--	30 (x,z)	1500 (y,z)						
12674-11-2	Aroclor 1016	PCB-AROCLOR	--	--	--	7 (x,z)	530 (y,z)						
53469-21-9	Aroclor 1242	PCB-AROCLOR											
	DDD							--		3.54	8.51	1.22	7.81
	DDE							--		1.42	6.75	2.07	374
	DDT							--		1.19	4.77	1.19	4.77
72-54-8	4,4'-DDD	PEST	--	--	--	8	60	--					
72-55-9	4,4'-DDE	PEST	--	--	--	5	190						
50-29-3	4,4'-DDT	PEST						--					
	2,4'-DDD + 4,4'-DDD	PEST											
	2,4'-DDT + 4,4'-DDT	PEST	--	--	--	8	710						
	DDT, Total	PEST	-- (w)	-- (w)	-- (w)	7 (w)	120 (w)						
309-00-2	Aldrin	PEST	--	--	--	2	80						
319-84-6	BHC, alpha	PEST	--	--	--	6	100						
319-85-7	BHC, beta	PEST	--	--	--	5	210						
319-86-8	BHC, delta	PEST											
58-89-9	BHC, gamma (Lindane)	PEST	--	--	--	3 (x,z)	10 (y,z)	3.7	SQB				
BHC_TOTAL	BHCs, total (Historical)	PEST	--	--	--	3	120						
57-74-9	CHLORDANE	PEST	--	--	--	7	60	--		4.5	8.87	2.26	4.79
DDT_TOTAL	DDTS, total of 6 isomers (Historical)	PEST											
60-57-1	Dieldrin	PEST	--	--	--	2	910	52	SQC	2.85	6.67	0.71	4.3
1031-07-8	Endosulfan sulfate	PEST											
959-98-8	Endosulfan, alpha	PEST						2.9	SQB				
33213-65-9	Endosulfan, beta	PEST						14	SQB				
72-20-8	Endrin	PEST	--	--	--	3	1300	20	SQC	2.67	62.4	2.67	62.4
7421-93-4	Endrin aldehyde	PEST											
76-44-8	Heptachlor	PEST											
1024-57-3	Heptachlor epoxide	PEST	--	--	--	5 (x)	50 (y)			0.6	2.74	0.69	2.74
118-74-1	Hexachlorobenzene	PEST				20	240						
72-43-5	Methoxychlor	PEST						19	SQB				
2385-85-5	Mirex	PEST	--	--	--	7	1300						
CARP406	Total DDT	PEST						1.6	ER-L				
8001-35-2	Toxaphene	PEST						28	SQB	0.1		0.1	
CARP409	TPH	TPH											

Table B-2: Sediment Screening Values
Focused Feasibility Study
Lower Passaic River Restoration Project

(1) USEPA 2001 Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment. Originally published November 1995. Website version last updated November 30, 2001: http://www.epa.gov/region4/waste/ots/ecolbul.htm

(a): Contract Laboratory Program Practical Quantification Limit.

(b): Long, Edward R., and Lee G. Morgan. 1991. The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program. NOAA Technical Memorandum NOS OMA 52.

(c): MacDonald, D.D. 1994. Approach to the Assessment of Sediment Quality in Florida Coastal Waters. Florida Department of Environmental Protection.

(d): Long, Edward R., Donald D. MacDonald, Sherri L. Smith, and Fred D. Calder. 1995. Incidence of Adverse Biological Effects within Ranges of Chemical Concentrations in Marine and Estuarine Sediments. Environmental Management 19(1):81-97.

(e): USEPA. 1993. Interim Report on Data and Methods for Assessment of 2,3,7,8 - Tetrachlorodibenzo-p-dioxin Risks to Aquatic Life and Associated Wildlife. EPA/600/R-93/055.

(2) USEPA 2003 U.S. EPA, Region 5, RCRA. Ecological Screening Levels. August 22, 2003.

(f): Unless noted otherwise, all sediment Ecological Screening Levels were derived using equilibrium partitioning equation and the corresponding water ESL. $ESL_{sediment} = K_{oc} \times ESL_{water} \times 0.01$

(g): Environment Canada. September 1994. Interim Sediment Quality Assessment Values. Ecosystem Conservation Directorate. Evaluation and Interpretation Branch.

(h): Ontario Ministry of the Environment. August 1993. Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario.

(i): Consensus based threshold effect concentrations (TECs) as presented in MacDonald et al., 2000. Development and evaluation of consensus-based guidelines for freshwater ecosystems.
Arch Environ Contam Toxicol 39:20-31 (see Table 2 of Region 5 ESLs). The TEC for mercury had a high incidence of toxicity and was not used.
These values do not consider bioaccumulation or biomagnification.

(j): New ESL data is lower than the previous table.

(3) NJDEP, 1998 Guidance for Sediment Quality Evaluations. NJDEP. November 1998.

(k): NJDEP = New Jersey Department of Environmental Protection; LEL = Lowest Effect Level; SEL = Severe Effect Level; LEL are ecological screening levels to be used in the Baseline Ecological Evaluation.

(4) Jones et al. (1997) Jones, D.S., G.W. Suter II, R.N. Hull. November 1997. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment-Associated Biota: 1997 Revision. ES/ER/TM-95/R4

(l): NOAA = National Oceanic and Atmospheric Administration; ER-L = Effects Range-Low; ER-M = Effects Range Median; except where noted, effects levels are the updated and revised values from Long et al. (1995).
FL DEP = Florida Department of Environmental Protection; TEL = Threshold Effects Level; PEL = Probable Effects Level. Source document is MacDonald (1994).

(m): Source document is Long and Morgan (1991).

(n): Total DDT is the sum of the concentrations of the o,p'- and p,p'-isomers of DDD, DDE, and DDT.

(o): LMW = low molecular weight and is the sum of the concentrations of acenaphthene, acenaphthylene, anthracene, fluorene, 2-methylnaphthalene, naphthalene, and phenanthrene.
HMW = high molecular weight and is the sum of the concentrations of benz(a)anthracene, benzo(a)pyrene, chrysens, dibenzo(a,h)anthracene, fluoranthene, and pyrene.
Total is the sum of the concentrations of the aforementioned low and high molecular weight PAHs.

(5) Jones et al. (1997) Equilibrium Partitioning-Derived Sediment Quality Benchmarks for Nonionic Organic Chemicals Corresponding to Conventional Aqueous Benchmarks

(p): Conventional aqueous benchmars are presented in Suter and Tsao (1996). Estimated to 2 significant figures assuming 1% TOC.
Estimated sediment quality benchmarks greater than 10% (100,000,000 ug/kg) not included because such concentrations are assumed unlikely to be exceeded under natural conditions [applies to bis(2-ethylhexyl)phthalate and di-n-octylphthalate].

(q): Denotes proposed EPA sediment quality criteria.

(r) Column C denotes polar nonionic compounds, for which the EqP model is likely to provide a conservative estimate of exposure.

(s): Most conservative (i.e., lowest) recommended value for reported configurations. BHC (other) is lowest of alpha-, beta-, and delta-BHC only.

(t): Source is USEPA (1995b) and Source is ATSDR (1989).

(6) Jones et al. (1997) Summary of Selected Toxicity Test- and Screening Level Concentration-Based Sediment Quality Benchmarks for Freshwater Sediments

(u): ARCS = Assessment and Remediation of Contaminated Sediments Program; TEC = Threshold Effect Concentration; PEC = Probable Effect Concentration; NEC = high No Effect Concentration from EPA (1996).

(v): Ontario MOE = Ontario Ministry of the Environment;
Low = lowest effect level and is the 5th percentile of the screening level concentration except where noted otherwise;
Severe = severe effect level and is the 95th percentile of the screening level concentration except where noted otherwise;
Source document is Persaud et al. (1993). Values for organic chemicals were normalized assuming 1% TOC.

(w): Total DDT is the sum of the concentrations of the o,p'- and p,p'-isomers of DDD, DDE, and DDR.

(x): 10th percentile of the screening level concentration.

(y): 90th percentile of the screening level concentration.

(z): Denotes tentative guideline.

(7) Jones et al. (1997) OSWER Sediment Screening Values

(aa): Screening values are presented with the same number of significant digits used in the EPA source documents.

(bb): OSWER = EPA Office of Solid Waste and Emergency Response Ecotox Thresholds (ET). Only the most preferred ET, as defined in OSWER (1996), is presented

(cc): ER-L = effects range-low and, except where noted otherwise, is from Long et al. (1995);
SQC = the lower limit of the 95% confidence interval of the proposed EPA sediment quality criteria, assuming 1% TOC;
SQB = the EPA sediment quality benchmark based EPA Tier II Chronic value (USEPA, Region IV, 1995), assuming 1% TOC.

(8) Canadian Reference Canadian Sediment Quality Guidelines for the Protection of Aquatic Life. (Canadian Council of Ministers of the Environment) 1999. updated 2001.

(dd): ISQG = Interim Sediment Quality Guidelines; PEL = Probable Effects Level

(ee): Values expressed as ng TEC/kg; TEQ = units of Toxicity Equivalence Quotient
Based on WHO 1998 TEF values for fish.

(9) " --" Indicates that the chemical was listed in the guidance document but no value was provided.

(10) Jones et al. (1997) sources:

Long, E.R., and L.G. Morgan. 1991. *The Potential for Biological Effects of Sediment-Sorbed Contaminants in the National Status and Trends Program* , NOAA Technical Memorandum NOS OMA 52, National Oceanic and Atmospheric Administration.

Suter, G.W. II, and C.L. Tsao. 1996. *Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1996 Revision* , ES/ER/TM-96/R2, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

U.S. Environmental Protection Agency, 1995b. *National Sediment Inventory: Documentation of Derivation of Freshwater Sediment Quality* , Office of Water, Washington, D.C.

ATSDR (Agency for Toxic Substances and Disease Registry) 1989. *Toxicological Profile for Selected PCBs* , ATSDR/TP-88/21, U.S. Public Health Service, Washington, D.C.

Persaud, D., R. Jaagumagi, and A. Hayton. August 1993. *Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario* , Ontario Ministry of the Environment and Energy.

Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. "Incidence of Adverse Biological Effects within Ranges of Chemical Concentrations in Marine and Estuarine Sediments," *Environmental Management* **19**(1), 81-97.

U.S. Environmental Protection Agency, Region IV. 1995. *Ecological Screening Values* , Ecological Risk Assessment Bulletin No. 2, Waste Management Division, U.S. Environmental Protection Agency Region IV, Atlanta, GA.

U.S. Environmental Protection Agency. 1996. *Calculation and Evaluation of Sediment Effect Concentrations for the Amphipod Hyalella azteca and the Midge Chironomus riparius* , EPA 905-R96-008, Great Lakes National Program Office, Chicago, IL.

Office of Solid Waste and Emergency Response (OSWER). 1996. "Ecotox Thresholds," *ECO Update* 3(2):1-12.

Development of Preliminary Remediation Goals

LOWER PASSAIC RIVER RESTORATION PROJECT
DEVELOPMENT OF PRELIMINARY REMEDIATION GOALS

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LOWER PASSAIC RIVER RESTORATION PROJECT
DEVELOPMENT OF PRELIMINARY REMEDIATION GOALS

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DEVELOPMENT OF PRELIMINARY REMEDIATION GOALS

Human health and ecological risk assessments (HHRA and ERA, respectively) were conducted to assess the potential for unacceptable risks following exposure to contaminated environmental media in the Lower Passaic River Restoration Project (LPRRP) study area. The risk assessments are provided in Appendix C. The following sections summarize the technical approaches employed and present the preliminary remediation goals (PRG) to support the Draft Focused Feasibility Study (FFS). Health protective PRGs were developed for both sediment and fish media; the latter are provided for consideration during a potential long-term monitoring phase following implementation of a remedial alternative.

1.0 HUMAN HEALTH PRELIMINARY REMEDIATION GOALS

The HHRA [provided as Appendix C of the Draft FFS (Battelle, 2007)] was conducted by estimating carcinogenic risks and noncarcinogenic health hazards for exposures to an adult angler/sportsman and other family members (*i.e.*, adolescent and child) from ingestion of self-caught fish and blue crab from the Lower Passaic River. The results of the HHRA determined that total cancer risks are above the National Contingency Plan (NCP) risk range of 10^{-4} (one in ten thousand) to 10^{-6} (one in a million) and noncancer health hazards are above a hazard quotient (HQ) of 1.0. The following chemicals of potential concern (COPC) have individual cancer risks above 10^{-4}:

- Dioxins/furans as tetrachlorodibenzodioxin (TCDD) toxic equivalency quotients (TEQ) [TCDD TEQ Dioxins/furans (D/F)]
- Polychlorinated biphenyls (PCB) as total PCBs (sum of Aroclors)
- PCB dioxin-like congeners evaluated as TCDD TEQ [TCDD TEQ (PCB)]

The following COPCs have individual noncarcinogenic health hazards above a HQ of 1.0:

- Total PCBs (sum of Aroclors)
- Total chlordane
- Methyl mercury

The HHRA evaluated cancer risks and non-cancer health hazards under a reasonably maximum exposure (RME) and a central tendency exposure (CTE) or average exposure to describe the magnitude and range of exposure that might be incurred by the receptor groups. The United States Environmental Protection Agency (USEPA, 1989) defines the RME as the highest exposure that is reasonably expected to occur at a site. According to USEPA guidance (1995), central-tendency estimates are intended to reflect central (more typical) estimates of exposure or dose. The objective of providing both the RME and CTE exposure cases is to bound the risk estimates, although decisions are based on the RME consistent with the NCP (USEPA, 1985).

1.1 CALCULATION OF PRELIMINARY REMEDIATION GOALS

Human health risk-based PRGs were calculated for fish and crab tissue for those COPCs individually exceeding the NCP criteria of 10^{-4} for cancer risk or 1.0 for noncancer health hazards: namely, TCDD TEQ, total PCBs, total chlordane, and methyl mercury. A PRG based on carcinogenic effects was calculated for total PCBs, but not for the TCDD TEQ (PCB), for two reasons. First, the estimated carcinogenic risks determined during the HHRA for total PCBs and dioxin-like PCB congeners [TCDD TEQ (PCB)] are comparable, and calculated PRGs using both total PCBs and coplanar PCBs separately would not significantly differ. Second, any remedial action based on total PCB PRGs would address the presence of the dioxin-like PCB congeners.

Exposure Assumptions for Fish Ingestion. The PRGs were calculated following Risk Assessment Guidance for Superfund Part B (USEPA, 1991). For this analysis, the exposure assumptions used in the HHRA were used in the calculation of the PRGs. As described in the HHRA, the adult annualized ingestion rate for fish of 25 grams per day (g/day) was based on data collected for recreational freshwater anglers obtained from the Exposure Factors Handbook (EFH) (USEPA, 1997). The ingestion rate is the amount of fish or crab an individual consumes on a daily basis (units g/day) based on averaging the reported consumption rate in one year [365 days per year (days/year)]. As an annualized rate, 25 g/day of fish equates to approximately 40 eight-ounce fish meals per year [25 g/day x 365 days/year, assuming a portion size of eight ounces (USEPA, 1997)].

Exposure Assumptions for Crab Ingestion. There is limited information in the published literature regarding the rates of crab consumption by humans. Studies conducted in the Newark Bay Complex area were reviewed (Burger, 2002; Burger *et al.,* 1999; and May and Burger, 1996) to identify an appropriate consumption rate. Of the studies reviewed, the Burger study (2002) was the only one that contained sufficient information regarding crab consumption in the area of the Lower Passaic River. Therefore, the Burger study (2002) was used to derive the consumption rate used in the HHRA. Based on the crab consumption patterns for people who catch crab only, as reported in Burger (2002), the RME ingestion rate for the adult angler/sportsman was selected as 23 g/day. Separate fish and crab PRGs have not been developed because the ingestion rate for crab of 23 g/day used in the HHRA is very close to the ingestion rate for fish (25 g/day), and as such, PRGs for each tissue type would not be significantly different. Although the ingestion rate used to develop the PRGs is the higher ingestion rate of 25 g/day, the PRGs are applicable to either fish or crab tissue.

Calculations. Equations used to derive PRGs for carcinogenic and noncarcinogenic effects are provided below as Equations 1 and 2, respectively. These equations are the same equations used in the HHRA (refer to Sections 5.1.4 and 5.3 of the HHRA in Appendix C) to calculate the RME chemical intake from ingesting fish/crab and to estimate cancer risk and noncancer health hazards. The equations have been rearranged to solve for the biota tissue concentration (C_b) using substituted target risk levels (*e.g.*, 10^{-6}) and hazard quotients (*e.g.*, 1.0). USEPA (1991) states that an appropriate point of departure for remediation of carcinogenic risk is a concentration that corresponds to a risk of 10^{-6} for one chemical in a particular medium; however, concentrations corresponding to the other risk levels addressed in the NCP (*e.g.*, 10^{-5} and 10^{-4}) also have been used as substituted target risk levels in order to provide a range of concentrations to assist in the risk management decision process. Table 1 provides a summary of the exposure parameter definitions and values.

For carcinogenic effects:

$$C_b = \frac{\text{BW x AT x TR}}{\text{ED x EF x IR x FI x CF x CSF}} \qquad \text{Equation 1}$$

For noncarcinogenic effects:

$$C_b = \frac{\text{BW x AT x THQ}}{\text{ED x EF x IR x FI x CF x } 1/\text{RfD}} \qquad \text{Equation 2}$$

Table 1: Summary of Exposure Parameters for Calculation of PRGs

Exposure Parameter	Definition	Units	Value
C_b	Chemical Concentration in Biota (*i.e.*, fish or crab)	mg/kg	Chemical-specific
TR	Target Risk	unitless	1×10^{-6} 1×10^{-5} 1×10^{-4}
THQ	Target Hazard Quotient	unitless	1.0
IR	Ingestion Rate	grams/meal	227 (8 ounces)[a]
EF	Exposure Frequency	meals/year[b]	40
ED	Exposure Duration	years	24
BW	Body Weight	kg	70
AT	Averaging Time	days	25,550 for carcinogenic effects; 8,760 (ED x 365 days) for noncarcinogenic effects
FI	Fraction from Source	unitless	1.0
CF	Conversion Factor	kg/g	0.001
CSF	Oral Cancer Slope Factor	$(\text{mg/kg-day})^{-1}$	Chemical-specific[c]
RfD	Oral Reference Dose	mg/kg-day	Chemical-specific[c]

mg/kg: milligrams per kilogram
a: Source: New Jersey Department of Environmental Protection (NJDEP), 2006; USEPA, 1997; and USEPA, 2000.
b: 40 meals/year = ~1 fish meal every 1.5 weeks; 12 meals/year = 1 fish meal every month; 6 meals/year = 1 fish meal every other month; 2 meals/year = 1 fish meal every six months.
c: Refer to Table 2.

For development of the PRGs, the IR is defined as the amount of fish (in grams) consumed at one meal. USEPA (1997; 2000) and NJDEP (2006) have identified a value of eight ounces (227 grams) of uncooked fish fillet per 70-kg consumer body weight as an average meal size for adults in the general population. At this time, USEPA recommends that the same default value for meal size be used for shellfish (USEPA,

2000). No cooking loss was assumed for calculation of the PRGs. Oral toxicity values, such as the CSF and RfD, are chemical-specific and are provided in Table 2 for each of the COPCs.

Table 2: Oral Toxicity Values and PRGs Developed for Fish/Crab Tissue

COPC	Oral Toxicity Values	
	CSF	RfD
	$(mg/kg\text{-}day)^{-1}$	mg/kg-day
TCDD TEQ	1.50×10^{5}	NA[a]
Total PCBs	2.00×10^{0}	2.0×10^{-5}
Total Chlordane	3.5×10^{-1}	5.0×10^{-4}
Methyl mercury	NA[b]	1.0×10^{-4}

NA: Not Available
a: No toxicity data at this time.
b: Classification — C; possible human carcinogen, but an oral cancer slope factor has not been developed for this chemical.

Calculated PRGs. The PRGs developed for the adult angler who consumes fish or crab from the Lower Passaic River are summarized in Table 3. When available data indicate that a COPC is associated with both carcinogenic and noncarcinogenic health effects, as is the case for total PCBs and total chlordane, PRGs based on both types of effects were calculated. For total PCBs, it is recommended that the toxicological effect resulting in the more conservative PRG be used to be protective of both types of health effects. Although total chlordane is also associated with both carcinogenic risk and non-cancer health hazards, only the non-cancer health endpoint is considered in selecting the PRG because the current cancer risks estimated for this COPC were within the NCP risk range.

Table 3: Summary of the PRGs Developed for Fish/Crab Tissue

COPC	PRGs[a] for Fish/Crab Tissue for an Adult Angler			
	Cancer PRGs (ng/g)			Noncancer PRGs (ng/g)
	1×10^{-6}	1×10^{-5}	1×10^{-4}	
TCDD TEQ	0.00005	0.00055	0.0055	ND[b]
Total PCBs	4.1	41	410	56
Total Chlordane	23	234	2345	1407
Methyl mercury	ND[c]			281

ng/g: nanograms per gram
ND: Not Determined
a: Assumes 40 eight-ounce fish or crab meals per year.
b: No toxicity data at this time.
c: Classification —There is no quantitative estimate of carcinogenic risk from oral exposure.

1.2 ALTERNATIVE TISSUE CONCENTRATIONS COMPARABLE TO CONSUMPTION ADVISORIES

Statewide fish consumption advisories developed by NJDEP may indicate "do not eat" or do not eat more than one meal per week, one meal per month, four meals per year, or one meal per year, where a meal is defined as an eight-ounce serving (NJDEP, 2006). Additional risk-based tissue concentrations were developed based on the number of fish meals of a specified meal size (*i.e.*, eight ounces) that may be consumed over a period of time as is often prepared for fish advisories. The additional concentrations that have been developed for each of the COPCs were based on numbers of fish meals per year, ranging from one meal per year up to 12 meals per year, and are summarized in Table 4. The PRG value derived for the 40 meals per year also has been included in Table 4 for comparison purposes. These values may provide interim remediation goals.

1.3 SEDIMENT CONCENTRATIONS ESTIMATED FROM RISK-BASED TISSUE CONCENTRATIONS

Sediment concentrations required for biota to meet the risk-based concentration levels were estimated by dividing the tissue concentrations by a chemical-specific bioaccumulation factor (BAF). The estimated risk-based sediment concentrations are presented in Table 5. BAFs were derived as the ratio of biota (*i.e.,* fish and crab) tissue concentration to sediment concentration and are also presented in Table 5. A detailed description of how the BAFs were derived is provided in Section 7 of the risk assessment (Appendix C).

Table 4: Summary of Alternative Risk-Based Tissue Levels Based on the Number of Fish Meals per Year for the Adult Angler Receptor

			Risk-Based Tissue Concentrations Based on # Fish Meals[a] per Year for an Adult															Noncancer Tissue Concentrations Based on # Fish Meals[a] per Year for an Adult				
			40 meals per year			12 meals per year			6 meals per year			2 meals per year			1 meal per year								
CASRN	Units	Chemical	$1x10^{-6}$	$1x10^{-5}$	$1x10^{-4}$	$1x10^{-6}$	$1x10^{-5}$	$1x10^{-4}$	$1x10^{-6}$	$1x10^{-5}$	$1x10^{-4}$	$1x10^{-6}$	$1x10^{-5}$	$1x10^{-4}$	$1x10^{-6}$	$1x10^{-5}$	$1x10^{-4}$	40 meals per year	12 meals per year	6 meals per year	2 meals per year	1 meal per year
Inorganics																						
22967-92-6	ng/g	Methyl Mercury	Classification — C; possible human carcinogen; There is no quantitative estimate of carcinogenic risk from oral exposure.															281	938	1,876	5,628	11,256
Pesticides																						
12789-03-6	ng/g	Total Chlordane	23	234	2345	78	782	7816	156	1563	15633	469	4690	46898	938	9380	93796	1407	4690	9,380	28,139	56,278
PCB Aroclors																						
SUM_PCB	ng/g	Total PCBs[b]	4.1	41	410	14	137	1,368	27	274	2,736	82	821	8,207	164	1,641	16,414	56	188	375	1,126	2,251
Dioxins/Furans																						
1746-01-6	ng/g	TCDD TEQ	0.00005	0.00055	0.0055	0.00018	0.0018	0.018	0.00036	0.0036	0.036	0.0011	0.011	0.11	0.0022	0.022	0.22	No toxicity data at this time				

CASRN: Chemical Abstracts Service Registry Number

a: 40 meals/year = ~1 fish meal every 1.5 weeks; 12 meals/year = 1 fish meal every month; 6 meals/year = 1 fish meal every other month; 2 meals/year = 1 fish meal every six months.

b: For total PCBs, PRGs have been calculated for both carcinogenic and noncarcinogenic health effects. It is recommended that the toxicological effect resulting in the more conservative PRG be used to be protective of both types of health effects.

Table 5: Summary of Estimated Sediment Concentrations

			Sediment Concentrations Based on # Fish Meals[a] per Year for an Adult																Noncancer Sediment Concentrations Based on # Fish Meals per Year and BAF[b]				
				40 meals per year			12 meals per year			6 meals per year			2 meals per year			1 meal per year							
CASRN	Units	Chemical	BAF[b]	1.E-06	1.E-05	1.E-04	1.E-06	1.E-05	1.E-04	1.E-06	1.E-05	1.E-04	1.E-06	1.E-05	1.E-04	1.E-06	1.E-05	1.E-04	40 meals per year	12 meals per year	6 meals per year	2 meals per year	1 meal per year
22967-92-6	ng/g	Mercury	0.1	Classification — C; possible human carcinogen; There is no quantitative estimate of carcinogenic risk from oral exposure															2814	9380	18759	56278	112555
12789-03-6	ng/g	Total Chlordane	19.6	1	12	120	4	40	399	8	80	798	24	239	2393	48	479	4786	72	239	479	1436	2871
SUM_PCB	ng/g	Total PCBs	2.2	2	19	187	6	62	622	12	124	1244	37	373	3731	75	746	7461	26	85	171	512	1023
1746-01-6	ng/g	2,3,7,8-TCDD	0.2	0.00027	0.0027	0.027	0.00091	0.0091	0.091	0.0018	0.018	0.18	0.0055	0.055	0.55	0.011	0.11	1.1	No toxicity data at this time				

a: 40 meals/year = ~1 fish meal every 1.5 weeks; 12 meals/year = 1 fish meal every month; 6 meals/year = 1 fish meal every other month; 2 meals/year = 1 fish meal every six months

b: Sediment PRG = Tissue PRG/BAF

2.0 ECOLOGICAL PRELIMINARY REMEDIATION GOALS

Appendix C also presents the ERA that evaluated hazards to wildlife, fish, and benthos associated with direct contact exposures to contaminated LPRRP study area sediment and dietary exposures to those constituents capable of bioaccumulating in the estuarine food web. A residue-based analysis was also employed to evaluate the potential hazards associated with tissue burdens measured in fish. Based on the findings of the ERA it was determined that ecological hazards (as represented by HQs) to the receptor categories evaluated substantially exceed a value of 1.0.

Ecological PRGs were developed for all chemicals of potential ecological concern (COPECs), as determined in the FFS COPEC screening process documented in Attachment 4 to the ERA (Appendix C). COPECs include copper, lead, mercury (including methyl mercury), low- and high-molecular weight polycyclic aromatic hydrocarbons (PAH) (LPAH and HPAH, respectively), total PCBs (sum of Aroclors), the sum of DDD (dichlorodiphenyldichloroethane), DDE (dichlorodiphenyldichloro-ethylene), and DDT (dichlorodiphenyltrichloroethane) isomers (total DDx), dieldrin, TCDD TEQ (D/F)[1], and TCDD TEQ (PCB).

2.1 CALCULATION OF PRELIMINARY REMEDIATION GOALS

Sediment PRGs were developed for benthic organisms (including bivalves) and for estuarine-dependent wildlife for the subset of COPECs that are capable of bioaccumulating (*i.e.,* all except PAHs) in estuarine biota. It was assumed that the PRGs developed for these two categories of receptors will be sufficiently protective of fish species as well[2]. A residue-based analysis was conducted in the ERA to evaluate the significance of measured tissue burdens in fish and the toxicity data utilized in this

[1] Consistent with the Toxic Equivalency approach (Tillitt, 1999), the toxicological basis for the PRGs for dioxin, furan, and coplanar PCB compounds is 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (2,3,7,8-TCDD). TCDD TEQ refers to the combined equivalency associated with all aryl hydrocarbon receptor (AhR) mediated toxicity.

[2] However, see later text discussion (which is developed more fully in the ERA) regarding the potential sediment toxicity of PAHs to fish.

assessment [*i.e.*, Critical Body Residues (CBR)] were selected as PRGs for the fish tissue medium along with calculated wildlife-protective values.

Benthos. Sediment concentrations protective of benthic infauna exposed directly to various constituents were derived for marine and estuarine habitats by Long *et al.* (1995). These values, termed Effects Range Low (ER-L)[3], represent the low end of a range of levels at which adverse effects have been observed in compiled studies. As such, ER-Ls represent threshold levels in sediment above which toxicity could be anticipated to occur in sensitive species (Long *et al.*, 1995).

An ER-L is not available for 2,3,7,8-TCDD; therefore a site-specific PRG for bivalves was derived by the United States Fish and Wildlife Service (USFWS) using Newark Bay sediment, oyster tissue chemistry, and ecological effects presented in Wintermyer and Cooper (2003).

Wildlife. Wildlife-protective sediment concentrations for bioaccumulative COPECs were calculated with the same exposure dose equations as used in the ERA. The otter (*Lutra canadensis*) and belted kingfisher (*Ceryle alcyon*) were selected as the model receptors due to their relatively large dietary exposures to sediment-associated chemicals that can bioaccumulate in biological tissue. Equation 3 was used to estimate PRGs for piscivorous wildlife receptors in the LPRRP study area.

$$PRG_{sed} = \frac{THQ * TRV * BW}{\left(BAF_{fish} * IR_{fish} * P_{fish} * SFF\right)} \qquad \text{Equation 3}$$

[3] It is important to recognize that the ER-Ls were developed for use in screening-level analyses, and the authors specifically recommend against the use of these values in establishing sediment remediation goals (Long *et al.*, 1995). These values should be considered with due caution and careful consideration of the relevant uncertainties, particularly if an ER-L was to be identified as the basis for establishing a remediation goal for any sediment constituent.

Where

PRG_{sed} : Preliminary Remediation Goal for sediment protective of bioaccumulation hazards associated with the fish consumption pathway [micrograms (μg) COPEC/g sediment].

THQ: Target Hazard Quotient for the COPEC based on tissue residue effects (dimensionless); a THQ of 1.0 was used.

TRV: Toxicity Reference Value: receptor-specific literature-based toxicity threshold value. The selected value is the geometric mean of the No Observed Adverse Effects Level (NOAEL)- and Lowest Observed Adverse Effects Level (LOAEL)-based values.

BW: Receptor body weights (kg).

BAF_{fish} : Bioaccumulation Factor between sediment and fish prey consumed by the receptor [g sediment (dry weight)/g fish (wet weight)].

IR_{fish}: Daily fish ingestion rate (kg fish consumed per day).

P_{fish}: Percentage of fish in the diet.

SFF: Site Foraging Frequency (unitless); fraction of time receptor is assumed to forage at the site.

Wildlife PRGs were also derived for prey tissue (Equation 4) based on a piscivorous diet.

$$PRG_{biota} = \frac{THQ * TRV * BW}{\left(IR_{fish} * P_{fish} * SFF\right)} \qquad \text{Equation 4}$$

Where

PRG_{biota}: Preliminary Remediation Goal for prey tissue protective of bioaccumulation hazards associated with the fish consumption pathway (μg COPEC/g biota).

THQ: Target Hazard Quotient for the COPEC based on tissue residue effects (dimensionless); a THQ of 1.0 was used.

TRV: Toxicity Reference Value: receptor-specific literature-based toxicity threshold value. The selected TRV value is the geometric mean of the NOAEL- and LOAEL-based values.

BW: Receptor body weights (kg).

IR_{fish}: Daily fish ingestion rate (kg fish consumed per day).

P_{fish}: Percentage of fish in the diet.

SFF: Site Foraging Frequency (unitless); fraction of time receptor is assumed to forage at the site.

Table 6 summarizes the exposure parameters used in the development of the PRGs protective of wildlife. BAFs are presented in Table 7.

Table 6: Summary of Exposure Parameters Used to Develop Ecological PRGs for Wildlife

Parameter	Value	Units	Reference
PRG_{sed}	Calculated using Equation 1	µg COPEC/g sediment	-
THQ	1	unitless	-
TRV	Chemical-specific	µg COPEC/g-day	Table 8
BW	7.4 (otter)	kg	USEPA, 1993a
	0.136 (kingfisher)		USEPA, 1993a; Brooks and Davis,1987
BAF_{fish}	Chemical-specific	unitless	Table 7
IR_{fish}	0.4 (otter)	kg/day	USEPA, 1993a
	0.068 (kingfisher)		USEPA, 1993a; Alexander, 1977
P_{fish}	100	%	Assumption
SFF	1	unitless	Assumption

Table 7: Summary of Bioaccumulation Factors Used to Develop Ecological PRGs for Wildlife

COPEC	BAF (g_{sed}/g_{tissue})	Reference
Copper	1.6	Bechtel Jacobs, 1998
Lead	0.066	Bechtel Jacobs, 1998
Mercury	1.1	Bechtel Jacobs, 1998
Total PCB (sum of Aroclors)	1.9	USEPA, 2004
Total DDx	7.7	USEPA, 2004
Dieldrin	1.8	USEPA, 2004
2,3,7,8-TCDD	0.025	USEPA, 2004

g_{sed}/g_{tissue}: gram of sediment per gram of tissue

Table 8: Summary of Toxicity Reference Values Used to Develop Ecological PRGs for Wildlife

COPEC	Units	TRV			Reference
		Low	High	Geometric mean	
Mammal					
Copper	ng/g	2,670	632,000	41,078	USEPA, 2002
Lead	ng/g	1,000	241,000	15,524	USEPA, 2002
Mercury	ng/g	32	160	72	Sample *et al*., 1996
Total PCB (sum of Aroclors)	ng/g	360	1,280	679	USEPA, 2002
Total DDx	ng/g	800	16,000	3,578	USEPA, 2002
Dieldrin	ng/g	20	200	63	Sample *et al*., 1996
2,3,7,8-TCDD[a]	ng/g	-	-	-	-
Bird					
Copper	ng/g	2,300	52,300	10,968	USEPA, 2002
Lead	ng/g	14	8,750	350	USEPA, 2002
Mercury	ng/g	6	64	20	Sample *et al*., 1996
Total PCB (sum of Aroclors)	ng/g	90	1,270	338	USEPA, 2002
Total DDx	ng/g	9	600	73	USEPA, 2002
Dieldrin	ng/g	77	770	243	Sample *et al*., 1996
2,3,7,8-TCDD[a]	ng/g	-	-	-	-

a: PRGs obtained from USEPA, 1993b; no TRV necessary.

Rather than deriving PRGs for TCDD using the above approach, sediment concentrations protective of piscivorous mammals [2.5 picograms/gram (pg/g) or parts per trillion] and birds (21 pg/g) derived by USEPA (1993b) were used. The lower of these values was selected as the wildlife PRG value for fish tissue.

Fish. CBRs for whole body[4] fish tissue were compiled to support the ERA; further details regarding their development is provided in Appendix C[5].

Calculated PRGs. Table 9 presents the ecological PRGs for the selected sediment COPECs for each category of receptor considered in the ERA. The overall ecological

[4] In the case of 2,3,7,8-TCDD, a CBR value was established based on threshold concentrations determined in fish eggs, as the embryo is known to be the most sensitive life stage. Application of this CBR to whole body tissue assumes a 1:1 correspondence between these two compartments in adult females, which is believed to be a conservative assumption (Phillip Cook, personnel communication).

[5] The fish tissue PRGs are believed to be generally protective of the fish species likely to be encountered in the Lower Passaic River; however, PAH compounds are metabolized by most species into more toxicologically active compounds (Barron *et al*., 2004; Incardona *et al.*, 2006) that are not routinely analyzed. It is thus reassuring that the ER-Ls appear to be protective of sediment exposures of sensitive benthivorous fish as well as invertebrate species. A review of fish injury studies from Puget Sound demonstrated that the sediment threshold for sublethal effects in English sole (a species known to be sensitive to hepatic lesions) is approximately 1,000 ng/g (Johnson, 1999).

PRG is the lower of the two values. The fish tissue PRGs presented in Table 10 include results of the residue-based (fish) and dose-based (wildlife) analyses conducted as part of the ERA.

Table 9: Summary of Sediment PRGs for Ecological Receptors

CASRN	Units	Chemical	Sediment PRGs		Lowest
			Benthos[a]	Wildlife[b]	
Inorganics					
7440-50-8	ng/g	Copper	34,000	13,318	Wildlife PRG
7439-92-1	ng/g	Lead	46,700	10,606	Wildlife PRG
7439-97-6	ng/g	Mercury	150	37	Wildlife PRG
PAHs					
SUM_LOW_PAH	ng/g	Low Molecular Weight PAHs	552	-	NOAA ER-L
SUM_HIGH_PAH	ng/g	High Molecular Weight PAHs	1,700	-	NOAA ER-L
PCB Aroclors					
SUM_PCB	ng/g	Total PCBs	22.7	365	NOAA ER-L
Pesticides/Herbicides					
SUM_TDDT	ng/g	DDx	1.58	19	NOAA ER-L
60-57-1	ng/g	Dieldrin	0.02	271	NOAA ER-L
Dioxins/Furans					
TCDD TEQ	ng/g	TCDD TEQ[c]	0.0032	0.0025	Wildlife PRG

NOAA: National Oceanic and Atmospheric Administration
a: ER-L = Effects Range-Low from Long *et al.*, 1995, except where noted.
b: Derived as described in the FFS COPEC Screening Technical Memorandum (Appendix C).
c: Benthic benchmark for 2,3,7,8-TCDD derived by USFWS using sediment chemistry for Newark Bay and oyster effect data presented in Wintermyer and Cooper, 2003; wildlife value from USEPA, 1993b.

Table 10: Summary of Fish Tissue PRGs for Ecological Receptors

CASRN	Units	Chemical	Fish Tissue PRGs		Lowest
			Fish[a]	Wildlife[b]	
Inorganics					
7440-50-8	ng/g	Copper	6.3	21,935	Fish
7439-92-1	ng/g	Lead	88	700	Fish
7439-97-6	ng/g	Mercury	19	40	Fish
PAHs					
SUM_LOW_PAH	ng/g	Low Molecular Weight PAHs	89	-	Fish
SUM_HIGH_PAH	ng/g	High Molecular Weight PAHs	89	-	Fish
PCB Aroclors					
SUM_PCB	ng/g	Total PCBs	7.9	676	Fish
Pesticides/Herbicides					
SUM_TDDT	ng/g	DDx	0.3	147	Fish
60-57-1	ng/g	Dieldrin	35	487	Fish
Dioxins/Furans					
TCDD TEQ	ng/g	TCDD TEQ[c]	0.050	0.0007	Wildlife

a: Based on CBRs as summarized in Appendix C.
b: Derived as described in the FFS COPEC Screening Technical Memorandum (Appendix C); lowest of mammal and avian values.
c: Low risk fish concentrations for 2,3,7,8-TCDD from USEPA, 1993b.

3.0 **ACRONYMS**

2,3,7,8-TCDD	2,3,7,8-Tetrachlorodibenzo-*p*-dioxin
AhR	Aryl Hydrocarbon Receptor
AT	Averaging Time
BAF	Bioaccumulation Factor
BTAG	Biological Technical Assistance Group
BW	Body Weight of Receptor
CASRN	Chemical Abstracts Service Registry Number
C_b	Chemical Concentration in Biota
CBR	Critical Body Residue
CF	Conversion Factor
COPC	Chemical of Potential Concern
COPEC	Chemical of Potential Ecological Concern
CSF	Oral Cancer Slope Factor
CTE	Central Tendency Exposure
D.C.	District of Columbia
DDD	Dichlorodiphenyldichloroethane
DDE	Dichlorodiphenyldichloroethylene
D/F	Dioxin/Furan
DDT	Dichlorodiphenyltrichloroethane
ED	Exposure Duration
EF	Exposure Frequency
EFH	Exposure Factors Handbook
ERA	Ecological Risk Assessment
ER-L	Effects Range-Low
FI	Fraction from Source
FFS	Focused Feasibility Study
g	gram
g_{sed}	gram of sediment
g_{tissue}	gram of tissue

HHRA	Human Health Risk Assessment
HPAH	High Molecular Weight PAH
HQ	Hazard Quotient
IR	Ingestion Rate
kg	kilogram
LOAEL	Lowest Observed Adverse Effects Level
LPAH	Low Molecular Weight PAH
LPRRP	Lower Passaic River Restoration Project
mg	milligram
NA	Not Available
NCP	National Contingency Plan
ND	Not Determined
ng	nanogram
NJDEP	New Jersey Department of Environmental Protection
NOAA	National Oceanic and Atmospheric Administration
NOAEL	No Observed Adverse Effects Level
P	Percentage of Fish in a Receptor's Diet
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
pg	picogram
PRG	Preliminary Remediation Goal
RfD	Oral Reference Dose
RME	Reasonably Maximum Exposure
SFF	Site Foraging Frequency
TCDD	Tetrachlorodibenzodioxin
TEQ	Toxic Equivalency Quotient
THQ	Target Hazard Quotient
Total DDx	Sum of DDD, DDE, and DDT Isomers
TR	Target Risk
TRV	Toxicity Reference Value
µg	microgram

USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service

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