Coastal Hazardous Waste Site

REVIEWS

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ORCA

Office of Ocean Resources Conservation and Assessment

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Hazardous Materials Response and Assessment Division
7600 Sand Point Way NE
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June 1995

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Table 1. Sites which NOAA has reviewed (569) as of June 1995, including those sites for which a Coastal Hazardous Waste Site Review (266) or Preliminary Natural Resource Survey (PNRS; 123) has been completed. (Asterisked sites are included in this volume of reports.)

			Report Date	
State	**Cerclis**	**Site Name**	**Review**	**PNRS**
Federal Region 1				
CT	CTD980732333	Barkhamsted-New Hartford Landfill	1989	
CT	CTD072122062	Beacon Heights, Inc.	1984	
CT	CTD108960972	Gallup's Quarry	1989	
CT	CTD980670814	Kellogg-Deering Well Field	1987	
CT	CTD980521165	Laural Park, Inc.		1988
CT	CTD001153923	Linemaster Switch		
CT	CTD980906515	New London Submarine Base	1990	
CT	CTD980669261	Nutmeg Valley Road		
CT	CTD980667992	O'Sullivans Island	1984	
CT	CTD980670806	Old Southington Landfill		
CT	CTD004532610	Revere Textile Prints Corps		
CT	CTD001449784	Sikorsky Aircraft Div UTC		
CT	CTD009717604	Solvents Recovery Service		
CT	CTD009774969	Yaworski Waste Lagoon	1985	1989
MA	MAD001026319	Atlas Tack Corp	1989	
MA	MAD001041987	Baird & McGuire, Inc.		
MA	MAD982191363	Blackburn & Union Privileges	1993	
MA	MAD079510780	Cannon Engineering Corp., Bridgewater		1988
MA	MAD980525232	Cannon Engineering Corp., Plymouth	1984	1990
MA	MAD003809266	Charles George Land Reclamation	1987	1988
MA	MAD980520670	Fort Devens - Sudbury Training Annex		
MA	MA7210025154	Fort Devens		
MA	MAD980732317	Groveland Wells 1&2	1987	1988
MA	MA8570024424	Hanscom Air Force Base	1995*	
MA	MAD980523336	Haverhill Municipal Landfill	1985	
MA	MAD980732341	Hocomonco Pond		
MA	MAD076580950	Industri-plex	1987	1988
MA	MAD051787323	Iron Horse Park		
MA	MA1210020631	Natick Lab, Army Research, Development, & Eng. Ctr	1995	
MA	MA6170023570	Naval Weapons Industrial Reserve Plant		
MA	MAD980731335	New Bedford	1984	
MA	MAD980670566	Norwood PCB's		
MA	MAD990685422	Nyanza Chemical Waste Dump	1987	1993
MA	MA2570024487	Otis Air National Guard/Camp Edwards		
MA	MAD980731483	PSC Resources		
MA	MAD980520621	Re-Solve, Inc.		
MA	MAD980524169	Rose Disposal Pit		
MA	MAD980525240	Salem Acres		1991
MA	MAD980503973	Shpack Dump		
MA	MAD000192393	Silresim Chemical Corp.		
MA	MAD980731343	Sullivan's Ledge	1987	1989
MA	MAD001002252	W. R. Grace and Co. (Acton Plant)		
MA	MAD980732168	Wells G & H		1990
ME	ME8170022018	Brunswick Naval Air Station	1987	1991

State	Cerclis	Site Name	Report Date Review	Report Date PNRS
Federal Region 1, cont.				
ME	ME9570024522	Loring Air Force Base		
ME	MED980524078	McKin Company	1984	
ME	MED980731475	O'Connor Company	1984	
ME	ME7170022019	Portsmouth Naval Shipyard		
ME	MED980732291	Pinettes Salvage Yard		
ME	MED980504393	Saco Municipal Landfill	1989	
ME	MED980520241	Saco Tannery Waste Pits		
ME	MED042143883	Union Chemical Company, Inc.		
ME	ME7170022019	Portsmouth Naval Shipyard		
ME	MED980504435	Winthrop Town Landfill		
NH	NHD980524086	Auburn Road Landfill		1989
NH	NHD064424153	Coakley Landfill	1985	1989
NH	NHD980520191	Dover Municipal Landfill	1987	1990
NH	NHD001079649	Fletcher's Paint Works and Storage	1989	
NH	NHD069911030	Grugnale Waste Disposal Site	1985	
NH	NHD981063860	Holton Circle Ground Water Contamination		
NH	NHD062002001	Kearsarge Metallurgical		
NH	NHD092059112	Keefe Environmental Services		
NH	NHD980503361	Mottolo Pig Farm		
NH	NHD001091453	New Hampshire Plating Co.	1992	
NH	NHD990717647	Ottati & Goss Great Lakes Container Corp		
NH	NH7570024847	Pease Air Force Base	1990	
NH	NHD980671002	Savage Municipal Water Supply	1985	1991
NH	NHD980520225	Somersworth Sanitary Landfill		
NH	NHD980671069	South Municipal Water Supply Well		
NH	NHD099363541	Sylvester	1985	
NH	NHD989090469	Tibbetts Road		
NH	NHD062004569	Tinkham Garage		
RI	RID980520183	Central Landfill (Johnston Site)		
RI	RID980731459	Davis GSR Landfill		
RI	RID980523070	Davis Liquid Waste Site	1987	
RI	RI6170022036	Davisville Naval Construction Battalion Ctr	1990	1994
RI	RID093212439	Landfill and Resource Recovery (L&RR)		
RI	RI6170085470	Newport Naval Education/Training Center	1990	1994
RI	RID055176283	Peterson/Puritan, Inc.	1987	1990
RI	RID980579056	Picillo Farm	1987	1988
RI	RID980521025	Rose Hill Regional Landfill	1989	1994
RI	RID980731442	Stamina Mills	1987	1990
RI	RID009764929	Western Sand and Gravel	1987	
RI	RID981063993	West Kingston Town Dump/URI Disposal Area	1992	
VT	VTD981064223	Bennington Municipal Landfill		
VT	VTD980520092	BFI Sanitary Landfill	1989	
VT	VTD003965415	Burgess Brothers Landfill		
VT	VTD980520118	Darling Hill Dump		
VT	VTD000860239	Old Springfield Landfill	1987	1988
VT	VTD981062441	Parker Sanitary Landfill		
VT	VTD980523062	Pine Street Canal		
VT	VTD000509174	Tansitor Electronics, Inc		

State	Cerclis	Site Name	Report Date Review	Report Date PNRS
Federal Region 2				
NJ	NJD000525154	Albert Steel Drum	1984	
NJ	NJD002173276	American Cyanamid	1985	
NJ	NJD030253355	AO Polymer		
NJ	NJD980654149	Asbestos Dump		
NJ	NJD063157150	Bog Creek Farm	1984	1992
NJ	NJD980505176	Brick Township Landfill	1984	
NJ	NJD053292652	Bridgeport Rental & Oil Services (BROS)		1990
NJ	NJD078251675	Brook Industrial Park	1989	
NJ	NJD980504997	Burnt Fly Bog		1992
NJ	NJD048798953	Caldwell Trucking Co.		
NJ	NJD000607481	Chemical Control	1984	
NJ	NJD980484653	Chemical Insecticide Corp	1990	1992
NJ	NJD047321443	Chemical Leaman		1989
NJ	NJD980528889	Chemsol, Inc.		
NJ	NJD980528897	Chipman Chemical	1985	
NJ	NJD001502517	Ciba-Geigy Corp.	1984	1989
NJ	NJD980785638	Cinnaminson		
NJ	NJD094966611	Combe Fill South Landfill		
NJ	NJD000565531	Cosden Chemical	1987	
NJ	NJD002141190	CPS Chemical/Madison Industries		1990
NJ	NJD011717584	Curcio Scrap Metal	1987	
NJ	NJD980529002	Delilah Landfill		
NJ	NJD046644407	Denzer and Schafer X-Ray	1984	1992
NJ	NJD980761373	De Rewal Chemical Co.	1985	
NJ	NJD980528996	Diamond Alkali/Diamond Shamrock	1984	
NJ	NJD980529416	D'Imperio Property		
NJ	NJD980529085	Ellis Property		
NJ	NJD980654222	Evor Phillips Leasing		1992
NJ	NJD980761365	Ewan		
NJ	NJ9690510020	FAA Tech Center	1990	
NJ	NJ2210020275	Fort Dix (Landfill)		
NJ	NJD041828906	Fried Industries		
NJ	NJD053280160	Garden State Cleaners	1989	
NJ	NJD980529192	Gems Landfill		
NJ	NJD063160667	Global Sanitary Landfill	1989	1991
NJ	NJD980530109	Goose Farm		
NJ	NJD980505366	Helen Kramer Landfill		1990
NJ	NJD002349058	Hercules, Inc.	1984	1993
NJ	NJD053102232	Higgins Disposal Service Inc.	1989	
NJ	NJD981490261	Higgins Farm	1989	
NJ	NJD980663678	Horseshoe Road Industrial Complex[1]	1984/1995*	
NJ	NJD980532907	Ideal Cooperage	1984	
NJ	NJD980654099	Imperial Oil Co. Inc./Champion Chemicals		
NJ	NJD981178411	Industrial Latex	1989	
NJ	NJD980505283	Jackson Township Landfill	1984	
NJ	NJ0141790006	Jamaica Bay (Gateway Recreational Area)		
NJ	NJD097400998	JIS Landfill		
NJ	NJD002493054	Kauffman and Minteer	1989	

[1]Previously known as Horseshoe Road Dump

State	Cerclis	Site Name	Report Date Review	Report Date PNRS
Federal Region 2, cont.				
NJ	NJD049860836	Kin-Buc Landfill	1984	1990
NJ	NJD980505341	King of Prussia		
NJ	NJD002445112	Koppers Company/Seaboard Plant	1984	
NJ	NJD980529838	Krysowaty Farm	1985	
NJ	NJD980505416	Lipari Landfill		
NJ	NJD980505424	Lone Pine Landfill		1992
NJ	NJD085632164	M&T Delisa Landfill		
NJ	NJD980654180	Mannheim Avenue Dump		
NJ	NJD980529762	Maywood Chemical Co.		
NJ	NJD002517472	Metaltec/Aerosystems		
NJ	NJ0210022752	Military Ocean Terminal (Landfill)		
NJ	NJD000606756	Mobil Chemical Company	1984	
NJ	NJD980505671	Monroe Township Landfill		
NJ	NJD980654198	Myers Property		
NJ	NJD061843249	N.L. Industries	1984	1992
NJ	NJD002362705	Nascolite Corp.		
NJ	NJ7170023744	Naval Air Engineering Center, Lakehurst		
NJ	NJ0170022172	Naval Weapons Station, Earle - Site A		
NJ	NJD980529598	Pepe Field		
NJ	NJD980653901	Perth Amboy's PCB's	1984	
NJ	NJD980505648	PJP Landfill	1984	1990
NJ	NJD981179047	Pohatcong Valley Groundwater Cont.		
NJ	NJD980769350	Pomona Oaks		
NJ	NJD070281175	Price Landfill	1984	1993
NJ	NJD980582142	Pulverizing Services Inc.		
NJ	NJD000606442	Quanta Resources (Allied, Shady Side)		
NJ	NJD980529713	Reich Farms		
NJ	NJD070415005	Renora, Inc.		
NJ	NJD980529739	Ringwood Site		
NJ	NJD073732257	Roebling Steel Company	1984	1990
NJ	NJD030250484	Roosevelt Drive-In	1984	
NJ	NJD986623569	Sayreville Pesticide Dump[2]	1984	
NJ	NJD980505754	Sayreville Landfill	1984	1990
NJ	NJD070565403	Scientific Chemical Processing, Inc.	1984	1989
NJ	NJD980505762	Sharkey Landfill		1990
NJ	NJD002365930	Shield Allow Corporation		
NJ	NJD980766828	South Jersey Clothing Co.	1989	
NJ	NJD041743220	Swope Oil & Chemical Co.		
NJ	NJD064263817	Syncon Resins	1984	1992
NJ	NJD980529127	T. Fiore Demolition, Inc.	1984	
NJ	NJD980761357	Tabernacle Drum Dump		
NJ	NJD002005106	Universal Oil Products, Inc.	1984	
NJ	NJD980761399	Upper Deerfield Township Sanitary Landfill		
NJ	NJD980529879	Ventron/Velsicol	1984	
NJ	NJD002385664	Vineland Chemical		1990
NJ	NJD054981337	Waldick Aerospace Devices		1990
NJ	NJD001239185	White Chemical Company	1984	
NJ	NJD980529945	Williams Property	1984	1992

[2] Now part of Horseshoe Road Industrial Complex

State	Cerclis	Site Name	Report Date Review	PNRS
Federal Region 2, cont.				
NJ	NJD980532824	Wilson Farm		
NJ	NJD045653854	Witco Chemical Corporation		
NJ	NJD980505887	Woodland Route 532 Dump		
NJ	NJD980505879	Woodland Route 72 Dump		
NY	NYD072366453	Action Anodizing Site	1989	
NY	NYD980506232	ALCOA Oil and Wastewater Lagoons		
NY	NYD002066330	American Thermostat		
NY	NYD001485226	Anchor Chemical		
NY	NYD980535652	Applied Environmental Services	1985	1991
NY	NYD980507693	Batavia Landfill		
NY	NYD980768675	BEC (Binghampton Equipment Co.) Trucking		1990
NY	NYD980768683	Bioclinical Laboratories		
NY	NYD980652275	Brewster Wellfield		
NY	NY7890008975	Brookhaven National Lab	1990	
NY	NYD980780670	Byron Barrel and Drum		
NY	NYD981561954	C and J Disposal Site	1989	
NY	NYD010968014	Carrol and Dubies Sewage Disposal	1989	
NY	NYD981184229	Circuitron Corp. Site		
NY	NYD002044584	Claremont Polychemical		
NY	NYD000511576	Clothier Disposal		
NY	NYD980768691	Colesville Municipal Landfill		
NY	NYD980528475	Cortese Landfill		
NY	NYD980508048	Croton Point Sanitary Landfill		
NY	NYD980780746	Endicott Village Wellfield		
NY	NYD981560923	Forest Glen Subdivision		
NY	NYD002050110	Genzale Plating Site		
NY	NYD091972554	GM Foundry		1989
NY	NYD980768717	Goldisc Recordings, Inc.		
NY	NY4571924451	Griffiss AFB		
NY	NYD980785661	Haviland Complex		
NY	NYD980780779	Hertel Landfill		
NY	NYD002920312	Hooker/Ruco Polymer Corp.		
NY	NYD980763841	Hudson River PCBs (GE)		1989
NY	NYD000813428	Jones Chemicals, Inc.		
NY	NYD980534556	Jones Sanitation	1987	
NY	NYD980780795	Katonah Municipal Well		
NY	NYD986882660	Li Tungsten	1992	1993
NY	NYD053169694	Liberty Heat Treating Co., Inc.		
NY	NYD000337295	Liberty Industrial Finishing	1985	1993
NY	NYD013468939	Ludlow Sand & Gravel		
NY	NYD010959757	Marathon Battery	1984	1989
NY	NYD000512459	Mattiace Petrochemical	1989	1990
NY	NYD980763742	MEK Spill, Hicksville		
NY	NYD002014595	Nepera Chem Co., Inc.		
NY	NYD980506810	Niagara 102nd Street (Hooker Chem)		
NY	NYD000514257	Niagara County Refuse		
NY	NYD980664361	Niagara Mohawk Power Corp.		
NY	NYD980780829	Ninety-Third Street School		
NY	NYD980762520	North Sea Municipal Landfill	1985	1989
NY	NYD991292004	Pasley Solvents		
NY	NY6141790018	Pennsylvania Ave. Landfill		

State	Cerclis	Site Name	Report Date Review	Report Date PNRS
Federal Region 2, cont.				
NY	NYD000511659	Pollution Abatement Services		
NY	NYD980654206	Port Washington Landfill	1984	1989
NY	NYD980768774	Preferred Plating Corp.		
NY	NYD002245967	Reynolds Metal Co.		
NY	NYD980507735	Richardson Hill Road Landfill		
NY	NYD980535124	Rocket Fuel Site - MALTA		
NY	NYD981486954	Rowe Industries	1987	1991
NY	NYD980507677	Sidney Landfill	1989	
NY	NYD980535215	Sinclair Refinery Site		
NY	NYD980421176	Solvent Savers		
NY	NYD980780878	Suffern Wellfield Site		
NY	NYD000511360	Syosset Landfill		
NY	NYD002059517	Tronic Plating		
NY	NYD980509376	Volney Landfill		
NY	NYD980535496	Wallkill Landfill		
NY	NYD980506679	Warwick Landfill Site		
NY	NYD000511733	York Oil		
PR	PRD090416132	Clear Ambient Service	1984	
PR	PRD980640965	Frontera Creek	1984	1991
PR	PRD090282757	GE Wiring Devices		
PR	PRD980512362	Juncos Landfill		
PR	PR4170027383	Naval Security Group Activity, Sabana Seca	1989	1991
PR	PRD980301154	Upjohn		
PR	PRD980763775	Vega Alta Public Supply Wells		
USVI	VID982272569	Tutu Wellfield	1993	
Federal Region 3				
DE	DED980494496	Army Creek Landfill	1984	
DE	DED980714141	Chem-Solv, Inc.		
DE	DED980704860	Coker's Sanitation Services Landfills	1986	1990
DE	DED980551667	Delaware City PVC	1984	
DE	DED000605972	Delaware Sand & Gravel Landfill	1984	
DE	DE8570024010	Dover Air Force Base	1987	1989
DE	DED980693550	Dover Gas and Light Company	1987	
DE	DED980555122	E.I. Du Pont - Newport Landfill	1987	1991/1992[3]
DE	DED980830954	Halby Chemical Company	1986	1990
DE	DED980713093	Harvey & Knott Drum		
DE	DED980705727	Kent Co. Landfill	1989	
DE	DED980552244	Koppers Company Facilities site	1990	
DE	DED043958388	National Cash Register Corp., Millsboro	1986	
DE	DED058980442	New Castle Spill Site	1984	1989
DE	DED980705255	New Castle Steel	1984	
DE	DED980704894	Old Brine Sludge Landfill	1984	
DE	DED980494603	Pigeon Point Landfill	1987	
DE	DED981035520	Sealand	1989	
DE	DED041212473	Standard Chlorine of Delaware, Inc.	1986	
DE	DED980494637	Sussex Co. Landfill #5	1989	
DE	DED000606079	Tybouts Corner Landfill	1984	

[3] PNRS updated in 1992.

State	Cerclis	Site Name	Report Date Review	PNRS
Federal Region 3, cont.				
DE	DED980705545	Tyler Refrigeration Pit Site		
DE	DED980704951	Wildcat Landfill	1984	
MD	MDD980504187	Aberdeen Dump	1986	
MD	MDD980705057	Anne Arundel County Landfill	1989	
MD	MD0120508940	Beltsville Agricultural Research Center	1995*	
MD	MDD980504195	Bush Valley Landfill	1989	
MD	MDD982364341	Ordnance Products, Inc.	1995*	
MD	MDD980705164	Sand Gravel & Stone Site	1984	1990
MD	MDD064882889	Mid-Atlantic Wood Preservers		
MD	MDD980704852	Southern Maryland Wood Treating	1987	
MD	MD2210020036	USA Aberdeen - Edgewood	1986	
MD	MD3210021355	USA Aberdeen - Michaelsville	1986	
MD	MDD980504344	Woodlawn Co Landfill	1987	
PA	PAD004351003	A.I.W. Frank/Mid-County Mustang		
PA	PAD000436436	Ambler Asbestos Piles		
PA	PAD009224981	American Electronic Lab, Inc.		
PA	PAD980693048	AMP, Inc.		
PA	PAD987341716	Austin Avenue Radiation Site	1993	
PA	PAD061105128	Bally Township		
PA	PAD047726161	Boarhead Farms	1989	
PA	PAD980831812	Brown's Battery		1991
PA	PAD980508451	Butler Mine Tunnel	1987	
PA	PAD980419097	Crater Resources, Inc.	1993	
PA	PAD981035009	Croydon TCE Spill	1986	
PA	PAD981038052	Delta Quarries/Stotler Landfill		
PA	PAD002384865	Douglassville Disposal Site	1987	
PA	PAD003058047	Drake Chemical		
PA	PAD980830533	Eastern Diversified Metals		
PA	PAD980552913	Enterprise Avenue	1984	
PA	AD077087989	Foote Mineral Company	1993	
PA	PAD002338010	Havertown PCP		
PA	PAD002390748	Hellertown Manufacturing Company	1987	
PA	PAD009862939	Henderson Road		1989
PA	PAD980829493	Jacks Creek/Sitkin Smelting & Refining	1989	
PA	PAD981036049	Keyser Ave. Borehole	1989	
PA	PAD980508667	Lackawanna Refuse		
PA	PA2210090054	Letterkenny-Property Disposal Area (USA)		
PA	PA6213820503	Letterkenny-Southeast Industrial Area (USA)		
PA	PAD046557096	Metal Bank of America	1984	1990
PA	PAD980538763	Middletown Air Field		
PA	PAD980539068	Modern Sanitation Landfill		
PA	PAD980691372	MW Manufacturing		
PA	PAD096834494	North Penn-Area 1		
PA	PAD980229298	Occidental Chemical/Firestone	1989	
PA	PAD002395887	Palmerton Zinc Pile		
PA	PAD980692594	Paoli Railyard	1987	1991
PA	PAD981939200	Publicker Industries/Cuyahoga Wrecking Plant	1990	
PA	PAD039017694	Raymark		
PA	PAD002353969	Recticon/Allied Steel	1989	
PA	PAD051395499	Revere Chemical Company	1986	
PA	PAD091637975	Rohm and Haas Landfill	1986	

State	Cerclis	Site Name	Report Date Review	Report Date PNRS
Federal Region 3, cont.				
PA	PAD002498632	Spra-Fin, Inc. (North Penn-Area 7)		
PA	PAD014269971	Stanley Kessler		
PA	PA6143515447	Tinicum National Environmental Center	1986	
PA	PAD980692024	Tysons Dump #1	1985	
PA	PAD980539126	UGI Columbia Gas Plant		
PA	PA6170024545	U.S. Navy Naval Air Warfare Center		
PA	PAD980539407	Wade (ABM) Site	1984	
PA	PAD980537773	William Dick Lagoons		
VA	VAD980551683	Abex Corp.	1989	
VA	VAD042916361	Arrowhead Assoc/Scovill Corp	1989	
VA	VAD990710410	Atlantic Wood Industries	1987	1990
VA	VAD049957913	C&R Battery Co., Inc.	1987	
VA	VAD980712913	Chisman Creek	1984	
VA	VAD007972482	Clarke, L.A. & Son		
VA	VAD980539878	H & H Inc.		
VA	VA1170024722	Marine Corps Combat Development Command	1995*	
VA	VA2800005033	NASA-Langley Research Center	1995*	
VA	VA7170024684	Naval Surface Weapons Center, Dahlgren	1993	
VA	VA8170024170	Naval Weapons Station Yorktown	1993	
VA	VAD071040752	Rentokil Inc. Wood Preserving		
VA	VAD980831796	Rhinehart Tire Fire Dump		
VA	VAD003117389	Saunders Supply Co.	1987	
VA	VAD980917983	Suffolk City Landfill Waste Disposal Ponds		
VA	VA3971520751	U.S. Defense General Supply Center		
Federal Region 4				
AL	ALD001221902	Ciba-Geigy Corp	1990	
AL	ALD008188708	Olin Corp. McIntosh Plant	1990	
AL	ALD980844385	Redwing Carriers Inc./Saraland	1989	
AL	ALD095688875	Stauffer Chemical Co. Cold Creek Plt./Lemoyne		1990
AL	ALD007454085	T.H. Agriculture Nutrition Co.		
FL	FLD980728877	62nd Street Dump/Kassouf-Kimerling	1984	1989
FL	FLD980221857	Agrico Chemical Site	1989	
FL	FLD008161994	American Creosote Works	1984	1989
FL	FLD088783865	Bay Drum/Tampa		
FL	FLD980494660	Beulah Landfill		
FL	FLD981930506	Broward County - 21st Manor Dump	1992	
FL	FL5170022474	Cecil Field Naval Air Station	1990	
FL	FLD080174402	Chem-Form Inc.	1990	
FL	FLD050432251	Florida Steel Corporation		
FL	FLD000827428	Gardinier, Inc./Ft. Meade Mine		
FL	FLD000602334	Harris Corp. (Palm Bay Plant)	1986	1990
FL	FLD053502696	Helena Chemical Company	1993	
FL	FLD980709802	Hipps Road Landfill		
FL	FLD004119681	Hollingsworth Solderless Terminal Co.		
FL	FL7570024037	Homestead Air Force Base		
FL	FL6170024412	Jacksonville Naval Air Station	1990	
FL	FLD084535442	Munisport Landfill	1984	
FL	FL6170022952	Naval Air Station Key West (Boca Chica)		
FL	FLD004091807	Peak Oil Co.		

State	Cerclis	Site Name	Report Date Review	PNRS
FL	FL9170024567	Pensacola Naval Air Station	1990	
Federal Region 4, cont.				
FL	FLD980556351	Pickettville Road Landfill	1984	1990
FL	FLD004054284	Piper Aircraft Corp., Vero Beach		
FL	FLD000824888	Reeves SE Corp., Wire Div.		
FL	FLD980602882	Sapp Battery Salvage		1989
FL	FLD062794003	Schuylkill Metal Corp		
FL	FLD004126520	Standard Auto Bumper Corp.	1989	
FL	FLD010596013	Stauffer Chemical Co., Tarpon Springs	1993	
FL	FLD004092532	Stauffer Chemical Co., Tampa	1993	
FL	FLD000648055	Sydney Mine Sludge Ponds		1989
FL	FL1690331300	USCG Station Key West		
FL	FLD980602767	Whitehouse Waste Oil Pits		
FL	FLD041184383	Wilson Concepts of Florida		
FL	FLD981021470	Wingate Road Municipal Incinerator Dump		
FL	FLD004146346	Woodbury Chemical Co.	1989	
GA	GAD095840674	Cedartown Industries Inc.		
GA	GAD990741092	Diamond Shamrock Corp. Landfill		
GA	GAD990855074	Firestone Tire & Rubber Co. Inc.		
GA	GAD004065520	Hercules Inc.		
GA	GAD980556906	Hercules 009 Landfill		
GA	GAD000827444	International Paper Co.		
GA	GAD099303182	LCP Chemicals - Georgia, Inc.		1995
GA	GA7170023694	Marine Corps Logistics Base 555		
GA	GAD001700699	Monsanto Co.		
GA	GAD042101261	T.H. Agriculture & Nutrition Co.., Albany		
GA	GA1570024330	USAF Robins Air Force Base		
GA	GAD003269578	Woolfolk Chemical Works, Inc.		
MS	MSD098596489	Gautier Oil Co. Inc.	1989	
NC	NCD024644494	ABC One Hour Cleaners	1989	
NC	NCD980840409	Charles Macon Lagoon & Drum Storage		
NC	NCD980840342	Dockery Property		
NC	NCD981475932	FCX (Washington Plant)	1989	
NC	NCD981021157	New Hanover County Airport Burn Pit	1989	
NC	NCD981023260	Potter's Septic Tank Service Pits	1989	
NC	NC1170027261	USMC Air Station Cherry Point		
NC	NC6170022580	USMC Camp Lejuene, Site 21	1989	
SC	SCD980844260	Beaufort County Landfill		
SC	SCD987581337	Calhoun Park/Ansonborough Homes/SCEGCO		1993
SC	SCD980711279	Geiger (C&M Oil)	1984	
SC	SCD058753971	Helena Chemical Co.	1989	
SC	SCD055915086	International Paper/Sampit River		
SC	SCD980310239	Koppers Company, Inc., Charleston Plant	1993	
SC	SC8170022620	Naval Weapons Station - Charleston		
SC	SC1890008989	Savannah River Site (USDOE)	1990	
SC	SCD037405362	Wamchem Inc.	1984	
Federal Region 6				
TX	TXD008123168	ALCOA (Point Comfort)/Lavaca Bay)		
LA	LAD000239814	American Creosote, Inc., Winnfield		
LA	LAD980745632	Bayou Bonfouca		
LA	LAD980745541	Bayou Sorrell	1984	

LA LAD980501423 Calcasieu Parish Landfill

			Report Date	
State	**Cerclis**	**Site Name**	**Review**	**PNRS**
Federal Region 6, cont.				
LA	LA6170022788	New Orleans Naval Air Station		
LA	LAD057482713	Petro-Processors of Louisiana, Inc.		
TX	TXD980864649	Bailey Waste Disposal	1985	1989
TX	TXD980625453	Brio Refining , Inc.	1989	1989
TX	TXD990707010	Crystal Chemical Company	1989	1989
TX	TXD089793046	Dixie Oil Processors	1989	1989
TX	TXD980514814	French Limited	1989	1989
TX	TXD980748453	Geneva Industries/Fuhrmann Energy Corp		
TX	TXD980745582	Harris (Farley Street)		
TX	TXD980514996	Highlands Acid Pit	1989	
TX	TXD980625636	Keown Supply Co.		
TX	TXD980629851	Motco Corp.	1984	
TX	TXD980873343	North Cavalcade Street		
TX	TXD980873350	Petro-Chemical Systems, Inc.		
TX	TXD980513956	Sikes Disposal Pits	1989	
TX	TXD980873327	Sol Lynn/Industrial Transformers		
TX	TXD980810386	South Cavalcade Street		
TX	TXD062113329	Tex-Tin Corporation	1989	
TX	TXD055143705	Triangle Chemical Company		
Federal Region 9				
AS	ASD980637656	Taputimu Farm, Tutuila Isl.	1984	
CA	CA2170023236	Alameda Naval Air Station	1989	
CA	CAD052384021	Brown & Bryant, Inc. (Arvin Plant)		
CA	CA2170023533	Camp Pendleton Marine Corps Base	1990	1992
CA	CAD009114919	Chevron USA Richmond Refinery		
CA	CAD063015887	Coast Wood Preserving	1984	
CA	CAD055753370	Cooper Drum Company	1993	
CA	CAD980498455	Crazy Horse Sanitary Landfill		
CA	CAD009212838	CTS Printex, Inc.	1989	
CA	CAD029544731	Del Amo	1992	
CA	CAD000626176	Del Norte County Pesticide Storage Area	1984	
CA	CA6170023208	El Toro Marine Corps Air Station	1989	
CA	CAD981159585	Farallon Islands Radioactive Waste Dumps		1990
CA	CA7210020676	Fort Ord	1990	1992
CA	CAD980636914	Fresno Municipal Sanitary Landfill		
CA	CAD980498562	GBF and Pittsburg Dumps	1989/1993[4]	
CA	CA3570024288	Hamilton Air Force Base		
CA	CAD980884209	Hewlett-Packard (620-40 Page Mill Rd)	1989	
CA	CAD058783952	Hexcel Corp. - Livermore		
CA	CA1170090087	Hunters Point Annex/Treasure Island Naval Air Station	1989	1989
CA	CAD041472341	Intersil Inc./Siemens Components	1989	
CA	CAD980498612	Iron Mountain Mine	1989	1989
CA	CAD000625731	J.H. Baxter		
CA	CAD009103318	Jasco Chemical Corp.	1989	
CA	CAD008274938	Kaiser Steel Corp. (Fontana Plant)		

[4]Waste Site Review updated in 1993.

State	Cerclis	Site Name	Report Date Review	PNRS
Federal Region 9, cont.				
CA	CAT000646208	Liquid Gold Oil Corp.	1984	
CA	CAD065021594	Louisiana Pacific Corp.		
CA	CA7170024775	Mare Island Naval Shipyard		
CA	CAD000074120	MGM Brakes	1984	
CA	CAD009106527	McCormick & Baxter Creosoting Company	1993	
CA	CAD982463812	Middlefield-Ellis-Whisman		
CA	CAD981997752	Modesto Ground Water Contamination		
CA	CA2170090078	Moffett Field Naval Air Station	1986	
CA	CAD008242711	Montrose Chemical Corp.	1985	
CA	CA7170024528	Naval Weapons Station, Concord	1989/1993[4]	1990
CA	CAD981434517	Newmark Ground Water Contamination		
CA	CA7170090016	North Island Naval Air Station		
CA	CA4170090027	Oakland Naval Supply Center		
CA	CAD980636781	Pacific Coast Pipelines	1989	
CA	CA9170027271	Pacific Missile Test Center		
CA	CA1170090236	Point Loma Naval Complex		
CA	CAD982462343	Redwood Shore Landfill		
CA	CAT000611350	Rhone-Poulenc, Inc./Zoecon Corp.	1985	
CA	CA7210020759	Riverbank Army Ammunition Plant	1989	
CA	CAD009452657	Romic Chemical Corp		
CA	CA0210020780	Sacramento Army Depot		
CA	CAD009164021	Shell Oil Co., Martinez Manufact. Complex		
CA	CAD980637482	Simpson - Shasta Ranch		
CA	CAD981171523	Sola Optical USA, Inc.	1989	
CA	CAD059494310	Solvent Service, Inc.		
CA	CAD980894885	South Bay Asbestos Area,`Alviso	1985	
CA	CAD009138488	Spectra-Physics, Inc.		
CA	CAD980893275	Sulphur Bank Mercury Mine		
CA	CAD990832735	Synertek, Inc. - Building 1		
CA	CA5570024575	Travis Air Force Base	1990	
CA	CAD009159088	TRW Microwave, Inc. - Building 825		
CA	CAD981436363	United Heckathorn		
CA	CAD981995947	Westminster Tract #2633 (Ralph Gray Trucking Co.)		
GU	GU6571999519	Andersen Air Force Base	1993	
GU	GU7170027323	Naval Station Guam		
HI	HID980637631	Del Monte Corporation (Oahu Plantation)	1995*	
HI	HID981581788	Hawaiian Western Steel Limited		
HI	HID980497184	Kailua-Kona Landfill		
HI	HID980497226	Kewalo Incinerator Ash Dump		
HI	HI6170022762	MCAS Kanehoe Landfill		
HI	HID980497176	Kapaa Landfill		
HI	HI3170024340	Naval Submarine Base		
HI	HID980585178	Pearl City Landfill	1984	
HI	HI2170024341	Pearl Harbor Naval Complex	1992	1993
HI	HID982400475	Waiakea Pond/Hawaiian Cane Products		1990
Federal Region 10				
AK	AK4170024323	Adak Naval Air Station	1993	
AK	AKD009252487	Alaska Pulp Corporation		
AK	AK8570028649	Elmendorf Air Force Base	1990	1990

AK	AK6210022426	Fort Wainwright		
			Report Date	
State	**Cerclis**	**Site Name**	**Review**	**PNRS**
Federal Region 10, cont.				
AK	AKD980978787	Standard Steel & Metals Salvage Yard (USDOT)	1990	1990
ID	IDD980725832	Blackbird Mine	1995*	
OR	ORD009051442	Allied Plating	1987	1988
OR	ORD095003687	Gould Inc.	1984	1988
OR	ORD068782820	Joseph Forest Products		
OR	ORD052221025	Martin Marietta Aluminum Co.	1987	1988
OR	ORD009020603	McCormick-Baxter Creosoting		
OR	ORD980988307	Northwest Pipe & Casing Company	1993	
OR	ORD009025347	Stauffer Chemical Co. (Rhone-Poulenc, Inc.)	1984	
OR	ORD009042532	Taylor Lumber and Treating, Inc.		1991
OR	ORD050955848	Teledyne Wah Chang Albany	1985	1988
OR	ORD009049412	Union Pacific, The Dalles	1990	1990
WA	WAD009045279	ALCOA (Vancouver Smelter)	1989	1989
WA	WAD057311094	American Crossarm & Conduit Co.	1989	1988
WA	WA5170027291	Bangor Naval Submarine Base	1990	1991
WA	WA7170027265	Bangor Ordnance Disposal(Site A)		1991
WA	WA1891406349	Bonneville Power Admin. Ross Complex (USDOE)	1990	1990
WA	WAD980836662	Centralia Landfill	1989	1989
WA	WAD980726301	Commencement Bay - South Tacoma Channel	1984[5]	
WA	WAD980726368	Commencement Bay Nearshore/Tideflats	1984[5]	1988
WA	WA5210890096	Hamilton Island Landfill (USACOE)		
WA	WA3890090076	Hanford - 100 Area (DOE)	1989	1988
WA	WA2890090077	Hanford - 300 Area (DOE)		
WA	WAD980722839	Harbor Island - Lead	1984	1989
WA	WA3170090044	Jackson Park Housing Complex (U.S. Navy)		
WA	WA5170090059	NAS Whidbey Island - Ault Field	1986	1989
WA	WA6170090058	NAS Whidbey Island - Seaplane Base	1986	1989
WA	WA1170023419	Naval Undersea Warfare (4 Areas)		1989
WA	WAD027315621	Northwest Transformer (South Harkness)	1989	1988
WA	WAD009248287	Pacific Sound Resources (Wyckoff Co.,/West Seattle)	1995*[6]	1992
WA	WAD009422411	Pacific Wood Treating		
WA	WA4170090001	Port Hadlock Detachment (U.S. Navy)		1989
WA	WA2170023418	Puget Sound Naval Shipyard Complex	1995*	
WA	WA2170023426	Puget Sound Naval Supply Center (Old Navy Dump)		
WA	WAD980639215	Quendall Terminals	1985	
WA	WAD980639462	Seattle Municipal Landfill (Kent Highlands)	1989	1988
WA	WAD980976328	Strandley/Manning Site		1992
WA	WAD980639256	Tulalip Landfill	1992	1991
WA	WAD009487513	Western Processing	1984	
WA	WAD009248295	Wyckoff Company/Eagle Harbor	1986	1988

[5] A single site report was done for both of these sites.
[6] Previous Waste Site Review done in 1986; previous PNRS done in 1988.

Table 2. Acronyms and abbreviations used in Coastal Hazardous Waste Site Reviews

AWQC	Ambient water quality criteria for the protection of aquatic life
bgs	below ground surface
BHC	benzene hexachloride
BNA	base, neutral, and acid-extractable organic compounds
BOD	biological oxygen demand
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
cfs	cubic feet per second
cm	centimeter
COD	chemical oxygen demand
COE	U.S. Army Corps of Engineers
CRC	Coastal Resource Coordinator
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DNT	dinitrotoluene
DOD	U.S. Department of Defense
DOI	U.S. Department of the Interior
EPA	U.S. Environmental Protection Agency
ERL	Effects range-low
ERM	Effects range-median
HMX	cyclotetramethylene tetranitramine
HRS	Hazard Ranking System
IRM	Immediate Removal Measure
kg	kilogram
km	kilometer
l	liter
LOEL	Lowest Observed Effects Level
m	meter
m^3/second	cubic meter per second
µg/g	micrograms per gram
µg/kg	micrograms per kilogram
µg/l	micrograms per liter
µR/hr	microroentgens/hour
mg	milligram
mg/kg	milligrams per kilogram
mg/l	milligrams per liter
mR/hr	milliroentgens per hour
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
OU	Operable Unit
PAH	polynuclear aromatic hydrocarbon
PA/SI	Preliminary Assessment/Site Investigation
PCB	polychlorinated biphenyl
PCE	perchloroethylene (aka tetrachloroethylene)
pCi/g	pico Curies per gram (1 pico Curie=10^{-12} Curie)
pCi/l	pico Curies per liter
PCP	pentachlorophenol
PNRS	Preliminary Natural Resource Survey
ppb	parts per billion
ppm	parts per million
ppt	parts per thousand

Table 2. Acronyms and abbreviations, cont.

PRP	Potentially Responsible Party
PVC	polyvinyl chloride
RCRA	Resource Conservation and Recovery Act
RD/RA	Remedial Design/Remedial Action
RDX	cyclonite
REM/year	Roentgen Equivalent Man
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SVOC	semi-volatile organic compound
TCA	tetrachloroethylene
TCE	trichloroethylene
TCL	Target Compound List
TNT	trinitrotoluene
TPH	total petroleum hydrocarbons
TSS	total suspended solids
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UST	underground storage tank
VOC	volatile organic compound

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Hanscom Air Force Base

Middlesex County, Massachusetts
CERCLIS #MA8570024424

Site Exposure Potential

Hanscom Air Force Base (AFB) is located in Middlesex County, Massachusetts within the towns of Bedford, Concord, Lexington, and Lincoln. The site is located at the headwaters of the Shawsheen River, which flows for approximately 40 km downstream before entering the Merrimack River (Figure 1). The Merrimack River enters the Atlantic Ocean about 45 km downstream from the confluence of the Shawsheen River.

Military operations began in 1942, with the U.S. Air Force occupying 420 hectares at the site by 1952. Numerous hazardous substances were used, generated, and disposed during military operations at the site. These substances included chlorinated solvents, gasoline and jet fuels, tetraethyl lead, and PCBs. Fourteen potential source areas have been identified at Hanscom AFB (Table 1; Halliburton NUS 1993). Six of the source areas are shown in Figure 2; the locations of the remaining eight source areas were not available.

Although military flying activities ceased in 1973, the U.S. Air Force continues to operate the Electronic Systems Division of the Air Force

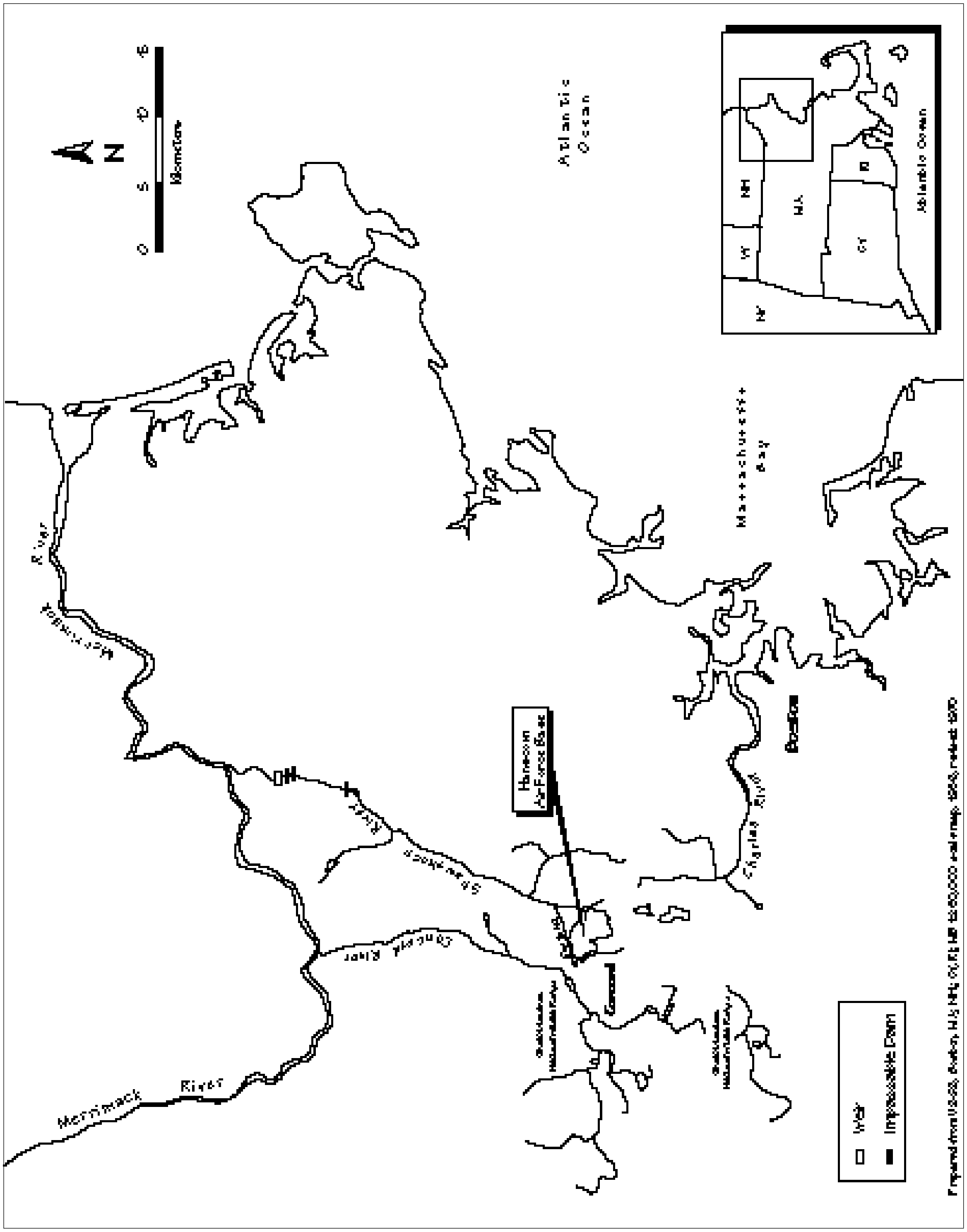

Figure 1. Hanscom Air Force Base in Massachusetts.

Table 1. Types of waste disposed of at 14 areas of concern at the Hanscom Air Force Base.

Source Area	Period of Operation	Type of Waste Disposed or Spilled
Fire Training Area I	1950s to 1960s	Contaminated fuels, solvents, and spent laboratory chemicals were dumped into a pit and ignited. An estimated 60 to 80 drums of unspecified volume were disposed.
Fire Training Area II	Late 1960s to 1973	Unknown quantities of degreasing chemicals, paint thinners, solvents, and waste oils were dumped into a pit and ignited.
Paint Waste Disposal Area	1966 to 1972	Unknown quantities of paint waste, solvents, and metal plating wastes were disposed. Approximately 50 208-liter drums of waste airplane oils and waste paint were buried in a trench.
Jet Fuel Residue/ Tank Sludge Disposal Area	1959 and 1960	An estimated 2,500 to 7,000 drums of unspecified volume containing waste airplane fuel, oils, and paint wastes were buried in trenches. Some drums were reportedly leaking at the time of burial.
Sanitary Landfill	1964 to 1974	Unknown quantities of wastes from all shops and laboratories were disposed of, including spent laboratory chemicals.
Scott Circle Landfill	Early 1950s to 1973	The primary waste was construction debris, but paint, paint thinner, solvents, waste oils, and laboratory chemicals were also reportedly disposed. Exact quantities of waste are unknown.
Industrial Wastewater Treatment System	1955 to 1976	This system removed oily wastes and neutralized wash water from base machine shops. Unknown quantities of sludge from the system was dewatered at the filter beds and placed in the Tank Sludge Disposal Area.
Former Filter Bed Area	Late 1940s to early 1970s	This area was used to dewater sludge, and as a sludge disposal area and landfill. Approximately 200 DDT canisters of unknown size were buried in the late 1940s.
Administration Building Jet Fuel Spill	1954	Approximately 19,000 liters of JP-4 jet fuel were spilled on 0.2 hectares of land.
Building 1128 Mercury Spill	1975	An unknown quantity of elemental mercury spilled into the sanitary sewer system.
Motor Pool Fuel Leak	1981	A leaking 72,000-liter underground unleaded gasoline tank was removed and contaminated soils were excavated.
Base Service Station Leak	1981	Approximately 42,000 liters of fuel leaked from an underground gasoline tank.
Various Fuel Spills on Runways and Taxiways	Various dates	Quantities of fuel at various spills ranged from 19 to more than 1,100 liters.
PCB Transformer Area	Unknown	Unserviceable transformers containing PCBs were stored in a building constructed on a concrete slab floor with no floor drains. No release to the environment is suspected at this site.

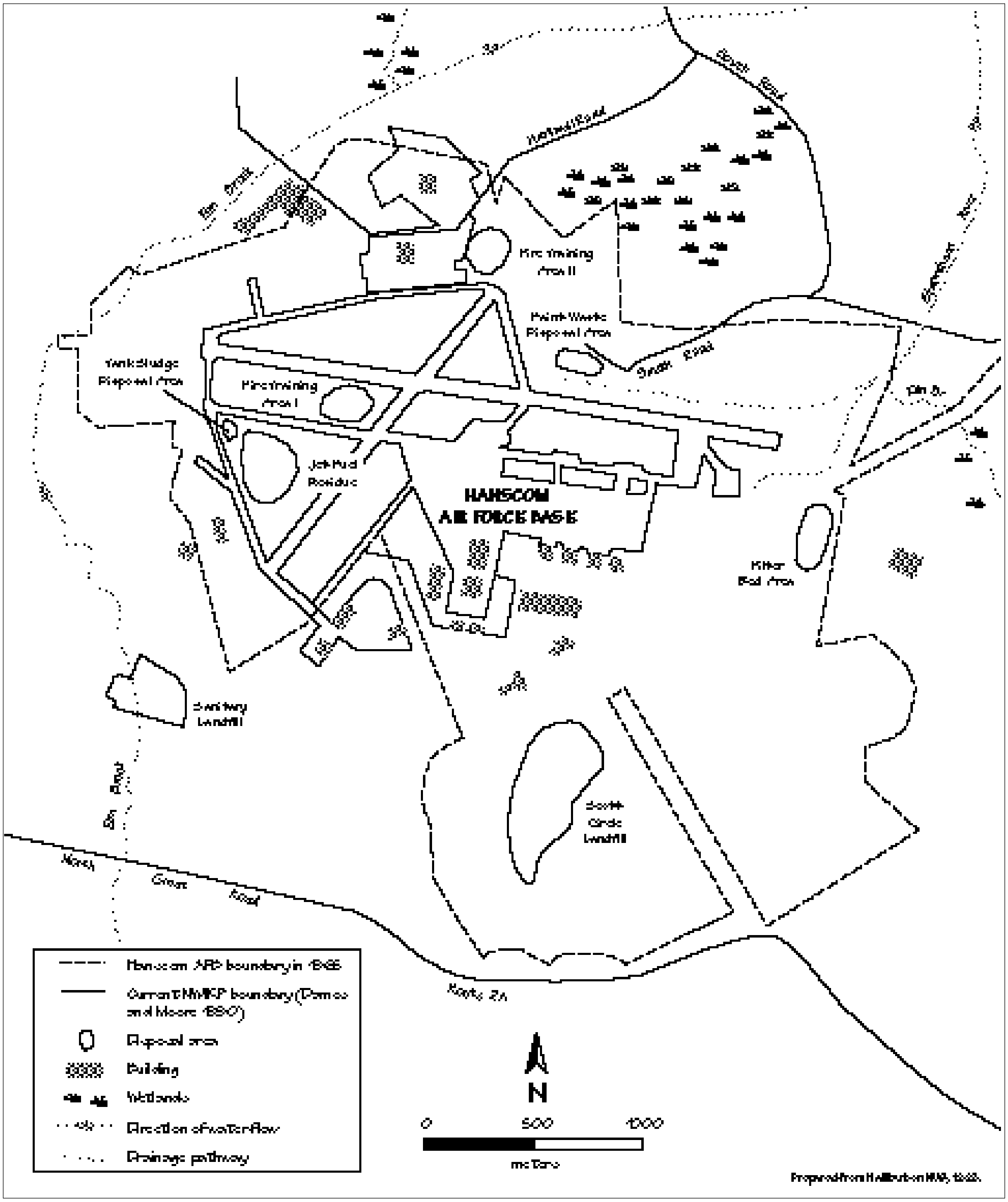

Figure 2. Hazardous waste sites at Hanscom Air Force Base. The locations of all 14 sites identified in Table 1 were not available.

Systems Command on 160 hectares at Hanscom AFB. The Massachusetts Port Authority currently operates a civilian airport, L.G. Hanscom Field, on land that was previously part of Hanscom AFB.

Surface water runoff and groundwater migration are the potential pathways of contaminant transport from the site to NOAA trust resources and associated habitats. Hanscom AFB is located on a flat plain with very low relief. The principal surface drainage features at the site are the Shawsheen River, which originates in the eastern part of the site and flows toward the northeast, and Elm Brook, which is located in the western part of the site and flows northwest into the Shawsheen River. Surface runoff from the site enters a storm drain system consisting of ditches, culverts, and subdrains. The stormwater system drains into Elm Brook, the Shawsheen River, and the wetlands to the northeast of the site.

Groundwater is 1.2 to 3 m below the ground surface within lacustrine deposits of glacial origin. The upper, unconfined aquifer consists of sandy outwash deposits 5.5 to 7 m thick. A low-permeability lacustrine deposit of fine sands, silts, and clays underlies the outwash deposits, and varies in thickness from 6 to 15 m. A thin, sandy till underlies the lacustrine deposits, forming a semi-confined lower aquifer above the bedrock. Groundwater flow in the surficial aquifer is generally toward the northeast (NUS Corporation 1988).

■ NOAA Trust Habitats and Species

Habitats of primary concern to NOAA are surface water and associated bottom substrates of Elm Brook and the Shawsheen River. At a measuring location in Bedford about 1 km downstream from the site, the river bottom varies from sandy to rocky, with a measured stream flow ranging from 0.079 to 2.6 m^3/second. In general, the Shawsheen River is a wide, shallow, slow-moving river. Some channelized areas in the river contain gravel and faster-moving water that could be suitable spawning habitat for anadromous fish (Jackson personal communication 1994). Surface water of the Shawsheen River is designated Class B (fishable and swimmable) by the Massachusetts Department of Environmental Protection.

American eel are the only NOAA trust resource near the site. Anadromous fish such as Atlantic salmon, American shad, alewife, and blueback herring may have used the Shawsheen River historically. However, fish passage on the river is now restricted by one weir and three dams between the Merrimack River and Hanscom AFB (Jackson personal communication 1994). The weir, which represents the first restriction on the Shawsheen River, is approximately 6.8 km upstream from the Merrimack River. Fish passage beyond the weir is only possible at high water. Three dams are situated above the weir at 8.2 km (the J.P. Stevens Dam), 9 km (the Redman Card and Clothing Co. Dam), and 13 km (Ballardvale Dam) upstream from the Merrimack River.

Fish passage is not possible at any of these dams. Although there is a restoration program for Atlantic salmon in the Merrimack River watershed, the Shawsheen River is not included in the program and there are no plans to install fish passage facilities. Atlantic salmon, American shad, and alewife have been caught at the confluence of the Shawsheen and Merrimack rivers. It is not known whether those species would travel upstream in the Shawsheen River if there were no barriers to migration.

The Shawsheen River supports a recreational fishery for warmwater fish species. The Massachusetts Division of Fisheries and Wildlife annually stocks trout in both Elm Brook and the Shawsheen River. In 1993, 350 brook trout and 300 brown trout were released in Elm Brook, and 2,000 rainbow trout were released in the Shawsheen River (Jackson personal communication 1994).

There are no health advisories for the consumption of fish caught in Elm Brook or the Shawsheen River.

■ Site-Related Contamination

There has been limited environmental sampling at the site. Information was not available regarding contamination of soils at the site. Site investigations consisted primarily of groundwater monitoring for VOCs. Five rounds of sampling were conducted between 1986 and 1991, from 38 monitoring wells (Haley & Aldrich 1991). Groundwater samples were collected from only five of the 14 waste disposal areas: the Former Fire Training Area I, the Former Fire Training Area II, the Jet Fuel Residue/Tank Sludge Disposal Area, the Sanitary Landfill, and the Paint Waste Disposal Area. Trichloroethylene (TCE), the primary contaminant of concern in groundwater samples collected from the site, was measured at a maximum concentration of 48,000 µg/l in a sample collected from the Former Fire Training Area II (GEI Consultants, Inc. 1991). AWQC are not available for TCE, but the freshwater chronic LOEL is 21,900 µg/l (U.S. EPA 1993). Other VOCs (1,1-dichloroethane, 1,1-dichloroethene, 1,2-dichloroethane, 1,2-dichloroethene, tetrachloroethylene, and 1,1,1-trichloroethane) were frequently detected in groundwater at concentrations below their respective LOELs, where those guidelines were available. Vinyl chloride was detected in groundwater from the Fire Training Area II at a maximum concentration of 650,000 µg/l (GEI Consultants, Inc. 1991). Screening guidelines were not available for vinyl chloride.

Groundwater samples collected by Haley and Aldrich in 1986 were analyzed for trace elements (NUS 1988). Maximum concentrations of cadmium, chromium, copper, and lead in groundwater exceeded their respective freshwater chronic AWQCs, but not by more than ten times. Detailed information was not available in the documents reviewed on the location of monitoring wells, and the nature and extent of groundwater contamination by trace elements. .

Two surface-water samples were collected from a drainage pathway leading from the Former Fire Training Area II to the wetlands north of the site as part of the monitoring program conducted by Haley & Aldrich (1991). The surface water samples were analyzed only for VOCs. TCE was detected at a concentration of 93 µg/l in the surface water sample collected closest to the site. It is not known whether surface water or sediment samples were collected from Elm Brook or the Shawsheen River to evaluate contaminant migration via surface transport.

■ Summary

Investigations at the Hanscom AFB have been limited primarily to contamination of environmental media by VOCs. The detection of VOCs in surface water draining the site suggests that contaminants are being transported off-site. Little information has been collected regarding contamination by trace elements, PAHs, PCBs, or pesticides. Three dams situated between 27 and 33 km downstream from the site currently block the upstream migration of all NOAA trust species except for the catadromous American eel. There are no plans for restoring fish passage to the Shawsheen River. Due to the nature of activities conducted over the past 50 years, past disposal practices, and proximity to local waterways, it is possible that site-related contaminants have migrated off-site to habitat used by American eel.

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Natick Research, Development, and Engineering Center

Natick, Massachusetts
CERCLIS #MA1210020631

Site Exposure Potential

The U.S. Army Natick Research, Development, and Engineering Center (NRDEC) is composed of two sites: the Natick Laboratory, in Natick, Middlesex County, Massachusetts, and the Sudbury Annex, to the north near the towns of Maynard, Stow, and Hudson. The Natick Laboratory has a greater potential to affect NOAA trust resources than the Sudbury Annex (Dames and Moore 1991).

The Natick Laboratory, a 30-hectare installation on a peninsula along the east shore of Lake Cochituate, is surrounded by the town of Natick (Figure 1). Lake Cochituate supplied water for the City of Boston from 1848 until about 1930. The outlet of Lake Cochituate, Cochituate Brook, flows approximately 1 km into the Sudbury River. Approximately 25.5 km further downstream, the Sudbury and Assabet rivers merge to form the Concord River, which flows 27 km to the Merrimack River. Sixty kilometers downstream, the Merrimack River discharges into the Atlantic Ocean.

The U.S. Army finished building Natick Laboratory in 1954. Activities at the site included food science and engineering; aero-mechanical engineering; and clothing, materials, and equipment engineering. Site operations included the use and storage of tetrachloroethylene, trichloroethane,

Figure available in hardcopy

Figure 1. The Natick Laboratory site and the Sudbury River drainage basin in Middlesex County, Massachusettes.

carbon disulfide, benzene, chloroform, tetraethyl lead, acetone and other VOCs, solvents and thinners, paints and inks, lubricants, pesticides, metal dusts, and chemical waste. Although stored chemicals and wastes have been removed, specific information on the quantities, usage, and removal of site-related chemicals has not been reported. Two main sources of contamination remain on site: the Building T-25 Area and the Gymnasium Area (Figure 2). A third source, the Boiler House area, is contaminated with hydrocarbons from petroleum spills (Halliburton NUS 1993).

Groundwater and surface water runoff are potential pathways for migration of contaminants to NOAA trust habitats. Groundwater occurs at depths of 1 to 10 m near the Natick Laboratory facility. The unconfined alluvial aquifer consists of poorly sorted, coarse- to fine-grained sands that overlie moderately well-sorted silty sands, sandy silts, or silty clays. Bedrock probably occurs at 40 to 45 m. Groundwater is linked to Lake Cochituate and to the wetlands, streams, and ponds of the Lake Cochituate drainage basin, but flow is to the north-northwest, away from the lake. The Evergreen and Springvale municipal wells may influence the direction of flow so that Lake Cochituate may provide up to 75 percent of the recharge to the alluvial aquifer near these wells (USATHAMA 1992).

The laboratory site is relatively level, although there are steep slopes along the waterfront. Surface water on the Natick Laboratory site is mainly controlled by storm sewers that discharge directly into Lake Cochituate. All surface water from this site drains into the lake. A french drain along the shoreline in the Gymnasium Area discharges into Lake Cochituate. Overflow from a small pond northeast of the Gymnasium Area also drains into Lake Cochituate through a culvert. During storms Natick Laboratory personnel have observed an oil-like sheen near the Building T-25 (Dames and Moore 1991). Concentrations of contaminants in surface water runoff generated by storms have not been investigated.

NOAA Trust Habitats and Species

Habitats of concern to NOAA are surface water and bottom substrates of Lake Cochituate, Cochituate Brook, and the Sudbury, Concord, and Merrimack rivers. American eel is the only NOAA trust species known to inhabit Lake Cochituate (Miller personal communication 1993). Historically, American shad, blueback herring, alewife, and striped bass inhabited the Concord and Sudbury rivers. Atlantic salmon may also have used these rivers, although they prefer to spawn in faster-moving water. Information was not available about the historical use of Lake Cochituate and Cochituate Brook by anadromous fish species. However, adult and juvenile anadromous fish would possibly use the lake as habitat for foraging or migration pathways with unrestricted access (O'Leary personal communication 1992).

Figure available in hardcopy

Figure 2. Detail of Natick Laboratory and areas of concern.

A dam on the Concord River and two dams on Cochituate Brook at the outlet of the lake restrict potential upstream migration of anadromous fish species to Lake Cochituate. The Centennial Island Dam, associated with a hydroelectric facility, is on the Concord River about 2 km upstream from the confluence with the Merrimack River. Fish passage facilities were opened at the dam in 1991. Fish passage is restricted at the Talbot Dam in Billerica, about 5 km farther upstream. However, as part of the Merrimack River Anadromous Fish Restoration Program, facilities for fish passage are expected to be operational at the dam five years after 500 American shad pass the Centennial Island Dam (Merrimack River Policy and Technical Committees 1990). Plans for fish passage facilities are being developed by the operators of the hydropower plant at the Talbot Dam by the U.S. Fish and Wildlife Service, the Federal Energy Regulatory Commission, and the Massachusetts Division of Fisheries and Wildlife (Mass DFW). No official fish counts have been taken yet at the Centennial Island Dam because anadromous fish have not been observed near the dam and Mass DFW does not believe that fish use the passage facilities (O'Leary personal communication 1993). There are two dams on Cochituate Brook at the outlet of the lake. The first dam was built to raise the water level by 2.7 m and the second dam was built inside the first dam to raise the level an additional 1.2 m. It is unlikely that anadromous fish can pass these dams, which are not slated for restoration (Miller 1993).

The lake is about 20 m deep at its deepest and has a silty substrate with some sandy areas along the shoreline. Lake Cochituate is considered mesotrophic, and problematic algae blooms have occurred in recent years (Massachusetts Department of Environmental Protection 1992; Screpetis personal communication 1993). Lake Cochituate State Park owns a thin margin of land surrounding most of the lake. Land use in the watershed is a mixture of residential, industrial, and urban.

Recreational fishing for stocked trout is popular in Lake Cochituate (Miller personal communication 1993). Although there are no advisories for fish caught in the lake, the Massachusetts Department of Public Health did issue a catch and release advisory in 1986 for all fish caught along the Sudbury River from Ashland to the confluence of the Sudbury and Assabet rivers because of high concentrations of mercury in fish tissue. In May 1993 a massive fish kill from unknown causes involved several species of fish in the southern portion of Lake Cochituate near the Natick site (Miller personal communication 1993).

Site-Related Contamination

Data collected during several site investigations indicated that groundwater, soil, and surface water were contaminated to varying degrees with pesticides, trace elements, SVOCs, and VOCs. In 1989, soil samples from the Gymnasium Area were found to be contaminated by trace elements and organic compounds. During a soil gas survey conducted in 1989, VOC plumes were found at both the Building T-25 and Gymnasium Areas. During the 1991 Expanded Site Inspection, soil, groundwater, and surface water were sampled at locations based on site history and past investigations.

The pesticides BHC and lindane were detected in soil borings collected from the Gymnasium Area (Table 1). Soil and sediment criteria are not available for these pesticides. Because the Gymnasium Area is close to Lake Cochituate and the measured soil concentrations are of concern, further sampling of soil and lake sediment in the Gymnasium Area is recommended.

Trace elements found in the soil were within their range of average U.S. soils as reported by Lindsay (1979), although some concentrations were above average (Table 1). Soil contained antimony, arsenic, chromium, lead, and mercury. Trace elements in groundwater include antimony, arsenic, chromium, copper, iron, lead, nickel, and zinc, but at concentrations less than ten times the applicable chronic AWQC. A set of surface water samples contained concentrations of lead above the AWQC, but the lead concentration was also high in the laboratory blank.

VOCs detected include benzene, toluene, xylene, freon, tetrachloroethylene, and trichloroethylene. 1,2-dichloroethylene (DCE) was detected in surface water samples from both the french drain and Lake Cochituate, east of the french drain outflow. VOC concentrations in groundwater samples were less than ten times the applicable AWQC. SVOCs detected in monitoring well samples of soil and groundwater from both the Building T-25 Area and the Gymnasium Area include bis(2-ethylhexyl) phthalate and various PAHs. VOC and SVOC concentrations were too low to threaten NOAA resources.

Table 1. Maximum trace element concentrations in Natick Laboratory soils and U.S. soils (Lindsay 1979).

Table available in hardcopy

Summary

Trace elements, VOCs, and SVOCs were detected at the Natick Laboratory site below levels of concern to NOAA. However, high concentrations of the pesticides BHC and lindane were found in soils on the site, close to Lake Cochituate. American eel is the only NOAA trust species now found in Lake Cochituate. Efforts are underway to restore runs of American shad in the Sudbury, Concord, and Merrimack rivers, which are fed by Lake Cochituate. Historically, these rivers supported spawning runs of American shad, blueback herring, alewife, striped bass and, possibly, Atlantic salmon.

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2

Horseshoe Road Industrial Complex

Middlesex County, New Jersey
CERCLIS #NJD980663678

Site Exposure Potential

The seven-hectare Horseshoe Road Industrial Complex site is in northern Sayreville, Middlesex County, New Jersey within 12 m of the Raritan River, which ultimately discharges into Raritan Bay 8 km downstream (Figure 1). The general area around the site, which is about 30 km from the Atlantic Ocean, is moderately developed and populated.

The site includes four distinct areas: the Horseshoe Road Drum Dump (HRDD), Sayreville Pesticide Dump (SPD), Atlantic Resources Corporation (ARC), and Atlantic Development Corporation (ADC) (Figure 2). The period of operation and types of waste disposed at each of these areas are listed in Table 1. Most of the wastes stored in the drums dumped at the two dump areas are unknown. The Horseshoe Road Dump area was discovered in 1981 when a marsh fire uncovered about 70 drums, a few of which were labeled ethyl acetate and silver cyanide. As part of an EPA Removal Action in 1985, the exposed drums were relocated inside a fence on the ADC property (NUS Corporation 1992). Another EPA removal action is underway to excavate and remove buried drums and contaminated debris from the dump areas (Osolin personal communication 1995.)

Figure available in hardcopy

Figure 1. Location of Horseshoe Road site in Sayreville, N.J.

Table 1. Wastes disposed at the Horseshoe Road site.

Figure available in hardcopy

A former employee of International Recycling Corporation, which occupied the ARC site for a period, anonymously reported that it was common practice for employees to dump drums of potassium cyanide; nitric, sulfuric, and hydrochloric acids; and 30-percent hydrogen peroxide at the HRDD (NUS Corporation 1992). The two companies that occupied the ARC area were primarily engaged in precious-metal recycling, although ARC may have operated a solvent recovery facility between 1976 and 1978. In 1985, 0.015 mg/kg of dioxin was detected in one of five soil samples collected from the area. An EPA-approved waste removal action was completed at the ARC site in 1989. The action included cleaning up a mercury spill and mercury-contaminated soils, stabilizing a leaky acid vat, and transporting off-site all wastes for disposal/treatment/reuse. Three drums of zinc powder were treated and left on site (NUS 1992).

The ADC Area was occupied by various companies from 1965 to 1982. The companies that operated in the area were reportedly engaged in the manufacture, processing, and blending of various chemicals though the exact nature of the activities is unknown. The site was abandoned in 1982 and a fire in 1983 burned more than 700 19-liter chemical containers and possibly other wastes. In the mid-1980s, the New Jersey Department of Environmental Protection removed about 1,000 drums from the site (NUS 1992). EPA removed 773 more drums and visibly contaminated soil from this area during the winter of 1992-93 (Roy F. Weston, Inc. 1993c).

Figure available in hardcopy

Figure 2. Detail of Horseshoe Road site in Sayreville, New Jersey (NUS 1992).

EPA collected soil samples on 15-meter centers over the entire complex in 1993. These samples indicated widespread contamination by trace elements, pesticides, PAHs, and PCBs at the site. No sampling of surface waterways, groundwater, or sediment is reported. Maximum concentrations are reported in Table 3 (Roy F. Weston, Inc. 1993a and b). Arsenic, chromium, copper, lead, and zinc contamination were found close to the Raritan River (Roy F. Weston, Inc. 1993a). Several pesticides, including DDT and its degradation products DDE and DDD, were also found in soil samples taken near the river (Roy F. Weston, Inc. 1993b).

Surface water runoff and groundwater are the potential pathways of contaminant transport from the site to NOAA trust resources and associated habitats. The Horseshoe Road site is generally flat and is surrounded by wooded knolls to the east and south. About 90 to 150 m of undeveloped marshland lie between the northern site boundary and the Raritan River. An unnamed drainage channel flows from immediately north of the SPD area for about 350 m before discharging into the Raritan River. Another unnamed ditch flows from the ARC site through the marsh for about 200 m before it enters the Raritan River. Oil was observed in the ditch on many occasions while the site was active (NUS 1992).

Groundwater flow from the site is most likely northwest towards the Raritan River, and is probably tidally influenced. Depth to groundwater is only 1 m in some portions of the site. Bedrock in the area of the site consists of the sandstones and shales of the Passaic Formation. Three strata have been identified as lying above this bedrock, in descending order: 1) the alluvial deposits associated with the Raritan River at a thickness ranging from 0 to 15 m; 2) the silts and clays of the Woodbridge Clay, which range from 6 to 12 m in thickness beneath the site; and 3) the Farrington Sand aquifer, which is confined near the site (NUS 1992).

NOAA Trust Resources and Habitat

Primary habitats of concern to NOAA are surface water, substrates, and associated wetlands of the Raritan River, and surface water and associated bottom substrates of Raritan Bay. The Raritan River provides habitat for numerous migratory and estuarine-dependent fish and invertebrate species of interest to NOAA (Table 2; Boriek personal communication 1991 and 1992; Stuart personal communication 1991; Byrne personal communications 1994). The Raritan River is included in the New York/New Jersey Harbor management area under the National Estuary Program, a Federal program designed to create management plans for estuaries of national significance (Gastrich personal communication 1990; Byrne personal communication 1994). Although water quality has improved in the Raritan River over the past 15 years, it remains a stressed urban watershed (Byrne personal communication 1994).

Table 2. Predominant NOAA trust resources using surface water associated with the Raritan River near the Horseshoe Road site.

Table available in hardcopy

The Raritan River flows approximately 8 km from the area of the site before joining Raritan Bay. The Raritan River next to the site is generally 2.5 to 7.5 m deep and 0.75 to 1.0 km wide, with bottom substrates composed largely of mud. Surface water is mesohaline, typically ranging from 5 to 20 ppt with averages of 10 to 15 ppt, depending on rainfall, tidal phase, saltwater intrusion, and urban runoff (Byrne personal communication 1994a). Tidal amplitude in this portion of the Raritan River commonly averages 1.6 m (U.S. Geological Survey 1981; Byrne personal communication 1994a).

Estuarine intertidal wetlands in this reach of the Raritan River are largely disturbed and commonly dominated by reed grass (*Phragmites communis*). Wetland areas in this portion of the Raritan River are fringed by isolated stands of salt meadow hay (*Spartina patens*), salt marsh cord grass (*Spartina alterniflora*), saltwater sedges (*Scripus* spp.), and salt grass (*Distichlis spicata*; Byrne personal communication 1994a).

The NOAA trust species that are most abundant near the site include bay anchovy, killifish, silversides, and grass shrimp (Table 2). Atlantic menhaden, weakfish, spot, Atlantic tomcod, bluefish, blue crab, and sand shrimp are common in the lower Raritan River estuary. Anadromous runs of alewife, blueback herring, and American shad commonly enter the Raritan River drainage during the spring to access suitable freshwater spawning habitats farther upstream. Juveniles generally return to the ocean and the lower Raritan Bay by the following fall (Byrne personal communication 1994a). Bluefish seasonally migrate into the Raritan River to forage on alewife, blueback herring, American shad, Atlantic menhaden, and killifishes (Pottern et al. 1989). Weakfish and spot use surface water near the site exclusively as a juvenile rearing habitat. American shad and Atlantic tomcod, both threatened species in New Jersey, use the Raritan River as an adult forage area and nursery habitat. It is generally assumed that tomcod in the Raritan River are strays originating from the Hudson River stock and do not represent a distinct population. American eel are found throughout the Raritan River drainage. Blue crab use the river as a seasonal juvenile and adult foraging area (Byrne personal communication 1994a and 1994b).

There is some recreational fishing and crabbing near the site, with striped bass, summer and winter flounder, and bluefish the most commonly captured species (Byrne personal communications 1994a and 1994b). There is sport fishing primarily during warm weather months when species of interest migrate into the Raritan River watershed (Stuart personal communication 1991). Commercial activities exclusively target the blue crab fishery in the Raritan River. There is regular commercial and recreational crabbing at Crab Island, 3.0 km upstream from the site. Gear restrictions to protect spawning fish stocks limit other forms of commercial harvesting of finfish in the river (Byrne personal communication 1994a).

A state-wide consumption advisory is in effect for striped bass, bluefish (exceeding 2.7 kg), white perch, white catfish, and blue crab due to PCB, dioxin, and chlordane contamination (Byrne personal communication 1994). Limits are imposed for the recreational landings of American shad, striped bass, white perch and several warm-water species (Boriek personal communication 1992). No federally protected species are known to frequent nearby habitats of concern (Pyle personal communication 1991).

There are no stocking, enhancement, or restoration programs for trust species in the Raritan River although American shad from the Delaware River were stocked in the upper Raritan for a limited period in the early 1980s (Stuart personal communication 1991; Byrne personal communication 1994). Stocking to encourage the restoration of the shad fishery upriver was discontinued and spawning has not been observed. In 1988, state authorities released approximately 160,000 chinook salmon and 1,100 steelhead trout into the Raritan River. No returns have been made to date, but low-level monitoring continues (Lupine personal communication 1991).

Site-Related Contamination

Trace elements, pesticides, and PAHs are the primary contaminants of concern to NOAA. Elevated concentrations of these contaminants were found in on-site soil, surface water, and sediments during previous site investigations. The maximum concentrations of trace elements, PAHs, PCBs, and pesticides detected in soil, surface water, and sediment are presented in Table 3. No surface water data was available from the Raritan River near the site, the marsh areas near the site, or from the drainage ditch out of the ARC area. Surface water and sediment data were collected only from the drainage ditch that flows from the SPD and ADC areas. No groundwater data have been collected at the site.

Maximum concentrations of pesticides in on-site soils exceeded available ecological screening levels by six orders of magnitude (Table 3). DDT and its metabolites DDD and DDE, aldrin, and heptachlor, were widespread in on-site soils and were found near the Raritan River. Sediments and surface water were not sampled for pesticides, PCBs, or PAHs (Roy F. Weston, Inc. 1993b).

Maximum concentrations of trace elements detected in on-site soils in the ARC or ADC areas far exceeded average concentrations for U.S. soils, in some cases by more than two orders of magnitude. Copper, lead, mercury, and zinc were each detected in surface water from an on-site ditch at concentrations exceeding freshwater chronic AWQC. None of the trace elements detected in sediments from the ditch exceeded ERL or ERM concentrations.

Concentrations of PAHs were detected in on-site soils, but no screening guidelines are available for these contaminants in soils. No PAHs were detected in on-site surface water. The PAHs

Table 3. Maximum concentrations of selected contaminants at the site (NUS Corporation 1992 and Roy F. Weston, Inc. 1993 a and b).

Contaminants	Soil (mg/kg) On-site Soil	Soil (mg/kg) Ave. U.S.[1]	Water (ug/l) Drainage Ditch	Water (ug/l) AWQC[2]	Sediment (mg/kg) Drainage Ditch	Sediment (mg/kg) ERL[3]	Sediment (mg/kg) ERM[4]
Trace Elements							
Arsenic	1,900	5.0	ND	190	ND	8.2	70
Cadmium	1,800	0.06	ND	1.1+	ND	1.2	9.6
Chromium	7,100	100	ND	11	0.053	81	370
Copper	6,200	30	230	12+	0.11	34	270
Lead	37,000	10	84	3.2+	0.048	46.7	223
Mercury	1,440	0.03	10	0.012	0.11	0.15	0.71
Nickel	6,800	40	49	160+	0.019	20.9	51.6
Silver	2,100	0.05	ND	0.12	ND	1.0	3.7
Zinc	9,800	50	430	110+	0.19	150	410
PAHs							
Anthracene	32,000	NA	ND	NA	39	0.085	1.1
Benzo(a)anthracene	30,000	NA	ND	NA	ND	0.26	NA
Benzo(a)pyrene	8,100	NA	ND	NA	1.2	0.43	1.6
Benzo(b/(k)fluoranthene	24,000	NA	ND	NA	1.2	NA	NA
Chrysene	27,000	NA	ND	NA	30	0.38	1.5
Fluoranthene	21,000	NA	ND	NA	ND	0.6	NA
Naphthalene	2,100	NA	ND	620*	ND	0.16	NA
Phenanthrene	26,000	NA	ND	6.3p	ND	0.24	NA
Pyrene	37,000	NA	ND	NA	ND	0.67	NA
Dioxin							
2,3,7,8-TCDD	0.015	NA	ND	$<1X10^{-8}$*	ND	NA	NA
PCBs							
PCB 1254	27,000	NA	ND				
Pesticides							
Aldrin	200	NA				NA	NA
4,4' DDD	12	NA				NA	NA
4,4' DDE	110	NA				0.0022	0.027
4,4' DDT	450	NA				0.016t	0.046
Chlordane	500	NA				NA	NA
Endosulfan	2,240	NA				NA	NA
Endrin	260	NA				NA	NA
gamma BHC (lindane)	46,000	NA				NA	NA
Heptachlor	2,700	NA				NA	NA
Methoxychlor	1,600,000[5]	NA				NA	NA

1: Lindsay (1979).
2: Ambient water quality criteria for the protection of aquatic organisms. Freshwater chronic criteria presented (U.S. EPA 1993).
3: Effects Range Low (Long and MacDonald 1992).
4: Effects Range Median (Long and MacDonald 1992).
5: This concentration was reported by the analytical laboratory with the notation that the sample exceeded the calibration range of the gas chromatograph and the concentration is estimated.
NA: Not available.
ND: Not detected; detection limits not available.
*: Lowest Observed Effect Level (U.S. EPA 1993).
p: Proposed criteria (US EPA 1993).
+: Hardness-dependent criteria (100 mg/l $CaCO_3$ used).
t: Total DDT

anthracene and chrysene were detected in ditch sediments at levels that exceeded ERM concentrations, while benzo(a)pyrene exceeded the ERL concentration (Table 3).

Summary

Elevated concentrations of trace elements, pesticides, and PAHs have been detected in the soil, surface water, and sediments at the Horseshoe Road site. Several of these contaminants were detected at concentrations that far exceeded their screening criteria or guidelines. The lack of available data on the groundwater at the site and on concentrations in sediment and surface water of the Raritan River near the site make it difficult to generate any conclusions about off-site migration of contaminants to NOAA trust resources. The Raritan River and its associated wetlands support numerous migratory and estuarine-dependent fish and invertebrate species of interest to NOAA. Site-related contaminants may pose a risk to NOAA trust resources in the Raritan River. The type of contaminants at the site, the presence of migration pathways to the river via current and historic drainage from the site, and possible groundwater transport suggest a potential risk.

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3

Beltsville Agricultural Research Center

Beltsville, Maryland
CERCLIS #MD0120508940

Site Exposure Potential

The Beltsville Agricultural Research Center (BARC) comprises about 2,830 hectares in Beltsville, Maryland, in the northern tip of Prince George's County (Figure 1). The site drains to Paint Branch, Little Paint Branch, Indian Creek, and Beaverdam Creek. All flow south, eventually feeding into the Northeast Branch about 5 km downstream from the boundaries of the site (Figure 2). The Northeast Branch then flows about 4 km before discharging to the Anacostia River, which subsequently discharges to the Potomac River approximately 13 km farther downstream. The site is approximately 200 km from Chesapeake Bay.

Operations at BARC began in 1910 when the U.S. Department of Agriculture purchased a 190-hectare farm for research on animal husbandry, dairying, and animal diseases. The facility has since expanded with operations focused on research on commercially available herbicides, insecticides, and fungicides. The site has more than 600 buildings, including farm, office, and some residential buildings, and research laboratories. Because hazardous wastes are generated by the laboratories and associated research projects, BARC is a RCRA hazardous waste generator.

Figure available in hardcopy

Figure 1. Location of the Beltsville Agricultural Research Center in Beltsville, Maryland.

Agricultural operations generate chemical and biological wastes (e.g., manure, animal carcasses, and waste bedding). Municipal-type waste is also generated as paper, wood, scrap metal, paints, cleaners, construction debris, and vegetative cuttings. A PA/SI identified 44 areas at the site with known or suspected disposal or release of wastes (Apex Environmental 1991). Apex identified 16 of these areas as potential receptors of

Table 1. Summary of sites at BARC where CERCLA hazardous substances may be present.

Figure available in hardcopy

CERCLA hazardous substances. Table 1 summarizes these 16 areas, with locations shown on Figure 2.

Apex determined that the remaining 28 areas were ineligible under CERCLA authority or EPA policy. However, EPA and the Maryland Department of the Environment do not agree, and are reviewing the 28 areas to determine which sites need further investigation. Of these 28 sites, the site that probably poses the most serious threat to NOAA resources is the Radiological Burial Site in

Figure available in hardcopy

Figure 2. Detail of Beltsville Agricultural Research Center.

the western portion of BARC. This site was established in 1949 and is an inactive landfill that was used for the disposal of low-level radioactive waste from the late 1940s until the early 1980s. Examples of the material disposed at the site include laboratory glassware, metal and plastic products, animal carcasses, and scintillation vials and fluids. The Waste Oil Pit near the airport could also pose a substantial threat to NOAA resources because of its likely contamination with trace elements and petroleum products and its nearness to a wetland area. The rest of the 28 sites are primarily landfills, small dumping areas, fill areas, storage areas, and minor spill areas that were determined not to pose more than a low potential for release of CERCLA hazardous wastes. However, because of the long history of undocumented dumping at the BARC facility at a variety of locations, NOAA resources could be at some risk from each of these sites.

An Environmental Photographic Interpretation Center historical analysis identified another 48 areas of potential concern that will need to be investigated to determine whether hazardous materials were stored, disposed, or released in these areas.

Surface water runoff and groundwater migration are the potential pathways of contaminant transport from the site to NOAA trust resources and associated habitats. Regional drainage is generally to the south with Paint Branch, Little Paint Branch, Indian Creek, and Beaverdam Creek collecting surface water from the site and discharging into the Anacostia River. The National Wetland Inventory maps show numerous isolated wetlands within the site boundaries and along surface water bodies at the site.

The Patuxent and Arundel formations underlie BARC, and the Patapsco formation may be present in the eastern portion of the site. The Patuxent and Patapsco formations are predominantly sand and gravel, while the intervening Arundel formation is predominantly clay. All three dip to the southeast. The Arundel clay tends to create a hydrologic barrier to flow beneath the Patuxent aquifer, which occurs at depths of approximately 50 m and greater in the areas at BARC that have been drilled for supply wells. Recharge of the aquifer is mostly in the western portion of the site where the aquifer outcrops.

NOAA Trust Habitats and Species

Habitats of concern to NOAA are surface water, bottom substrates, and riparian wetlands associated with Paint Branch, Little Paint Branch, Indian Creek, Beaverdam Creek, Northeast Branch, and the Anacostia River. Secondary habitats of concern to NOAA include surface water and associated bottom substrates of the Potomac River. While numerous anadromous species ascend the Potomac River tributaries, only alewife migrate upstream far enough to reach some of the on-site creeks.

Portions of Paint Branch, Little Paint Branch, Indian Creek, and Beaverdam Creek, which flow directly through the boundaries of the site, are representative of headwater streams commonly present in Maryland coastal floodplain drainages. On-site riparian areas are well-buffered, with varying degrees of scrub/shrub and forested canopies. In general, on-site creeks are relatively narrow and channelized, averaging approximately 9 m wide. Near the site, creek substrate is mostly sand and cobble, with isolated areas of silt (Cummins personal communication 1994). Bottom substrates of the Anacostia River are poorer,composed predominantly of silt and mud. Surface water of the Anacostia River is freshwater tidal upstream from its confluence with the Potomac River to Bladensburg, approximately 10 km downstream from the site. There are extensive submerged aquatic beds of hydrilla (*Hydrilla verticillata*) in substrates associated with central and lower reaches of the Anacostia River (Siemien personal communication 1994).

High volumes of urban runoff are discharged directly into the Anacostia River; this runoff contributes to sporadic flow rates and variable water quality. Lower portions of the river next to the metropolitan core of the District of Columbia are mostly bulkheaded, and surrounded by industrial and residential communities. Recreational water use is heavy near the site. During the summer months, surface water of the Anacostia River is frequently subjected to extended periods of low dissolved oxygen concentrations and warm water temperatures. Critically low dissolved oxygen concentrations (approximately 1.0 mg/l) have been recorded in the river during these periods (Siemien personal communication 1994).

There are runs of alewife, American shad, blueback herring, yellow perch, and white perch in the lower Anacostia River. Generally, anadromous alewife, blueback herring, and American shad enter the Potomac River drainage from March through May to spawn in suitable upstream environments. Juveniles generally return to the ocean and the lower Chesapeake Bay by the following fall. Resident species of the Anacostia River which occur in high densities include killifish, gizzard shad, and various warmwater fish (e.g., largemouth bass, sunfish, and bullhead). Juvenile striped bass typically use lower portions of the Anacostia River as a rearing habitat. The catadromous American eel is seen throughout the area (Siemien personal communication 1994).

Alewife is the only anadromous species that migrates far enough upstream to inhabit surface water of some of the on-site creeks. In addition, alewife probably use surface water of the Indian Branch and Beaverdam Creek for spawning. A sheet-pile metal weir, situated in Paint Branch approximately 150 m upstream from its confluence with Indian Creek, blocks all upstream alewife migrations. Plans to breach the structure within two years would restore migratory access to both Paint and Little Paint branches (Cummins personal communication 1994).

Some recreational fishing occurs in the Anacostia River, where shoreline angling is popular year-round. Warmwater species attract the greatest sport effort throughout the watershed, while adult striped bass are heavily targeted in the Potomac River during their summer and fall residences. Striped bass are closely managed using size, take limit, and seasonal restrictions. No additional information was available regarding recreational fisheries in site-related streams. Commercial fishing is prohibited in the Anacostia River drainage (Siemien personal communication 1994). There are no health advisories or restrictions for the consumption of fish from surface water near the site (Murphy personal communication 1994).

Site-Related Contamination

Preliminary data indicate that trace elements and pesticides are contaminants of primary concern to NOAA at the BARC site. PA/SI data on concentrations of contaminants in soil at the site were limited to the 16 sites identified where CERCLA hazardous substances were potentially present (Apex Environmental 1991). Surface water and sediment sampling were limited to the Biodegradable Site and the B409 Dump Site. Groundwater sampling was limited to the Biodegradable Site and the Chemical Disposal Pits. A Phase II environmental investigation of the Biodegradable Site included additional sampling of soil, surface water, groundwater, and sediments (Apex Environmental 1992).

Trace elements were detected in on-site soil at the Biodegradable Site at concentrations that exceeded average U.S. soil concentrations (Table 2). Copper, lead, and zinc were detected in groundwater at the Biodegradable Site at concentrations that exceeded freshwater chronic AWQC by at least ten times. Mercury was detected in surface water upstream of the Biodegradable Site at a concentration of 0.4 µg/l, which exceeded freshwater chronic AWQC. Lead and silver were detected in surface water downstream of the Biodegradable Site at concentrations that exceeded freshwater chronic AWQC. Chromium and nickel were the only trace elements detected in sediments at concentrations that exceeded screening guidelines.

The pesticides DDD, DDE, DDT, dieldrin, and toxaphene were measured in on-site soil, but there are no screening guidelines for these contaminants in soil. DDD and DDE were detected in groundwater; there are no screening guidelines for these contaminants in groundwater. DDT was detected at a concentration that exceeded freshwater chronic AWQC by more than two orders of magnitude. None of these contaminants were detected in the limited surface water and sediment sampling completed at the site.

Although a number of PAHs, VOCs , and SVOCs were detected in on-site soil, there are no screening guidelines for these contaminants. Only 1,1,1-trichloroethane and trichloroethylene were detected in surface water, and only xylene and tetrachloroethene were detected in sediments. Although toluene, xylene, 1,1,1-trichloroethane,

Table 2. Maximum concentrations of selected contaminants detected at BARC.

Contaminants	Soil (mg/kg)		Water (µg/l)			Sediment (mg/kg)		
	On-Site	Avg. U.S.[1]	Surface Water	Ground-water[2]	AWQC[3]	Sediment	ERL[4]	ERM[5]
TRACE ELEMENTS								
Arsenic	450	5	1.2	82	NA	ND	8.2	70
Cadmium	3	0.06	ND	ND	1.1+	ND	1.2	9.6
Chromium	67	100	9	300	11[6]	99	81	370
Copper	330	30	8	310	12+	ND	34	270
Lead	1200	10	3.6	1500	3.2+	ND	46.7	218
Mercury	61	0.03	0.4	0.3	0.01	0.06	0.15	0.71
Nickel	230	40	ND	250	160+	33	20.9	51.6
Silver	26	0.05	26	ND	0.12	ND	1.0	3.7
Zinc	280	50	56	1100	110+	40	150	410
PESTICIDES/PCBs								
DDD	3.9	NA	ND	0.28	NA	ND	NA	NA
DDE	1.4	NA	ND	0.08	NA	ND	0.0022	0.027
DDT	120	NA	ND	0.35	0.001	ND	0.0016t	0.46t
Dieldrin	0.75	NA	ND	ND	25	ND	NA	NA
Toxaphene	12	NA	NA	ND	0.0002	ND	NA	NA
PCB-1260	0.079	NA	NA	ND	NA	ND	NA	NA
Aldrin	0.08	NA	ND	ND	NA	ND	NA	NA
Heptachlor Epoxide	0.02	NA	ND	ND	0	ND	NA	NA
PAHs/VOCs/SVOCs								
Acetone	0.61	NA	ND	ND	NA	ND	NA	NA
Methylene chloride	0.17	NA	ND	ND	NA	ND	NA	NA
1,2-Dichloroethene	11	NA	ND	ND	NA	ND	NA	NA
2-Butanone	0.14	NA	ND	ND	NA	ND	NA	NA
1,1,2-Trichloroethane	0.07	NA	ND	ND	9400*	ND	NA	NA
Tetrachloroethene	0.08	NA	ND	ND	NA	13	NA	NA
Chlorobenzene	0.06	NA	ND	ND	NA	ND	NA	NA
1,2-Dichlorobenzene	9.8	NA	ND	ND	763*§	ND	NA	NA
Naphthalene	3.9	NA	ND	ND	620*	ND	0.16	2.1
Anthracene	0.74	NA	ND	ND	NA	ND	0.085	1.1
Benzo(k)fluoranthene	1.4	NA	ND	ND	NA	ND	NA	NA
Toluene	0.04	NA	ND	9	NA	ND	NA	NA
Xylene	0.088	NA	ND	6	NA	0.088	NA	NA
Phenanthrene	5.1	NA	ND	ND	6.3p	ND	0.24	2.1
Fluoranthene	7.1	NA	ND	ND	NA	ND	0.60	5.1
Pyrene	7.3	NA	ND	ND	NA	ND	0.665	2.6
Benzo(a)anthracene	3.9	NA	ND	ND	NA	ND	0.26	1.6
Chrysene	3.2	NA	ND	ND	NA	ND	0.38	2.8
Benzo(b)fluoranthene	5.2	NA	ND	ND	NA	ND	NA	NA
Benzo(a)pyrene	2.9	NA	ND	ND	NA	ND	0.43	1.6
1,1,1 Trichloroethane	0.012	NA	17	27	NA	ND	NA	NA
Trichlorethene	0.41	NA	13	46	NA	ND	NA	NA
1,1,2,2-Tetrachloroethane	5.4	NA	ND	9	NA	ND	NA	NA

1: Lindsay (1979).
2: Only a few groundwater sites were sampled.
3: Freshwater chronic AWQC for the protection of aquatic organisms (U.S. EPA 1993).
4: Effects Range-Low (Long and MacDonald 1992).
5: Effects Range-Median(Long and MacDonald 1992).
6: Value for Cr^{+6}
NA: Not available.
ND: Not detected; detection limits not available.

+: Hardness-dependent criteria (100 mg/l $CaCO_3$ used).
*: Lowest Observed Effect Level (U.S. EPA 1993).
§: Value for the summation of all isomers.
e: Estimated value.
t: DDT total.
p: Proposed criteria.

trichloroethene, and 1,1,2,2-tetrachloroethane were detected in groundwater, there are no screening guidelines for these contaminants in groundwater.

Summary

Elevated concentrations of trace elements and pesticides have been detected in the soil, surface water, sediment, and groundwater at the Beltsville Agricultural Research Center. Several of the trace elements were detected in soil at the site at concentrations that far exceeded averages for U.S. soil. Though 16 separate areas at the site have been identified where CERCLA hazardous substances may be present, the data on the nature and extent of contamination at these sites is very limited. Most of the data available for this report pertain to the soils, surface water, sediments, and groundwater near one site, the Biodegradable Site, a formerly used landfill. Elevated concentrations of trace elements and pesticides detected at this site could pose a risk to alewife in on-site streams and other downstream anadromous species. More contaminant information is needed on the rest of the BARC facility to determine the overall risk posed by the facility to resources of concern to NOAA.

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3

Langley Air Force Base

Hampton, Virginia
CERCLIS #VA2800005033

Site Exposure Potential

Langley Air Force Base (AFB) is located near Hampton, Virginia, approximately 160 km south of Washington, D.C. The base is located on the Hampton Flat, a low-lying area in the outer coastal plain of southeastern Virginia between the northwest and southwest branches of the Back River. The Back River flows into Chesapeake Bay about 5 km from the site (Figure 1).

Purchased in 1916, Langley AFB is the oldest continuously active Air Force base in the U.S. The 1,300-hectare base has been used as an experimental aviation station, as a fighter squadron homebase, and is now headquarters to the Air Combat Command. Thirty-three separate sites throughout the base have been identified as potentially contaminated due to current or historical activities (Table 1; Figure 2). Abandoned landfills account for eleven of the listed sites. The types of materials sent to these landfills included waste oils and solvents in drums, old paints and thinners, batteries, empty pesticide containers, avionics and electron tubes, tires, fabrics, adhesives, construction debris, municipal waste, and sludge from the sanitary wastewater treatment plant. Storage areas for pesticides and PCBs comprise four sites. Nine sites have been identified as UST or fuel-contaminated areas. Leakage, dumping of fuel and waste oil, and incidental spillage of petroleum products are

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Figure 1. Langley Air Force Base, Hampton, Virginia.

Table 1. Sites identified as potential sources of contaminants (Radian Corporation 1993; Radian Corporation and Law Environmental, Inc. 1993).

Site	Description	Status	Potential contaminant type
Landfills			
LF-001	Landfill	abandoned in 1950	unknown
LF-005	Landfill	abandoned in 1940s	unknown
LF-007	Landfill	abandoned in 1960s	metals, phenols, DDT
LF-010	Landfill/former bombing range	abandoned in 1965	metals, phenols, DDT
LF-011	Landfill	used 1965-1972	metals, phenols, DDT
LF-012	Landfill	used 1972-1980	metals, phenols, DDT
LF-017	Landfill	abandoned 1945	unknown
LF-018	Landfill	abandoned 1930s	unknown
LF-022	Landfill	abandoned 1930s	unknown
LF-13	Landfill	1953-1963	unknown
LF- 15	Landfill	abandoned in 1940s	unknown
PCB/DDT			
SS-019	Transformer storage	currently in use	PCBs
OT-025	Storage of pesticides & herbicides	current storage of debris	pesticide / herbicide
OR-051	Electrical substation	abandoned	PCBs, DDT
OT-06	Sewage treatment/ entomology building	demolished 1960s	unknown (possibly lindane, chlordane, and DDT)
UST/Fuel			
SS-016	Former gas station	removed	fuel oil, unknown
SS-024	Waste oil storage	abandoned UST	waste oil
FT-041	Fire training area	former site replaced with new facility	waste fuel dumped and ignited
OT-048	Former gas station	abandoned UST	gasoline/diesel, fuel oil and waste oil
OR-049	Fuel oil storage	abandoned UST	fuel oil
OT-050	Fuel oil storage	abandoned UST	fuel oil
SS-052	Gasoline storage	replaced UST	gasoline
OT-055	Storage yard/ liquid waste disposal pits	current storage yard	petroleum products, xylenes, toluene
SS-03	Underground fuel line	removed	fuel
Other sites			
OT-056	Six stormwater outfalls	In use	silver
WP-14	Chemical leach pit	abandoned	unknown
ST-035	Septic tank	abandoned	unknown
WP-002	Wastewater treatment plant	abandoned 1968	unknown
WP-008	Wastewater treatment plant	demolished 1960s	unknown
SS-023	Coal storage	removed	unknown
ST-038	Four burning pits	abandoned/removed	unknown
OT-040	Explosive ordnance disposal	abandoned	unknown
DP-09	Cylinder disposal	prior to 1935	unknown

sources of contamination on these sites. The remaining nine sites include two wastewater treatment plants, a coal storage area, a collection of burning pits, two separate disposal areas for gas cylinders and explosive ordnance, a waste chemical leach pit, septic tank area, and silver contamination in storm water throughout the base (Radian Corporation 1993; Radian Corporation and Law Environmental, Inc. 1993).

Surface-water runoff and groundwater discharge are the potential pathways of contaminant transport from the site to NOAA resources and associated habitats. There is poor drainage on the

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Figure 2. Installation Restoration Program (IRP) sites identified as potentially contaminated at Langley AFB.

featureless Hampton Flat, which lies between 1.5 and 2.5 m above mean sea level. Storm drains direct most of the runoff from the runway area at Langley AFB is directed via storm drains towards the southwest branch of the Back River. Tabbs Creek drains most of the northern part of the base, meandering to the northeast and discharging into the northwest branch of the Back River. The northernmost portion of Langley Research Center (NASA) is drained by Brick Kiln Creek. Due to the base's proximity to Chesapeake Bay, much of the drainage is tidally influenced. Surficial deposits (1 to 2 m) at the site are primarily sandy, silty clays overlying 600 m of sediments deposited from the early Cretaceous to Holocene periods. Several areas on the base, particularly those next to the southwest branch of the Back River, contain artificial material used to fill wetlands. The water table aquifer extends from 1.5 to 3 m below the surface to an estimated depth of 12 m. Two deeper artesian aquifers, the upper and principal, occur at depths of 120 m and 210 m, respectively. The artesian aquifers are separated from the shallow water table by silt and clay formations. Saline intrusion prevents any of the groundwater at the base from being a viable drinking water source. Surface and near-surface soils have low to moderate permeabilities. Groundwater flow is generally from west to east towards the Back River (Radian Corporation and Law Environmental, Inc. 1993).

NOAA Trust Habitats and Species

Habitats of concern to NOAA are surface water, bottom substrates, and brackish emergent wetlands associated with Tabbs Creek, Tides Mill Creek, Brick Kiln Creek, and the northwest and southwest branches of the Back River next to the site. Secondary habitats of concern are Back River surface water and substrates. The northwest and southwest branches of the Back River provide extensive nursery and adult forage habitat for numerous species (Table 2; Austin personal communication 1994; vanMontfrans personal communication 1994). Limited data were available regarding resource use of the creeks within the site. However, tidal exchange and the creeks' nearness to the northwest and southwest branches of the Back River suggest that they are regularly used by trust species.

Salinities in the northwest and southwest branches of the Back River near the site, classified as mesohaline, range from 8 to 20 ppt and fluctuate throughout the year depending on rainfall, saltwater intrusion, and urban runoff (Austin personal communication 1994; Hershner personal communication 1994). The creeks associated with the base are reportedly tidally influenced to approximately 2 km inland (Hershner personal communication 1994). The substrate of the northwest and southwest branches of the Back River is mainly mud (Austin personal communication 1994; Orth personal communication 1994). Eelgrass (*Zostera marina*) beds and isolated areas of widgeon grass (*Ruppia maritima*) are present in the Back River,

Table 2. Major species that use surface water associated with the Back River near Langley AFB.

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but bottom habitats associated with the northwest and southwest branches of the Back River are largely barren of submerged aquatic vegetation (Orth personal communication 1994).

Wetlands associated with Tabbs Creek, Tides Mill Creek, Brick Kiln Creek, and portions of the northern and southern fringes of the base are classified as brackish-water, emergent marsh. Wetland vegetation is predominantly large stands of saltmarsh cordgrass (*Spartina alterniflora*) and salt grass (*Distichlis spicata*). Marsh elder (*Iva frutescens*), groundsel tree (*Baccharis halimifolia*), and black needlerush (*Juncus roemerianus*) are associated with these areas but are less dominant in coverage (Hershner personal communication 1994).

Abundant populations of alewife, American shad, blueback herring, and striped bass use Back River surface water for juvenile rearing and adult forage. These anadromous species return as adults to upper portions of Chesapeake Bay in the spring and migrate to suitable freshwater habitats to spawn during late spring and mid-summer. After spawning, adults return to open marine environments by early fall. Juveniles commonly use areas within the Back River as nursery habitat before returning to the ocean by the following fall (Austin personal communication 1994).

Spot, Atlantic croaker, spotted seatrout, bluefish, cobia, weakfish, and summer flounder are common summer migrants typically returning to surface water near the site during the spring and summer. Resident finfish of the Back River that occur in substantial numbers include bay anchovy, hogchoker, oyster toadfish, killifish, and silverside. Bay anchovy, an estuarine species, the most abundant fish in the estuarine water of Chesapeake Bay, dominates the total biomass of pelagic fishes in the bay. The bay anchovy spawning period typically extends from early May through mid-September (Austin personal communication 1994).

Atlantic menhaden rear young in the surface water of the Back River system and are abundant near the site during the late summer months. Adult and juvenile Atlantic stingray and cownose ray frequently migrate into the Back River system during the summer. Northern puffer periodically occur near the site in the spring, while juvenile red and black drum commonly arrive later to rear in the Back River system during the summer months. The catadromous American eel is seen throughout the Back River system. Eel use intertidal habitats for juvenile and adult forage habitat and are likely to inhabit wetland areas associated with Tabbs and Tides Mill creeks (Austin personal communication 1994).

Blue crab are commonly densest in areas associated with submerged aquatic vegetation. Although unconfirmed, wetlands associated with the site may provide juvenile rearing and adult forage habitat to local populations of blue crab. Adult blue crab typically mate from May through July, with gravid females subsequently migrating to higher-salinity areas of the bay and coastal continental shelf for egg dispersal (vanMontfrans personal communication 1994). Some beds of eastern oyster are suspected to exist in the northwest and southwest branches of the Back River, but the extent of their presence near the site has not been established (Mann personal communication 1994).

The Back River system supports important recreational and commercial fisheries. Species commercially harvested in the greatest numbers include American shad, American eel, striped bass, spot, Atlantic croaker, bluefish, Spanish mackerel, northern puffer, blue crab, and northern quahog. Weakfish, sheepshead minnow, mullet, cobia, tautog, red hake, and eastern oyster are also commercially targeted, but to a lesser degree. Spot, Atlantic croaker, summer flounder, and quahog represent the most popular sport fisheries in the area. Striped bass, spotted seatrout, weakfish, mullet, bluefish, cobia, northern puffer, blue crab, eastern oyster, and grass shrimp are also fished recreationally. There are several bait fisheries in the Back River system, including blueback herring, alewife, bay anchovy, Atlantic menhaden, killifish, and silverside (O'Reilly personal communication 1994).

No closures or health advisories for the consumption of fish are reported for surface water near the site (Sherertz personal communication 1994). The Virginia Department of Health, Division of Shellfish Sanitation requires permits to harvest bivalves in Tabbs Creek, Tides Mill Creek, the southwest branch of the Back River, and upper portions of the northwest branch of the Back River. These restrictions are based on fecal coliform contamination associated with urban runoff. Bivalve harvesters in these areas are permitted to relay shellfish to certified areas for depuration when water temperatures exceed 10°C (Wright personal communication 1994).

Site-Related Contamination

There has been limited environmental sampling at Langley AFB. Since data are available for only eight of the 33 sites, and sampling at these sites was limited, the nature and extent of contamination at the site is not well characterized. All data reviewed were from sampling conducted between 1982 and 1992. The results from preliminary sampling indicate that trace elements, pesticides, and PCBs are the primary contaminants of concern to NOAA. Maximum concentrations of contaminants detected in samples collected from Langley AFB are presented in Table 3.

At Site LF-007, surface water and sediment samples were collected from 12 locations in Tides Mill Creek and analyzed for trace elements and pesticides. Low concentrations of pesticides and moderate concentrations of cadmium (5.3 mg/kg), compared to the respective ERL concentrations (Long and MacDonald 1992), were found in sediments. Contaminants were not detected in surface water samples (Radian Corporation and Law Environmental, Inc. 1993).

Three paired surface water and sediment samples were collected from Tabbs Creek to investigate potential contamination from three nearby sites: LF-010, LF-011, and LF-012. Four groundwater samples were collected near LF-010. Concentrations of pesticides in sediments (460 mg/kg DDT, 79 mg/kg DDD, and 44 mg/kg DDE) were elevated with respect to their screening guidelines. Low concentrations

Table 3. Maximum concentrations of contaminants of concern at seven of the waste sites at Langley AFB (Radian Corporation and Law Environmental, Inc. 1993).

	Water (µg/l)			Soil (mg/kg)	Sediment (mg/kg)	
Compound/Analyte	Groundwater	Surface water	AWQC[1]	Soils	Tabbs Creek Sediment	ERL[2]
Trace Elements						
Cadmium	60	<50	1.1+	NT	5.3[3]	5.0
Chromium	88	<50	11	NT	301	80
Lead	340	<50	3.2+	NT	5.8	35
Mercury	3.4	<2.5	0.012	NT	<2.5	0.15
Silver	230	790	0.12	NT	0.7	1.0
Organic Compounds						
o,p'-DDE	ND	trace[4]	NA	1.2	7.6	NA
p,p'-DDE	ND	trace	14	0.14	44	0.002
o,p'-DDD	ND	trace	NA	trace	29	NA
p,p'-DDD	ND	trace	0.6	0.12	79	0.002
o,p'-DDT	ND	trace	NA	0.3	66	NA
p,p'-DDT	ND	trace	0.001	0.52	460	0.001
PCB						
Aroclor 1254	ND	NT	0.014	1.7	NT	0.05
Aroclor 1260	ND	NT	0.014	1.0	NT	0.05

1: Ambient water quality criteria for the protection of aquatic organisms. The lower concentration of the marine or freshwater chronic criteria are presented, because waste sites are located near both marine and freshwater environments (EPA 1993).
2: Effects range low; the concentration representing the lowest 10 percentile value for the data in which effects were observed or predicted in studies compiled by Long and MacDonald (1992).
3: Tides Mill Creek sediment.
4: A peak, reported only as "trace," was measured at less than the detection limit.
+: freshwater chronic AWQC value dependent on water hardness (100 mg/l $CaCO_3$ used)
NA: Screening guidelines not available.
ND: Not detected; detection limit not available.
NT: Not tested; sample not analyzed for compound.

of pesticides were detected in the overlying surface water (no values reported). Trace elements were present in sediments (300 mg/kg chromium) and groundwater (60 µg/l cadmium, 88 µg/l chromium, 3.4 µg/l mercury, and 230 µg/l silver) at concentrations of concern to NOAA. The relative contribution of each individual site to contamination in Tabbs Creek is not known (Radian Corporation and Law Environmental, Inc. 1993).

Soil samples were collected from two sites (OT-025 and OR-051) suspected of pesticide and PCB contamination. Soils in four samples collected from Site 0T-025 contained maximum concentrations of 1.2 mg/kg DDE, 0.12 mg/kg DDD, and 0.52 mg/kg DDT. Three of the 18 samples collected at site OR-051 contained pesticides or PCBs (0.39 mg/kg DDE; 0.64 mg/kg DDT; 1.0 mg/kg Aroclor 1260; and 1.7 mg/kg Aroclor 1254). The source of PCBs is believed to be from transformer oil spilled at the abandoned electrical substation (Radian Corporation and Law Environmental, Inc. 1993).

High concentrations of silver (detected in 46 of 115 samples, 790 µg/l maximum concentration), with respect to the AWQC for silver, were recorded during the monthly sampling of effluent from the stormwater outfalls draining the base. The presence of silver may be the result of film incineration at the site. Silver was the only analyte tested in the stormwater effluent.

Low concentrations of petroleum-related compounds were also identified in soil and groundwater samples at site OT-055, although specific data were not available (Radian Corporation and Law Environmental, Inc. 1993).

Summary

DDT and its metabolites, cadmium, chromium, lead, mercury, and silver were measured at concentrations that pose a threat to NOAA resources in habitats likely used by NOAA trust resources. Numerous sites at the facility are sources of contamination. Sampling is limited to date; the main pathways from the site to NOAA trust resources and habitats are stormwater runoff and groundwater discharge to Tides Mill Creek, Tabbs Creek, and the northwest and southwest branches of the Back River next to Langley AFB. Trust resources are located in each of these pathways.

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3

Marine Corps Combat Development Command Quantico

Quantico, Virginia
CERCLIS #VA1170024722

Site Exposure Potential

The U.S. Marine Corps Combat Development Command (MCCDC) at Quantico, Virginia, borders the Potomac River and occupies more than 24,250 hectares of mainly undeveloped land. The base is spread over several watersheds, including Cedar Run Creek, Quantico Creek, Chopawamsic Creek, Aqua Creek/Beaver Dam Run, and Little Creek, all of which flow into the Potomac River on the eastern border of the site (Figure 1). The base lies between the tidal and estuarine transition zones of the Potomac River, approximately 130 km from the Chesapeake Bay. There are two major organizations at MCCDC Quantico: the Education Center, which prepares Marine Corps officers for general combat, and the Development Center, which focuses on research and development of Marine Corps equipment.

Seven sites have been identified as areas of concern: the Old Landfill, Old Batch Plant, Recently Closed Landfill, Fire Training Area, Arsenic Burial Area, Aero Club, and Pesticide Burial Area (Figure 2; Radian 1992 a-g). The dates of operation, types and quantities of waste, and pathways to NOAA trust resource habitats for these seven sites are presented in Table 1.

Surface runoff from the Old Landfill and the Old Batch Plant enters the Potomac River. Surface water flows from the Recently Closed Landfill and Fire Training Area into Chopawamsic Creek or its tributaries. Information was unavailable in the documents reviewed for surface pathways from the remaining three sites (the Pesticide Burial Area, Arsenic Burial Area, and the Aero Club). Details on surface water pathways are presented in Table 1.

Six of the seven sites of concern are located in the Atlantic Coastal plain. The overlying geology in the Atlantic Coastal plain consists of 1.5 to 2.7 m of sand, gravel, and sandy clay terrace riverine deposits. The coastal plain sediments are a recharge zone for underlying shallow aquifers, and groundwater tends to flow to the southeast, towards the Potomac River (Radian 1992 a-g). Groundwater discharge to the Potomac River is a potential pathway at the Old Landfill site. There is insufficient information to determine whether groundwater is a pathway from the Arsenic Burial Area and Pesticide Burial Area to NOAA trust resources. The Recently Closed Landfill is the one site that lies in the Piedmont Province, where leachate seeps indicate that shallow groundwater is discharging. Groundwater in the Piedmont Province is primarily contained in bedrock fractures, but information was not available on groundwater direction or depth under the MCCDC.

NOAA Trust Habitats and Species

Habitats of primary concern to NOAA are surface water, bottom substrates, associated wetlands of Chopawamsic Creek, and the Potomac River. MCCDC Quantico includes 19 km of tidal Potomac River shoreline. Chopawamsic Creek and the Potomac River provide substantial nursery and adult forage habitat for numerous trust species (Table 2). Quantico Creek and Chopawamsic Creek are relatively shallow, ranging from less than 1 m to 5 m, while the Potomac River averages 5 m deep, except for the deeper water of Shipping Point off the northeastern boundary of MCCDC Quantico (USGS 1986). The reach of the Potomac River near the site is characterized as the Potomac Transition Zone, with tidal influences and varying salinity levels resulting from the convergence of the Potomac River and Estuary (Radian 1992 a-g). Salinity levels range from 3 to 4 ppt. Tidal amplitude near MCCDC Quantico is approximately 0.4 m. Substrate composition in the Quantico area is sandy, loamy clay with abundant silt and sand (Steinkoenig personal communication 1994).

There are approximately 210 hectares of wetlands along Chopawamsic Creek, Quantico Creek, and the Potomac River near MCCDC. Most aquatic vegetation associated with open-water wetland areas is composed of aquatic hydrilla (*Hydrilla verticullata*) and Eurasian milfoil (*Myriophyllum heterophyllum*). Wetland vegetation associated with on-site wetlands include wild celery (*Valisheria americana*), water-nymph (*Najas* spp.), sago pondweed (*Potamogeton pectinatus*), broad-leaved cattail (*Typha latifolia*), yellow pond

Table 1. Summary of site operations and pathways at the MCCDC Quantico site.

Table available in hardcopy

Blue crab are the most abundant species of invertebrates near the site (Stone et al. 1994). The catadromous American eel is also a common species in the area. The Chopawamsic Creek has been classified as a nursery both for commercially valuable fish and sport fish (Steinkoenig personal communication 1994).

The Potomac River supports important commercial and recreational fisheries. NOAA trust species commercially harvested near the site include blueback herring, alewife, catfish, white perch, and yellow perch. There are also extensive commercial fisheries for blue crab and American eel. Recreational fishing is heavy in the spring on the Potomac River and creeks next to MCCDC Quantico. The primary species caught recreationally include alewife, channel catfish, blueback herring, hickory shad, white perch, yellow perch, striped bass, and blue crab. Oyster and American eel are also harvested recreationally in limited quantities (Steinkoenig personal communication 1994). A recent statewide moratorium on shad fishing restricts all 1994 harvests. There are no health advisories or restrictions for the consumption of fish from the Potomac River or surface water surrounding MCCDC Quantico (Steinkoenig personal communication 1994).

The State of Virginia stocks walleye (*Stizostedion vitreum*) at the Lunga Reservoir on the base, and MCCDC Quantico stocks trout in Chopawamsic and Quantico creeks. Neither of these two species is a NOAA trust resource.

Site-Related Contamination

Data collected during the remedial investigation indicated that sediment, soil, groundwater, and surface water at the base are contaminated with pesticides, PCBs, trace elements, and PAHs (Radian 1992 a-g). Contaminant data indicated that the Old Landfill had the most widespread contamination, the highest concentrations, and the most contaminants of concern (Radian 1992e).

Pesticides and PCBs were found at concentrations exceeding screening guidelines in sediment and surface water (Tables 3 and 4). Concentrations of PCBs and DDT constituents in Old Batch Plant drainage structure and creek sediment samples exceeded ERM guidelines. PCBs and DDT constituents in sediments exceeded ERM concentrations in the Old Landfill drainage ditch and creek, and also in the Potomac River next to the site. Concentrations of PCBs (maximum 8.4 µg/l) exceeded the acute AWQC in Old Landfill drainage ditch surface water. Fish tissue samples collected from the Potomac River next to the Old Landfill contained Aroclor 1260 (840 µg/kg), DDE (190 µg/kg), and DDD (460 µg/kg). Detection limits for sediment samples were generally above concentrations known to cause effects, and therefore contamination of the Potomac River was not adequately characterized in the RI. The Old Batch Plant surface water and groundwater sample detection limits for PCBs and DDT constituents were up to two orders of magnitude above the chronic AWQC (Table 4). Detection limits for DDT were two orders of magnitude above the chronic AWQC.

Sediments and biota were collected by the U.S Fish and Wildlife Service from the Quantico embayment of the Potomac River for a human health risk assessment (Pinkney 1995). Eleven of the 28 sediment samples from the Quantico embayment had concentrations of total PCBs that exceeded their ERM concentration. Eight of these 28 sediment samples had DDT concentrations that exceeded the ERM. Table 5 summarizes the maximum concentrations of total PCBs and total DDT in sediment and selected biota from the Quantico embayment (Pinkney et al. 1995).

are the primary contaminants of concern at the Recently Closed Landfill (Table 6), and concentrations of arsenic, copper, and silver in tributary sediments were detected above ERL guidelines. Surface water, leachate seeps, and filtered groundwater at the Old Landfill exceeded the chronic AWQC for lead, nickel, silver, and zinc. Fire Training Area soils are contaminated with trace elements with concentrations of lead (283 mg/kg), copper (56.6 mg/kg), and zinc (133 mg/kg) above the average found in U.S. soils.

Table 5. Maximum concentrations (mg/kg) of total PCBs and total DDT in sediments and selected biota from the Quantico embayment of the Potomac River (Pinkney et al. 1995).

Table available in hardcopy

Sediment concentrations of trace elements in Old Landfill drainages generally exceeded ERL guidelines (Table 3). Copper, lead, mercury, nickel, and silver exceeded ERL guidelines in the Potomac River. Surface water samples collected from the Old Landfill drainage channels had concentrations of cadmium, chromium, lead, nickel, silver, and zinc that exceeded the chronic AWQC, while copper exceeded its acute AWQC. Trace elements were ubiquitous in Old Landfill groundwater, with copper, lead, mercury, silver, and zinc the most prevalent, although none exceeded ten times the AWQC. Trace elements

Several PAHs in sediment samples from Old Landfill drainages and the Potomac River exceeded ERL concentrations (Table 3). PAHs were also detected in low concentrations in Chopawamsic Creek sediments collected next to the Fire Training Area. However, the Fire Training Area sediment samples were collected using a hand trowel, a method that tends to lose fine-grained material. Therefore, Chopawamsic Creek sediments were probably inadequately characterized.

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3

Ordnance Products, Inc.

North East, Maryland
CERCLIS #MDD982364341

Site Exposure Potential

The Ordnance Products, Inc. site covers approximately 40 hectares, 3 km northeast of the town of North East, Maryland. The site is bisected by an unnamed tributary that flows east and southeast for approximately 180 m before discharging to Little North East Creek (O'Brien & Gere 1990). Little North East Creek flows for about 3 km to North East Creek, which continues south for three more kilometers before discharging to the North East River, a wide, estuarine arm of upper Chesapeake Bay (Figures 1 and 2).

From 1960 to 1973, Ordnance Products, Inc. manufactured, tested, stored, and packed ammunition products for the U.S. Department of Defense. The site has both wooded and open terrain, 58 buildings, and several truck and house trailers. Plating wastes were disposed in five unlined surface-water impoundments on the site. In 1989, a field inventory noted six burn or disposal pits with nearly a metric ton of grenade fuses and slag, many discarded drums containing non-halogenated solvents, bags of ammonium sulfate and ammonium chloride, electrical transformers; and unknown sludges. Source-area soils are contaminated with trace elements at concentrations well above average background levels (O'Brien & Gere 1990).

Substances may migrate off-site via groundwater within overburden and bedrock, and via surface

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Figure 1. The Ordinance Products study area.

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Figure 2. The Ordinance Products site, North East, MD (O'Brien and Gere 1990).

water to an unnamed tributary, which flows past the five impoundments and a large source area before discharging to North East Creek, 180 m east of the site boundary. The overburden aquifer is shallow, encountered during site investigations at depths between 4 and 18 m below ground surface. The deeper bedrock aquifer was encountered between 30 and 90 m below ground surface. Geohydraulic studies indicate a potential for vertical flow between the aquifers, and found that both aquifers flow east, probably discharging to Little North East Creek (O'Brien & Gere 1990).

NOAA Trust Habitat and Species

Habitats of concern to NOAA are the surface water and bottom substrates of Little North East and North East creeks, and the North East River (Figure 2). The North East River drainage provides substantial nursery and adult forage habitat for numerous NOAA trust species (Table 1). Little North East Creek, near the site, and North East Creek, downstream of the site, are freshwater, non-tidal, low-gradient streams. They are generally fast-flowing with boulders forming high walls along the bank. Substrate composition varies from rock rubble to silt in the runs and pools. Overall, the streams are mostly hard bottom with some clay. Little North East Creek is approximately 6 m wide near the site. Approximately 5 km downstream of the site in the town of North East, North East Creek becomes tidal; tidal amplitude can fluctuate as much as 0.9 m (Heft personal communication 1994). The North East River is actually a shallow, estuarine embayment of upper Chesapeake Bay. The embayment is fairly shallow (approximately 1.5 m deep throughout the river); tidal amplitude is approximately 0.3 m. Subtidal substrate composition is primarily sand and mud, but gravel predominates along the beaches. Aquatic vegetation along the banks has increased in recent years, dominated by hydrilla (*Hydrilla verticullata*), Eurasian milfoil (*Myriophyllum heterophyllum*), and wild celery (*Valisheria americana*; Cosden personal communication 1994). Salinities in this portion of Chesapeake Bay are generally below 5 ppt, due to the large freshwater inputs of the Susquehanna River (Schubel and Pritchard 1987).

Anadromous species in the North East River include American shad, blueback herring, alewife, white perch, and striped bass (Table 1). The catadromous American eel is found throughout the area (Heft personal communication 1994). NOAA trust species that use the very low-salinity habitats of the North East River include mummichog, banded killifish, and silverside. There is a population of blue crab in the North East River though it is not large. Blueback herring, alewife, white perch, and striped bass use the lower tidal section of North East Creek approximately 5 km below the Ordnance Products site for nursery and adult forage habitat (Cosden personal communication 1994). It is not known whether anadromous fish use the upper reaches near the site because access is limited by a low dam in a state of disrepair about 4 km downstream of the site. This dam creates a small blockage that probably

Table 1. NOAA trust resources that use the Little North East Creek, North East Creek, and the North East River near the site.

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does not prevent passage. As part of a statewide program, Maryland fish passages are being built to span blockages in historical spawning streams, although it is not known whether this dam will be modified.

Commercial fisheries in the North East River are dominated by white perch, with some striped bass also harvested. There are no commercial fisheries in Little North East and North East creeks. However, recreational fishing is popular in the area, including around the Ordnance Products site. Popular recreational species include striped bass, white perch, and some blue crab. Striped bass is the only regulated species in the area, with a 45-day season extending from October through mid-November. There are no health advisories or restrictions for the consumption of fish from Little North East Creek or the North East River (Cosden personal communication 1994).

Site-Related Contamination

Trace elements are the primary contaminants identified by preliminary site investigations (Interim Technical Memoranda) that pose a threat to NOAA trust resources. Data collected during a preliminary investigation in 1990 indicate that soils in several areas on-site and sediments within the surface water impoundments contain elevated concentrations of trace elements. Lower concentrations appear associated with surface water and sediments of the tributary stream draining the site. Little North East Creek has not been sampled (O'Brien & Gere 1990).

Site investigations also found relatively low concentrations of several VOCs in environmental media on the site (O'Brien & Gere, 1990). It is unlikely that ecologically substantial impacts would occur due to the VOC concentrations observed in site investigations. However, the history of the site suggests that other, more toxic substances of concern, such as PCBs, SVOCs, and ordnance compounds may be present in source areas. Because these substances have not been measured, their presence has not been confirmed. The distribution and maximum concentrations of trace elements in soil, sediment, and surface water are presented in Table 2 along with applicable screening guidelines.

The greatest degree of contamination was observed in soil at Areas A1 and F. Each of these areas had measurable concentrations of seven trace elements that exceeded the U.S. average in soils by up to 30 times. Areas A2 and C had measurable concentrations of three trace elements that exceeded background levels, while each of the remaining areas generally exceeded background for one element (Table 2; Figure 2). Sediments in Impoundments 2, 3, and 4 were highly contaminated. Concentrations of five trace elements exceeded their respective ERLs by over an order of magnitude. Lower concentrations were observed in the sediment of Impoundments 1 and 5, although cadmium, nickel, and zinc in both impoundments slightly exceeded their sediment screening guidelines (Table 2; O'Brien & Gere 1990).

Site-related substances observed in the groundwater did not exceed screening guidelines (ten times the chronic AWQC). However, several VOCs were observed in the groundwater beneath the site in both the overburden and bedrock aquifers. Groundwater has not been sampled between the site and Little North East Creek to determine whether a contaminant plume is migrating toward the stream.

Sediment contamination was not observed in the unnamed tributary; however, no sediment stations were located in the stream next to the five surface-water impoundments. Rather, four stations were positioned upstream of the impoundments and one station downstream. One other station located in an on-site drainage south of the impoundments near Area A1 (see Figure 2) contained a measurable concentration of lead that exceeded average soil concentrations by over an order of magnitude. Sediment screening guidelines were also exceeded. Concentrations of chromium, nickel, and silver at this station also exceeded average soil concentrations (though within an order of magnitude) and sediment screening guidelines (Table 2; O'Brien & Gere 1990).

Contamination observed in the impoundments' surface water and in tributary streams was not as extensive as that found in sediment (O'Brien & Gere 1990). Concentrations of zinc in Impoundments 3, 4, and 5 ranged from 270 to 800 μg/l, exceeding the freshwater chronic AWQC. Copper was observed in Impoundment 5 at a concentration exceeding aquatic screening guidelines. Zinc, measured in one sample, was the only trace element that exceeded its AWQC in the unnamed tributary (Table 2).

Table 2. Maximum concentrations of trace elements observed in surface water, sediment, and soil at the Ordnance Products site.

	Surface Water (µg/l)			Sediment (mg/kg)			Soil (mg/kg) Study Area									
	On-site Drainage	Impound.	AWQC[1] (µg/l)	On-site Drainage	Impound.	ERL[2] (mg/kg)	A1	A2	B	C	D	E	F	H1	H2	Ave. U.S.*
TRACE ELEMENTS																
Antimony	ND	ND	30	<19	41	NA	29	<15	<14	4.1	<13	<17	<13	<13	<14	NA
Arsenic	ND	ND	190	4.1	4.1	8.2	6.1	7.4	5.7	5.0	4.4	9.3	3.6	4.1	4.9	5
Cadmium	ND	ND	1.1+	<1.9	900	1.2	35	<1.5	<1.4	<1.4	1.3	<1.7	15	<1.3	<1.4	0.06
Chromium	ND	ND	11	99	39,000	81	200	55	57	530	34	89	1,900	76	82	100
Copper	ND	ND	12+	17	88	34	150	29	70	29	12	27	92	38	14	30
Lead	ND	20	3.2+	380	820	47	2,070	310	35	53	9.0	52	3,300	13	47	10
Nickel	ND	ND	160+	32	73	21	330	36	23	670	14	41	1,000	21	17	40
Mercury	ND	ND	0.01	<0.5	3.0	0.15	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.03
Selenium	ND	ND	5	<9.5	<1.8	NA	<6.4	2.0	<6.6	<6.5	<6.4	<7.0	<6.5	<6.5	<6.6	NA
Silver	ND	ND	0.12	<1.9	<3.7	1.0	<1.4	<1.4	<1.4	<1.4	<1.3	<1.7	5.0	1.3	<1.4	0.05
Zinc	100	800	110+	140	51,000	150	15,000	130	150	850	44	330	2,800	64	400	50

1: Ambient water quality criteria for the protection of aquatic organisms. Freshwater chronic criteria presented (EPA 1993).

2: Effects Range-Low; the concentration representing the lowest 10 percentile value for the data in which effects were observed or predicted in studies compiled by Long and MacDonald (1992).

ND: Not detected; detection limit not available.

NA: Guideline not available.

<: Not detected at detection limit shown.

+: Value is dependent on hardness, 100 mg/l $CaCO_3$ used.

*: Lindsay (1979).

Summary

Preliminary site investigations that tested soils on the site and sediments in unlined surface water impoundments found high concentrations of several trace elements. Although site history suggests that the persistent organic contaminants, such as PCBs, SVOCs, and ordnance compounds, may also be present, these substances were not analyzed in preliminary studies. A tributary stream that drains the site and flows past the surface impoundments was sampled primarily upgradient of the contaminated impoundments. Because only one station was located downstream of the contaminated areas, the extent of off-site contaminant migration is not known. The tributary stream flows to Little North East Creek 180 m east of the site. Little North East Creek has not been sampled.

Anadromous American shad, white perch, striped bass, alewife, and blueback herring use the lower reaches of the North East Creek drainage (about 5 km downstream of the site) for juvenile rearing and adult forage habitat. These species have access to the site via an unnamed tributary to North East Creek. A low-head dam 4 km downstream of the site may allow passage of migratory fish, but no documented observations are available. Little North East Creek contains catadromous American eel throughout its system and in areas near the site.

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9

Del Monte Corporation (Oahu Plantation)

Oahu, Hawaii
CERCLIS #HID980637631

Site Exposure Potential

Del Monte Corporation's Oahu Plantation covers 2,400 hectares on the coastal plain of the Island of Oahu. The site is near an unnamed stream that flows into Poliwai Gulch, then to Waikele Stream, which flows another 13 km to the West Loch of Pearl Harbor (Figure 1; EPA 1993). The site has been used for pineapple cultivation since the 1940s. Fumigants were used to control nematode infestation; the active chemical being ethylene dibromide (EDB). In 1980 the Hawaii Department of Health sampled a plantation well during a groundwater program designed to determine whether fumigants had contaminated drinking water wells on Oahu. Analyses identified two fumigants: EDB and 1,2-dibromo-3-chloropropane (DBCP). Two sources of contamination were located on the site (Figure 2): an area used to store drums of fumigants from the 1940s to 1975 (Source Area 1), and an area where 1,870 l of EDB were spilled in 1977 (Source Area 2). Since the discovery of groundwater contamination, Del Monte has removed 16,300 metric tons of soil, which was spread on a nearby field to allow the EDB and DBCP to volatilize. Despite this action, groundwater is still contaminated (EPA 1993).

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Figure 1. DeLocation of Del Monte Oahu site.

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Figure 2. Del Monte Oahu site.

EDB and DBCP could migrate off-site via groundwater and, possibly, surface runoff, although neither pathway has been investigated. Groundwater that may be affected by the site occurs in two aquifers: a shallow, perched aquifer encountered between 6 and 9 m below ground surface, and the Waipahu basal aquifer approximately 250 m bgs. The two aquifers are hydraulically connnected. Both source areas on the site are also within 60 m of an unnamed stream, which flows approximately 1 km east to Poliwai Gulch.

NOAA Trust Resources

Habitats of primary concern to NOAA are surface water and associated bottom substrates of lower Waikele Stream, one of five principal streams draining into Pearl Harbor. NOAA trust species that use lower Waikele Stream are listed in Table 1. Principal streams in the area drain agricultural and newly urbanized lands before passing through highly urbanized areas near Pearl Harbor, where they remain brackish for short distances upstream (Grovhoug 1991). Pearl Harbor, a natural coastal plain estuary, is one of the largest estuaries in Hawaii, containing nearly 21 km^2 of surface water area and 58 km of linear shoreline. The harbor drains approximately 285 km^2 of total area. Some of the species listed in Table 1 spend portions of their life histories in habitats of the West Loch of Pearl Harbor.

Poliwai Gulch and central Waikele Stream near the site are intermittent and typically dry during most months of the year and are considered unlikely to provide any habitat to NOAA trust resources (Environmental Technologies International [ETI] 1993; Devick personal communication 1994). Permanent water flow does not appear in Waikele Stream until groundwater springs emerge near the Oahu Sugar Company property, about 10 km downstream from the site (referred to here as lower Waikele Stream).

Table 1. Major species that use surface water associated with Waikele Stream downstream of the Del Monte site.

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Downstream from the Farrington Highway bridge (Figure 1), a concrete channel lines the stream course for about 250 m. There is a 1-m concrete barrier formed by a USGS gauging station weir at the upstream head of the channel, approximately 1 km upstream from the West Loch of Pearl Harbor. This barrier is the upstream limit of tidal influence in Waikele Stream. Riparian vegetation along a 2-km stretch of Waikele Stream that extends north from the Farrington Highway consists mostly of thick stands of California grass (*Brachiaria mutica*). Mangroves line the lower estuary downstream from the terminus of the concrete channel (ETI 1993).

The Waikele Stream drainage basin appears to be dominated by introduced fish at lower elevations (ETI 1993; Devick personal communication 1994). Lower portions of Waikele Stream are influenced by water withdrawals and channelization, which may account for the predominance of introduced fish species. Tilapia, bristle-nosed catfish, and three species of topminnow constitute most of the fish numbers and biomass below 213 m elevation (ETI 1993). These species are not NOAA trust resources. Elevation at the site is approximately 260 m (U.S. Geological Survey 1983).

There are three known species of amphidromous endemic finfish, ‘o‘opu (*Awaous guamensis*, *Eleotris sandwicensis*, and *Stenogobius hawaiiensis*), in lower portions of Waikele Stream. Amphidromous fish species are considered a NOAA trust resource. The amphidromous ‘o’opu have an unique life history: they spend their entire adult life in freshwater streams and migrate downstream to spawn in freshwater close to estuaries or the ocean. Upon hatching, eggs drift out to the ocean as planktonic larvae. Returning post-larvae ascend freshwater streams. Some species (*A. guamensis*) are capable of climbing waterfalls and areas of rapids in streams (ETI 1993; Devick personal communication 1994). The first large rainstorm in the fall months is believed to trigger a downstream spawning run. However, post-larvae have been found throughout the year in different streams, indicating that spawning may occur at different times throughout the year (ETI 1993).

E. sandwicensis and *S. hawaiiensis* have been found only in low-elevation areas and were restricted to the Waikele estuary and the lowest elevations of Waikele Stream. In contrast, *A. guamensis* was found throughout the hydraulically accessible portions of Waikele Stream. None of the native endemic ‘o’opu in Waikele Stream are listed as Federal threatened or endangered species (ETI 1993).

There is limited fishing in the Waikele Stream drainage basin although local subsistence fishers periodically harvest Tahitian prawn and Asiatic clam. Recreational capturing of finfish is not considered likely to target any specific species (Devick personal communication 1994).

Site Related Contamination

Twenty soil borings were drilled and over 400 groundwater samples were collected at the two sources on the site and surrounding areas during preliminary site investigations between 1981 and 1991 by Del Monte and the Hawaii Department of Health. The primary contaminants that pose a threat to NOAA trust resources are EDB and DBCP, which have been observed in soil borings at Sources 1 and 2, the perched groundwater table beneath the sources, and the Kunia Well within the Waipahu basal aquifer. There have been no investigations in the unnamed stream near the sources (EPA 1993).

The highest concentrations of DBCP were observed in soil borings of Source Area 1. A maximum concentration of 3,000 mg/kg was reported; concentrations between 1.9 and 320 mg/kg were detected in four of five borings collected at this source. Maximum concentrations were measured in 0 to 60-cm samples nearest the former fumigant transfer device. High concentrations (up to 1.9 mg/kg) were measured in samples approximately 20 m from the unnamed stream, although a soil sample collected next to the stream contained measurable concentrations of only .001 mg/kg. EDB was also observed at Source Area 1; maximum concentrations observed within four of five borings collected at this source ranged from 5 mg/kg to 120 mg/kg. EDB was measured at 5 mg/kg approximately 20 m from the unknown stream, but was not detected in samples collected next to the stream (EPA 1993).

At Source Area 2, EDB was observed at the highest concentrations; maximum soil concentrations from seven of eight borings collected at this source ranged from 0.08 to 65 mg/kg. DBCP was observed at considerably lower concentrations at Source Area 2; concentrations within the same borings did not exceed 0.25 mg/kg (EPA 1993).

EDB and DBCP were observed in the shallow perched and the deeper Waipahu basal aquifers beneath both sources. In the perched aquifer, EDB was reported at the highest concentrations, ranging from 8 to 240,000 µg/l, while DBCP was reported at concentrations ranging from 0.14 to 17,000 µg/l. Much lower concentrations have been observed in the deeper Waipahu aquifer. Between 1981 and 1991, over 400 groundwater samples were collected from the deep aquifer. Concentrations generally ranged from undetected to 300 µg/l for EDB, and undetected to 11 µg/l for DBCP. The distribution of EDB and DBCP indicates that the two sources are the primary contributors to groundwater contamination as opposed to the surrounding pineapple fields. However, the extent of contaminated groundwater migration toward the unnamed stream has not been determined (EPA 1993).

Summary

EDB and DBCP were disposed or spilled at two sources at this site, approximately 60 m from a tributary of the Waikele Stream, the lower reaches of which provide habitat for NOAA trust resources. Elevated concentrations of EDB and DBCP were detected in soil borings and the shallow, perched groundwater which likely flows to the tributary. However, no groundwater discharge locations have been identified. Neither potential transport pathways from the sources to the tributary nor contamination in the tributary streams have been investigated. The downstream extent of contamination has not been determined. NOAA is concerned that these contaminants could migrate to the Waikele Stream watershed at concentrations of concern, and perhaps as far downstream as Pearl Harbor.

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10

Blackbird Mine

Lemhi County, Idaho
CERCLIS #IDD980725832

Site Exposure Potential

Blackbird Mine is approximately 40 km southwest of Salmon, Idaho, within the Salmon River drainage basin (Figure 1). Bucktail Creek drains the northern part of the site and Blackbird Creek drains the southern portion (Figure 2). Bucktail Creek flows to the northeast and joins with the South Fork of Big Deer Creek, which then flows into Big Deer Creek and, ultimately, Panther Creek. Blackbird Creek flows to the southeast and joins Panther Creek approximately 19 km upstream from the confluence of Big Deer Creek. Panther Creek flows north into the main stem of the Salmon River approximately 20 km downstream from Big Deer Creek. The Salmon River is part of the Snake River drainage system; the Snake River is the largest tributary to the Columbia River.

The Blackbird Mine is one of the largest cobalt deposits in North America. Active mining at the site began in the 1890s. The primary sulfide ores are a cobalt-arsenic sulfide called cobaltite, chalcopyrite, pyrite, and pyrrhotite. Some of the earliest descriptions of the operation, from the 1930s, suggest that all mine tailings were channeled directly into Blackbird Creek during that period (Reiser 1986). Settling ponds and tailing pipelines were subsequently constructed in the 1940s and 1950s. Periodic spills of tailings often

Figure available in hardcopy

Figure 1. Blackbird Mine study area in the Salmon National Forest, Lemhi County, Idaho.

entered Blackbird Creek due to ineffective containment of tailings, especially during spring runoff (Reiser 1986). When open-pit mining began in the late 1950s, about 3.8 million tons of waste rock near the headwaters of Blackbird and Bucktail creeks were excavated. Numerous waste rock piles are located throughout the mine area (Figure 2). The largest of the waste rock areas is the 5-hectare open pit, which contains over 765,000 m^3 of material. There are about 24 km of underground workings and about 34 hectares of exposed contaminated mine wastes at the site (Bennett 1977; Reiser 1986).

The site is currently owned by Noranda Mining, Inc., but has been inactive since 1982. Noranda planned to reopen the mine and had built a wastewater treatment facility to process water from the main adit as a condition of its 1980 NPDES permit. Noranda implemented several other remedial measures, including debris cleanup in Meadow Creek, and installation of several culverts for directing water around waste rock (Reiser 1986).

Primary pathways of concern are surface runoff, groundwater discharge, and direct discharge of leachate from mine adits. Surface water runoff from the mine enters Blackbird and Bucktail creeks. The surface runoff pathway is most important during the spring, when snow melt increases runoff. During this high-flow period, waste piles and tailings erode, as evidenced by gullies at the base of waste piles (Reiser 1986). Groundwater at the Blackbird Mine occurs in both unconsolidated surficial deposits and in fracture-controlled bedrock systems. Soils are gravelly, silty loams; loams; and sandy loams with moderate permeability and storage capacities. Groundwater in the surficial aquifer is in direct hydraulic contact with streams at the site, and may also migrate vertically into bedrock fractures. Groundwater has been observed to flow toward some of the adits along these fractures, suggesting a potential pathway for groundwater movement of contaminants. The metamorphic bedrock is not very porous; groundwater storage volumes are also expected to be low. There are seeps and springs at the base of several waste piles at the mine (Reiser 1986).

NOAA Trust Habitats and Species

The habitats of concern to NOAA are the surface water and associated bottom substrates of Panther and Blackbird creeks. Two anadromous fish species, chinook salmon and steelhead trout, use habitat in the Panther Creek basin to a very limited extent (Table 1). The only type of chinook salmon found in the Salmon River is classified as the spring/summer race of chinook.

Panther Creek emerges from underground approximately 70 km upstream from its confluence with the Salmon River. Bottom substrates are mixed along the length of the creek, consisting of various combinations of boulders, rubble, coarse gravel, and fine gravel. Habitat type

Figure available in hardcopy

Figure 2. Detail ofBlackbird Mine study area (Reiser 1986).

Table 1. NOAA trust resources in the Panther Creek watershed and the Salmon River.

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classifications in Panther Creek range from pool/cascade/boulder types to riffle/run types. Stream flow varies, depending on the seasons; lowest flows occur in the winter when precipitation accumulates as snowpack, and the highest flows occur during the spring snowmelt period. Stream flow measured in September 1984 ranged from 7 cfs near the headwaters to 101 cfs towards the mouth of the creek. Suitable spawning habitats for salmon have been identified at a number of locations in the Panther Creek basin (Reiser 1986). Cascades in Big Deer Creek block passage to anadromous fish at about 1 km above the confluence with Panther Creek. Blackbird Creek contains habitat that could potentially support anadromous and resident fish. However, mine effluent makes the creek uninhabitable by most aquatic life below the confluence of Meadow Creek.

Although there are no Snake River sockeye salmon in Panther Creek, this federally endangered species must pass by the mouth of Panther Creek as the fish migrate up the Salmon River to their last remaining spawning grounds in Redfish Lake (NMFS 1991b). Panther Creek historically supported large runs of chinook and steelhead, but these runs gradually declined during the 1940s when extensive mining activities began near Blackbird Creek. The runs were eliminated from the system by the early 1960s. Panther Creek remains largely uninhabited by anadromous fish (Reiser 1986).

The whole Panther Creek watershed is considered critical habitat for the federally threatened Snake River spring/summer chinook run (NMFS 1991a; Rose personal communication 1994). Water quality degradation in Panther Creek from the Blackbird Mine was cited as a factor responsible for the loss of salmon habitat and decline of the species, thereby contributing to the now threatened status of the Snake River spring/summer chinook (NMFS 1991b). Chinook adults build gravel nests (redds) and spawn in late August to September, whereas steelhead spawn from May to June. More than 95% of the suitable spawning habitats for both species are situated upstream of the confluence with Big Deer Creek, and about 70% of the suitable summer rearing habitats are located below the confluence with Blackbird Creek (Reiser 1986). Therefore, most of the salmon stock must pass through contaminated areas to reach suitable areas for spawning, and juveniles must migrate back downstream through contaminated areas for summer rearing. Juvenile salmonids, if present, would rear in lower Panther Creek for several months. During this time, water quality would need to be good enough to not harm the juvenile salmonids (Reiser 1986).

From the late 1970s to the late 1980s, efforts were conducted to reintroduce chinook and steelhead into Panther Creek. These attempts have been less successful than stocking efforts in other streams in the Salmon River watershed. It has been estimated that before 1945, the Panther Creek drainage basin supported 1,000 redds containing two adults per nest. However, field surveys conducted from 1990 to 1994 revealed only two or less redds in Panther Creek (Smith personal communication 1992; Rose personal communication 1994).

The Idaho Department of Fish and Game (IDFG) maintains a non-sustaining resident rainbow trout sport fishery in Panther Creek through annual "put and take" stocking (IDFG 1993). No restrictions have been placed on recreational fishing of spring/summer chinook or steelhead trout in Panther Creek because these species are generally not found in the basin (Rose personal communication 1994).

Site-Related Contamination

The primary contaminants of concern to NOAA at the Blackbird Mine site are arsenic, cobalt, and copper. Although no studies of contamination at Blackbird Mine have been undertaken as part of the NPL remedial process, a variety of studies have been conducted describing contamination of soil, groundwater, surface water, and sediment (Sauter and Wai 1981; Wai and Mok 1986; McHugh 1987; Mok and Wai 1989; Howell 1992; Hull 1992; Idaho Division of Environmental Quality 1992; RCG/Hagler, Bailly, Inc. 1993; and NOAA 1994).

Soils in the vicinity of Blackbird Mine are naturally enriched with the trace elements arsenic, cobalt, and copper. Concentrations of these trace elements were substantially higher than background concentrations in soil, waste piles, and areas containing mill tailings at the site (Table 2). Groundwater seeps and alluvial groundwater contained copper at maximum concentrations of 650,000 and 1,070,000 µg/l, respectively (Baldwin et al. 1978; Reiser 1986), greatly exceeding the 12 µg/l AWQC for copper. Very high concentrations of cobalt (up to

Table 2. Maximum concentrations (mg/kg) of trace elements of concern detected in surface soil deposits at the Blackbird Mine (RCG/Hagler, Bailly Inc. 1993; Hull 1992) compared with average concentrations in U.S. soil and background concentrations in the vicinity of the site.

	Mine Waste Piles	Efflorescent Crust on Waste Piles	Soil and Tailings in Blackbird Creek Floodplain and Along Banks	Mill Tailings	Background Range Near the Site[1]	U.S. Average[2]
Arsenic	5,100	770	6,700	4,500	8-10	5
Cobalt	2,400	2,700	1,100	9,000	6-440	8
Copper	13,000	20,000	1,900	21,000	4-2,400	30

1: Data were compiled and presented by NOAA (1994).
2: Lindsay (1979).

1,470,000 µg/l in alluvial groundwater) have been measured (Baldwin et al. 1978).

Concentrations of copper in both surface water and sediment from creeks downgradient of the site, including Panther Creek, frequently exceeded the screening guidelines, with maximum concentrations generally found in Bucktail Creek (Table 3). Concentrations of cobalt in surface water and sediment were elevated, but screening guidelines were not available for cobalt. Arsenic has been found in sediments of creeks draining the site, including Panther Creek, at concentrations substantially above the ERL for arsenic. Surface water did not contain elevated concentrations of arsenic when compared to the AWQC.

Several types of bioassessment studies have been conducted to determine whether site-related contaminants are causing adverse affects to aquatic biota. Results from bioassays with the amphipod *Hyalella azteca* showed that sediment collected in Panther Creek from two locations just downstream from the outlets of Blackbird and Big Deer creeks was substantially more toxic than sediment from the lab control and from an upstream location (NOAA 1994). *H. azteca* mortaility was positively correlated to concentrations of arsenic, cobalt, and copper in sediment. Results from benthic macroinvertebrate surveys in Panther Creek have consistently shown abundant, diverse populations upstream from the confluence with Blackbird Creek outlet. Downstream from Blackbird Creek, populations were depauperate and were dominated by pollution-tolerant chironomid and simulidae midges (Speyer 1982; Mangum 1985; Smith 1993). The IDFG has conducted in-situ caged fish studies in Panther Creek using juvenile chinook salmon or rainbow trout. Fish tested in Panther Creek just below the confluences of Blackbird and Big Deer creeks have shown substantial mortality relative to the upstream controls in some of the tests. All fish caged in Panther Creek at the mouths of Blackbird and Big Deer creeks

Table 3. Maximum concentrations of trace elements of concern detected in surface water (µg/l; dissolved) and sediment (mg/kg) of creeks draining Blackbird Mine.

	Blackbird Creek	Bucktail Creek	Panther Creek below Blackbird Creek	Panther Creek below Big Deer Creek	Screening Guideline
SURFACE WATER[1]					Freshwater Chronic AWQC[2] (µg/l)
Arsenic	4.6	6.5	6.3	2.6	190
Cobalt	2,800	150,000	120	40	NA
Copper	2,900	310,000	160	60	12+
SEDIMENT[3]					ERL[4] (mg/kg)
Arsenic	3,800	1,100	890	150	8.2
Cobalt	1,600	270	550	550	NA
Copper	9,000	19,000	2,900	1,200	34

1: Data from Wai and Mok 1986; McHugh 1987; IDEQ 1992; and RCG/Hagler, Bailly, Inc. 1993.
2: Ambient water quality criteria for the protection of aquatic organisms (U.S. EPA 1993)
3: Data from Sauter and Wai 1981; Mok and Wai 1989; Howell 1992; Hull 1992; and NOAA 1994.
4: Effects Range-Low; the concentration representing the lowest 10 percentile value for the data in which effects were observed or predicted in studies compiled by Long and McDonald (1992).
+: Hardness-dependent criteria (100 mg/l $CaCO_3$ used).
NA: Not Available

died (Corley 1967; U.S. Department of Energy 1985; Reiser 1986).

Summary

Concentrations of arsenic, cobalt, and copper in surface water, stream sediments, and surface soil deposits in the Blackbird Mine area are substantially higher than background concentrations of those elements. Chinook salmon and steelhead trout were numerous in the Panther Creek watershed before large-scale operation of the Blackbird Mine began in 1945. Since the early 1960s the watershed has been largely uninhabited by those species. Few anadromous fish return to Panther Creek relative to returns to other streams in the region in spite of restocking efforts. The weight of evidence from various bioassessment studies indicates that the aquatic environments of Panther Creek, lower Big Deer Creek, and lower Blackbird Creek continue to be severely stressed by releases from the Blackbird Mine.

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10

Pacific Sound Resources

Seattle, Washington
CERCLIS #WAD009248287

Site Exposure Potential

The Pacific Sound Resources site (formerly the Wyckoff Wood Treatment Facility) occupies 10 hectares in an industrialized area on the south shore of Elliott Bay in Seattle, Washington (Figure 1). Pacific Sound Resources has been a wood-treating facility since 1906. Activities conducted at the site included pressure-treatment of wood products using creosote, PCP, and chemonite (an inorganic, ammoniacal solution of copper, arsenic, and zinc salts). Other preservatives, such as phenol, chromium, boric acid, and fluoride, were used in the past (SAIC 1990).

Wood was treated at the site in a main operations area that includes nine retorts, two shops, a transfer table, several areas with storage tanks (for preservatives), a wood-preservative formulation area, and a process wastewater treatment area (Figure 2). After the wood treatment process, residual preservatives were collected in sumps, pretreated, and discharged to a City of Seattle sanitary sewer. Unknown quantities of waste products, including PCP sludge, copper arsenate sludge, and creosote sludge were stored at the site (Tetra Tech 1988). During the mid-1980s, EPA and the Municipality of Metropolitan Seattle documented the illegal dumping of creosote and wastewater to a storm drain that discharges to the West Waterway of the Duwamish River. EPA also found that hazardous waste had been illegally

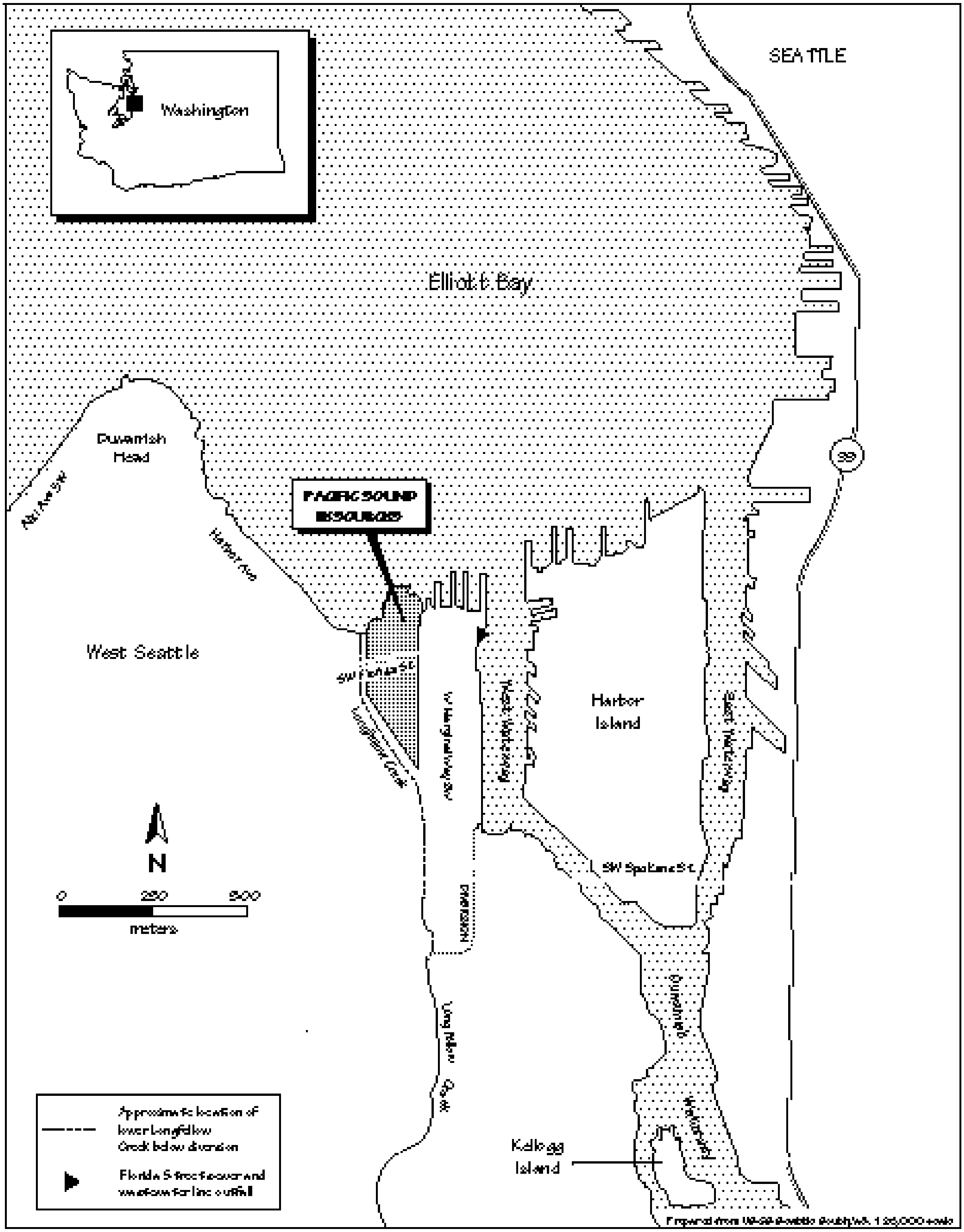

Figure 1 The Pacific Sound Resources site in Seattle, WA.

disposed in an unlined pond on the site (Hubbard and Sample 1988; Tetra Tech 1988).

Surface water runoff, groundwater, and direct discharge are the potential pathways of contaminant transport from the site to NOAA trust resources and associated habitats. The site is located on flat fill material next to Elliott Bay. When high tides are coupled with severe storm events, operational areas on the site are flooded and overland runoff discharges to Elliott Bay. Illegal discharge of site-related wastes turns the Florida Street storm sewer into a pathway for contaminant migration from the facility to the West Waterway. Surface runoff from the site may also enter Longfellow Creek. South of the site, a storm drain diverts the creek to discharge into the West Waterway (Figure 2). However, during high flow, upper Longfellow Creek may overflow the diversion structure and discharge via lower Longfellow Creek, which consists of a series of culverts, ditches, and ponds near the west border of the site. Surface runoff from the site has been observed to drain directly into exposed areas of the creek.

Groundwater is encountered at depths as shallow as 1 m below ground surface within an unconfined water table aquifer in the fill material. Regional geologic conditions suggest that the site is not likely to be underlain by a deep regional aquifer. Groundwater in the water table aquifer appears to flow north toward Elliott Bay and west toward lower Longfellow Creek. All wells north of Florida Street had elevated salinity and experienced tidal fluctuations in their water levels, especially in wells near the north end of the site, indicating a groundwater connection with the bay (SAIC 1990).

Contaminants may have been directly released into the bay as a result of storing freshly treated wood products on piers that extend over the bay. In addition, creosote was barged to the site by way of Elliott Bay and transferred to Tank Area 1 until 1985. Spills to the bay during the transfer process may have occurred, but have not been documented.

NOAA Trust Habitats and Species

The nearshore waters and sediments of Elliott Bay and the West Waterway at the mouth of the Duwamish River are the habitats of concern to NOAA. Elliott Bay, a functional estuary in Puget Sound, averages 85 m deep. The Bay has good circulation, with a flushing time estimated to range from two to ten days. Bottom substrates consist primarily of sandy muds, muddy sands, and coarse sands, except in the West Waterway where sandy substrates predominate (Dexter et al. 1981; PTI and Tetra Tech 1988). The shorelines of Elliott Bay and the Duwamish River have been modified with structures and almost all intertidal wetlands and shallow subtidal aquatic habitats have been eliminated (Port of Seattle 1985).

Elliott Bay provides habitat for numerous species of concern to NOAA, including anadromous fish,

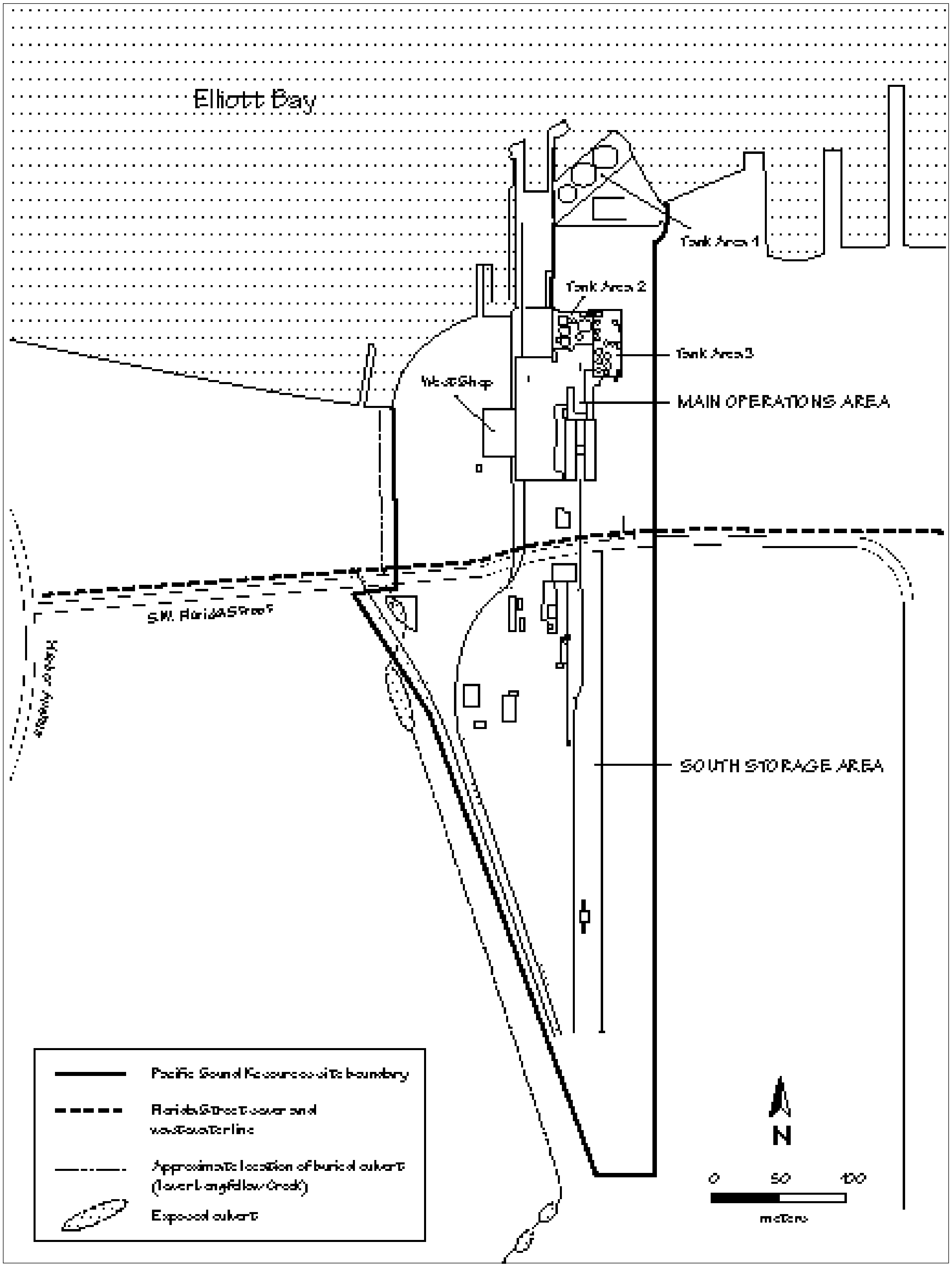

Figure 2. Detail of the Pacific Sound Resources site.

estuarine fish, invertebrates, and marine mammals (Table 1). Elliott Bay and the Duwamish River are documented migration corridors and juvenile nurseries for anadromous salmonids (Parametrix, Inc. 1982). The bay is also recognized as important rearing and foraging habitat for juvenile and adult estuarine fish species, as well as Dungeness crab (Williams et al. 1975; PTI and Tetra Tech 1988; Wood personal communication 1991).

Salmonid species use Elliott Bay and the Duwamish River as migration corridors to upstream spawning habitats in the Green River, which is one of the most prolific salmonid-producing streams in the Puget Sound basin. Chinook, chum, and pink salmon are the most common salmonids, followed by coho and sockeye salmon, steelhead trout, and cutthroat trout. Adult salmon congregate at the mouth of the Duwamish River before migrations, and juvenile salmon use the river mouth as nursery habitat (Dexter et al. 1981; Bradley personal communication 1991; Zichke personal communication 1991). There are seasonal multiple runs of both native and hatchery stocks in Elliott Bay and the Duwamish River. Spawning is widespread in the tributaries of the upper Duwamish basin (Bradley personal communication 1991; Pfeifer personal communication 1991).

Tribal salmon fisheries are the principal commercial fisheries in Elliott Bay. All salmon species are highly valued, and the fishery is intensively managed. Fishing locations vary between runs and over the years, but have included areas near the site. A general trend of diminishing catch totals has been observed in recent years (Washington Department of Natural Resources 1977; Bradley personal communication 1991; Pfeifer personal communication 1991; Zichke personal communication 1991).

Commercial fishing for estuarine fishes in Elliott Bay is limited by several factors, including a 1989 ban on commercial bottom trawling in Puget Sound south of Whidbey Island, low market values for demersal and mid-water pelagic species, commercial shipping and ferry traffic, and conflicts with sportfishing (Bargman personal communication 1991). Cumulatively, these factors have resulted in a low level of commercial fishing in Elliott Bay; the formerly large groundfish fishery for English, sand, and Dover sole, and starry flounder was particularly impacted. Commercial shellfishing is prohibited in Elliott Bay due to the likelihood of fecal coliform contamination (Suther personal communication 1994).

Recreational fishing is extremely popular in Elliott Bay and the Duwamish basin. Like the commercial fisheries, recreational harvests are dominated by salmon. The recreational salmon fishery is intensively managed and coincides with seasonal runs. Elliott Bay and the Duwamish River are particularly popular locations (Pfeifer personal communication 1991). The recreational fisheries in Elliott Bay for non-salmonid estuarine species are also active, but at a lower level than the salmon fisheries. There is a winter sport fishery for Pacific cod, hake, and walleye pollock in the bay near the Duwamish estuary. There is regular sportfishing for sea perch and black and

Table 1. NOAA trust resources using Elliott Bay near the mouth of the Duwamish River (Washington Department of Natural Resources 1977; Dexter et al. 1981; PTI and Tetra Tech 1988; Monaco et al. 1990).

Species		Habitat			Fisheries	
Common Name	Scientific Name	Spawning Ground	Nursery Ground	Adult Forage	Comm. Fishery	Recr. Fishery
ANADROMOUS FISH						
Cutthroat trout	*Oncorhynchus clarki*		♦	♦		♦
Pink salmon	*Oncorhynchus gorbuscha*		♦	♦	♦	♦
Chum salmon	*Oncorhynchus keta*		♦	♦	♦	♦
Coho salmon	*Oncorhynchus kisutch*	♦	♦	♦	♦	♦
Steelhead trout	*Oncorhynchus mykiss*		♦	♦		♦
Sockeye salmon	*Oncorhynchus nerka*		♦	♦	♦	♦
Chinook salmon	*Oncorhynchus tshawytscha*		♦	♦	♦	♦
Longfin smelt	*Sprinichus thaleichthys*	♦	♦	♦	♦	♦
ESTUARINE FISH						
Pacific sand lance	*Ammodytes hexapterus*	♦	♦	♦		
Tube-snout	*Aulorhynchus flavidus*	♦	♦	♦		
Arrow goby	*Clevelandia ios*	♦	♦	♦		
Pacific herring	*Clupea harengus pallasi*		♦	♦	♦	♦
Sculpins (various)	*Cottidae*		♦	♦		
Sea perches (various)	*Embiotocidae*	♦	♦	♦	♦	♦
Northern anchovy	*Engraulis mordax*	♦	♦	♦		
Cods (various)	*Gadidae*	♦	♦	♦	♦	♦
3-spine stickleback	*Gasterosteus aculeatus*	♦	♦	♦		
Greenlings (various)	*Hexagrammidae*		♦	♦	♦	♦
Ratfish	*Hydrolagus colliei*		♦	♦		
Surf smelt	*Hypomesus pretiosus*	♦	♦	♦	♦	♦
Snake prickleback	*Lumpenus sagitta*	♦	♦	♦		
Flounders (various)	*Pleuronectiformes*	♦	♦	♦		♦
Big skate	*Raga binoculata*			♦		
Rockfishes (various)	*Sebastes spp.*	♦	♦	♦		♦
Spiny dogfish	*Squalus acanthias*			♦	♦	
INVERTEBRATE SPECIES						
Dungeness crab	*Cancer magister*	♦	♦	♦		♦
Red rock crab	*Cancer productus*	♦	♦	♦		
Bent-nosed clam	*Macoma nasuta*	♦	♦	♦		
Blue mussel	*Mytilis edulis*	♦	♦	♦		
Shrimp (various)	*Pandalus spp.*		♦	♦		
MARINE MAMMALS						
Harbor seal	*Phoca vitulina*			♦		
California sea lion	*Zalophus californianus*			♦		
Harbor porpoise	*Phocoena phocoena*			♦		

yelloweye rockfish in Elliott Bay. There is also considerable sportfishing for groundfish, notably sanddab and rock sole, in the bay (Bargman personal communication 1991).

There are no sport fishery closures within Elliott Bay. However, an advisory is in effect against consumption of fish taken from urban shorelines of King County (where the bay is located) due to potential contamination from urban sources in general (Baker personal communication 1991; Suther personal communication 1994).

■ Site-Related Contamination

Several investigations have characterized the extent of site-related contamination in the study area (Cubbage 1989; SAIC 1990). As part of these investigations, samples were collected from approximately 50 on-site surface soil stations and borings, 21 on-site groundwater monitoring wells, and 26 sediment locations in waters next to the site. The primary contaminants of concern to NOAA identified in these studies are PAHs associated with creosote, PCP, chlorinated dibenzodioxins (CDDs), arsenic, chromium, copper, and zinc. Maximum concentrations of these contaminants detected during site investigations are presented in Table 2.

Total PAHs were detected at very high, often percent-level, concentrations in the top 2 m of soil collected from the main operations area.

Table 2. Maximum concentrations of contaminants detected in environmental samples collected from the site.

Contaminant	On-Site Soil (mg/kg)	Avg. U.S. Soil[1] (mg/kg)	Sediment (mg/kg)	ERL[2] (mg/kg)	ERM[2] (mg/kg)	Groundwater (µg/l)	Marine Chronic AWQC[3] (µg/l)
INORGANIC SUBSTANCES							
Arsenic	8,300	5.0	34	8.2	70	5,000	36
Chromium	1,900	100	130	81	370	2,000	50
Copper	9,000	30	360	34	270	1,100	2.9
Zinc	7,700	50	690	150	410	8,600	86
ORGANIC COMPOUNDS							
Total PAHs	46,000	NA	3,600	4.0	45	1.1×10^{8}	NA
PCP	4,100	NA	0.17	NA	NA	1.0×10^{6}	7.9
2,3,7,8-TCDD[4]	0.059	NA	NT	NA	NA	48	0.00001*

1: Lindsay (1979).
2: Effects Range Low and Effects Range Median; the concentrations representing the lowest 10 percentile value and the median value, respectively, for the data in which effects were observed or predicted in studies compiled by Long and MacDonald (1992).
3: Ambient water quality criteria for the protection of aquatic organisms. Marine chronic criteria presented (U.S. EPA 1993).
4: Presented concentrations are calculated toxicity equivalents of 2,3,7,8-TCDD.
*: Value presented is the freshwater chronic Lowest Observed Effects Level (LOEL). No LOEL or AWQC have been developed for marine water (U.S. EPA 1993).
NA: Screening guidelines not available.
NT: Not tested.

Lower concentrations of PAHs were generally detected in soils collected from depths below 3 m and in soils collected from the South Storage Area. The highest concentrations of total PAHs in groundwater were observed in floating and sinking oil layers in six groundwater wells next to Tank Areas 2 and 3, and west of the West Shop. These oil layers were up to 2 m thick in floating layers and 1.4 m thick in sunken layers. Dissolved-phase PAHs were also observed in the groundwater, with maximum concentrations of up to 1,700,000 µg/l observed 100 m inland from the intertidal zone of Elliott Bay (SAIC 1990). PAH concentrations in nearshore sediment exceeded ERL concentrations by up to three orders of magnitude. The highest concentrations were observed along the shore near Tank Area 1, where creosote continues to be stored (ETI 1990). Very high concentrations of PAHs were also found in sediment beneath an area where treated poles were loaded onto barges.

As with PAHs, PCP was detected at the highest concentrations in the surface soils of the main operations area; however, concentrations were generally one to two orders of magnitude less than those of PAHs. Concentrations of PCP in groundwater were consistently higher than marine chronic AWQC. The distribution of PCP in groundwater was similar to the PAHs, but concentrations were generally an order of magnitude lower. PCP was not detected in marine sediments next to the site at concentrations above ERL concentrations. However, because detection limits in many cases were higher than the ERL concentrations (by up to four orders of magnitude), PCP concentrations may exceed those screening guidelines.

The CDD compounds are byproducts of the PCP manufacturing process. Because there was only limited sampling for CDDs, there were not enough data to determine the areal extent of contamination in soils and groundwater. Elliott Bay sediments next to the site were not analyzed for CDDs. However, total CDDs (expressed as 2,3,7,8-TCDD toxicity equivalents) were measured in the product layer of groundwater near Tank Area 2 at a concentration exceeding the LOEL for aquatic organisms by six orders of magnitude.

The distribution of arsenic, chromium, copper, and zinc in on-site soils and groundwater was similar to that observed for organic compounds. All four trace elements were observed in groundwater at concentrations that exceeded their respective marine chronic AWQCs by more than an order of magnitude. In nearshore sediment, trace elements were frequently observed at concentrations above their ERL concentrations. Contamination by copper and zinc was most prevalent; concentrations in more than 75 percent of the samples collected were higher than the ERL concentrations. The highest concentrations of arsenic, copper, and zinc in the entire Duwamish River were found at the sediment station at the outfall of the Florida Street storm drain.

Summary

Very high concentrations of chemicals associated with wood-treating processes, including PAHs, PCP, arsenic, chromium, copper, and zinc, were measured in soil, groundwater, and nearshore sediment collected from the site. Contaminants were detected in various environmental media at concentrations that often greatly exceeded concentrations that have been shown to adversely affect aquatic organisms. Elliott Bay and the Duwamish River are migration corridors for anadromous salmonids to upstream spawning areas in the Green River, one of the most prolific salmonid-producing streams in the Puget Sound basin. Contamination of sediment as a result of activities at the site may adversely impact anadromous fish and other NOAA trust resources in Elliott Bay and the Duwamish River.

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10

Puget Sound Naval Shipyard

Bremerton, Washington
CERCLIS #WA2170023418

Site Exposure Potential

Puget Sound Naval Shipyard (PSNS) was established in Bremerton, Washington in 1891. The site is on 143 hectares of dry land and 137 hectares of submerged land along the northern shore of Sinclair Inlet (Figures 1 and 2; U.S. Navy 1989). The primary industrial activities at PSNS include the construction, repair, overhaul, and maintenance of ships; mooring, berthing, and dry docking of ships; and staging and supply. As part of the Installation Restoration Program, the U.S. Navy's environmental program, Site Inspections were conducted at eleven sites previously identified as the most important historical sources of contamination (Figure 3; URS 1992). The period of operation, types of waste disposed, and the chemicals of concern at each of these sites are summarized in Table 1.

Surface runoff, direct discharge, and groundwater are the potential pathways of contaminant transport from the site to NOAA trust resources and habitats. The facility maintains little natural vegetation and is dominated by buildings and other impervious surfaces such as asphalt and concrete. Overall, the facility slopes gently toward Sinclair Inlet; the northernmost areas in the shipyard (upland) are 15 to 20 m higher in elevation than the waterfront areas. Overland flow from two basins within the shipyard discharges directly into the inlet (URS 1992).

Figure available in hardcopy

Figure 1. Location of the Puget Sound Naval Shipyard, Bremerton, Washington.

Figure available in hardcopy

Figure 2. Location of the Puget Sound Naval Shipyard on Sinclair Inlet, Bremerton, Washington.

Surface runoff from these small basins consists primarily of stormwater discharged via storm drain outfalls and natural drainage channels. There is at least one combined sewage overflow (CSO) at PSNS, between Piers 6 and 7. The CSO discharges a mixture of stormwater runoff and raw sewage when the combined sanitary and storm sewer system's hydraulic capacity is exceeded during a heavy rain storm.

Figure available in hardcopy

Figure 3. Location of eleven sites where site inspections were performed at Puget Sound Naval Shipyard.

Two different sand and gravel aquifers have been described near PSNS (URS 1992). The upper aquifer overlies a silt and clay aquitard throughout the area. The base of the aquifer ranges from near sea level to 90 m above sea level. The saturated thickness of the upper aquifer ranges from 6 m to more than 60 m. The lower aquifer occurs at elevations ranging from slightly above mean sea level to approximately 90 m below mean sea level, and ranges in thickness from a few meters to 90 m. Despite the predominance of impervious surfaces, contaminants may have entered the groundwater via leaking underground storage tanks and cracked floors.

Previous investigations at the site indicate that the three fill areas that constitute Site 10 (Figure 3; Table 1) are hydraulically connected to Sinclair Inlet, and that groundwater in both aquifers moves toward Sinclair Inlet (URS 1992). Contaminants from the majority of the sites listed in Table 1 may have entered the groundwater and could subsequently be transported to Sinclair Inlet.

NOAA Trust Habitats and Species

Habitats of concern to NOAA are surface water and associated bottom substrates of Sinclair Inlet. Compared with other regions of Puget Sound, Sinclair Inlet is relatively shallow, an average of 13 to 22 m deep (U.S. Department of Commerce 1979). Substrates are predominantly mud, with areas of sand deposits along the southern shore of Sinclair Inlet (WDNR 1977). Currents near PSNS are weak and variable (average current speed is 0.08 knots; Tetra Tech 1988); tidal amplitude averages 2.5 m. Surface waters are cool (6.6 to 16.6°C), saline (24 to 31 ppt), and well-oxygenated (average 7.9 mg/l; WDNR 1977). Shallow nearshore depths and tidal wetlands combined with deeper, cooler troughs in the center of the inlet provide a diverse habitat.

A variety of anadromous, estuarine, and invertebrate NOAA trust resources use Sinclair Inlet (Table 2: U.S. Fish and Wildlife Service 1981; Freymond personal communication 1991; Fyfe personal communication 1991; WDF 1992; Zichke personal communication 1992). Sinclair Inlet and its drainages support various salmonids, including wild stocks of early and late chum salmon, sea-run cutthroat trout, and steelhead trout (Brooks personal communication 1992). Chum salmon is the most abundant and widely distributed species, followed by coho salmon. Chinook salmon are also present, but not as wild fall stocks. Chinook populations are limited by available upstream spawning habitat. Most upland drainages associated with Sinclair Inlet provide important salmon spawning habitats, especially the Gorst Creek (at the head of the inlet) and Blackjack Creek watersheds (Figure 2). The Anderson and Ross creek systems may occasionally support salmonids as well. Cutthroat trout are suspected to use all salmon habitat, while steelhead are less widely distributed (Freymond personal communication 1991). Several streams are stocked regularly by either the

Table 1. Sites, waste types, and chemicals of concern for eleven sites evaluated at Puget Sound Naval Shipyard as part of Site Inspection (URS 1992).

Site	Period of Operation	Waste Type	Size of Area/Estimated Quantity	Chemicals of Concern
1 Fill Area, Mooring A to Dry Dock 5	1960 - 1974	Construction debris, rubble, spent abrasive grit	1-ha/54,000 m^3 of fill	Trace elements, acids, PCBs
3 Helicopter Pad Area	1963 - 1972	Plating wastes, unopened paint cans, oils, metal parts and shavings	114,000 liters	Trace elements, acids, organic solvents, oil-based formulations, epoxies, organotin compounds
6 Drain Outfalls	Sanitary-until 1957; Storm - until present	Storm and sanitary sewer discharge	Unknown	PCBs, organic compounds, trace elements
7 Building 99, Old Plating Shop	Unknown	Chemical leakage through cracked floor	Unknown	Acids, bases, sodium cyanide, calcium sulfate, trace elements
8 Building 106, Old Power Plant	Unknown	Oil from leaking underground storage tanks	Unknown	PCBs
9 Crane Maintenance Area	Present	Debris from crane maintenance and painting	Unknown	Trace elements
10 Landfill Areas, Waterfront Areas[a]	Unknown	Fill (oily sludge, automobile scrap, construction and shipyard debris, spent abrasive grit)	Unknown	PCBs, trace elements, organic and organotin compounds
11 Oil Tank 316 Area	Until 1988	Fuel from leaking tanks, possibly contaminated soils for fill materials	Unknown	Petroleum hydrocarbons, trace elements, volatile organic and organotin compounds
12 Acid Drain Slab Area	Unknown	Unknown	Unknown	Trace elements, cyanide, PCBs

a: The Waterfront Area Landfills are divided into three separate locations: Site 10 East, Site 10 Central, and Site 10 West.

state or combined tribal/volunteer programs to enhance runs (Brooks personal communication 1992).

Several estuarine fish species use Sinclair Inlet for spawning, nursery, and adult forage habitat (U.S. Fish and Wildlife Service 1981). According to

Table 2. NOAA trust fish and invertebrate resources that use Sinclair Inlet near Bremerton, Washington.

Figure available in hardcopy

the Washington State Department of Fisheries, surf smelt spawn in the intertidal zone of the southern section of Sinclair Inlet and use both Sinclair Inlet and nearby Dyes Inlet as nursery habitat (Zichke personal communication 1991). Herring may spawn near PSNS. Numerous species of demersal fish, including Pacific hake, Dover sole, ling cod, and starry flounder, plus various species of perch, rockfish, and sculpin use Sinclair Inlet for seasonal nursery and adult forage habitat. These species may also congregate near the piers and pilings of PSNS.

Broad intertidal flats and bars provide excellent spawning and nursery substrate for molluscs. Littleneck, Manila, butter, and horse clams are abundant over most intertidal areas, particularly near Gorst Creek. Sea cucumbers are also abundant in Sinclair Inlet (Fyfe personal communication 1991). Oyster and adult crab populations are small. Dungeness crab, rock crab, and kelp crab tend to congregate near Rich Passage (Figure 2). Squid may drift seasonally into Sinclair Inlet and spawn (Zichke personal communication 1991).

Fish and shellfish fisheries in Sinclair Inlet are limited. Commercially harvested salmon make up the majority of landings from Sinclair Inlet. Substantial Suquamish Tribe effort is directed towards salmonid runs in the vicinity of Sinclair Inlet. Most fishing occurs in Port Orchard Sound above Illahee or in Sinclair Inlet (Figure 2). Three principal salmon fisheries occur annually on stocks of Sinclair Inlet origin: an August-September fall chinook tribal gillnet fishery, which targets returning enhanced chinook from the Gorst Creek rearing facility; the fall treaty and non-treaty harvest of chum salmon; and the fall treaty and non-treaty harvest of coho salmon (Zichke personal communication 1992). Small catches of smelt and perch also occur.

Recreational fishing effort in Sinclair Inlet is reported to be light, although catch data were not available. Summer steelhead and cutthroat trout fishing occurs in most streams which discharge to the inlet (Freymond personal communication 1991). In areas off the Bremerton shoreline and in Port Washington Narrows (Figure 2), there is usually moderate sport fishing for salmon from September to late November. The water around Ross Point (Figure 2) supports a recreational surf smelt fishery (Brooks personal communication 1992; WDF 1992). The sandy southern shore of Sinclair Inlet supports a regular demersal sport fishery targeting Pacific cod, starry flounder, and several species of sole (WDNR 1977). There is infrequent sport crabbing for Dungeness crab offshore in Port Orchard Sound (Zichke personal communication 1992).

The commercial harvest of bivalves from Sinclair Inlet has never been certified and is now prohibited by the Washington State Department of Health because of high fecal coliform counts (Melvin personal communication 1991; Nosho personal communication 1991). Although this prohibition does not officially extend to all recreational harvests, the Bremerton-Kitsap County

Health Department has recommended against harvesting bottom-dwelling organisms, including fish, from Sinclair Inlet (Jones personal communication 1993).

Site-Related Contamination

During site investigations 283 soil samples, 239 groundwater samples, 42 surface water samples, and 61 sediment samples were collected (URS 1992). Samples were analyzed for some or all of the following target analytes: VOCs, SVOCs, pesticides/PCBs, trace elements, cyanide, and TPH. Phenols (GeoEngineers 1986; U.S. EPA 1986a) and tributyl tin (Grovhoug et al. 1987) were measured in some studies. Detection limits were not available.

Trace elements and PAHs are the primary contaminants of concern to NOAA. Other contaminants of concern include PCBs and other organic compounds such as phthalate esters and chlorinated benzenes. These contaminants were limited in distribution and were not found at concentrations exceeding screening guidelines in all sampled media. The maximum concentrations of contaminants detected in media collected from the eleven waste sites at PSNS are presented in Table 3.

Ten trace elements were detected at elevated concentrations in soil, sediment, and groundwater (Table 3). Concentrations of all trace elements measured in soil, except silver, exceeded average values for U.S. soil (Lindsay 1979). Similar substances were detected in groundwater at concentrations exceeding their respective marine chronic AWQC by factors greater than ten. All ten trace elements were detected in sediments collected from Sites 3 and 6 at concentrations exceeding their ERL screening guidelines (Long and MacDonald 1992). Arsenic, copper, lead, mercury, nickel, and zinc were detected in sediment samples from these same areas at concentrations exceeding their respective ERM screening guidelines (Long and MacDonald 1992).

Toxicity tests were performed at the Pier D Dredging Project to determine whether the dredged sediment was suitable for open-water disposal in Puget Sound (U.S. Navy 1992). The results indicated that sediments were toxic to the amphipod *Rhepoxynius abronius*. The areal extent of the toxic sediments has not been determined. Comparison of the concentrations of zinc in the sediments with toxicity test data obtained from the scientific literature suggests that most of the sediment within the boundaries of PSNS is potentially toxic to sensitive marine organisms.

In addition, benthic infaunal analyses were performed with the site investigations at 12 locations within PSNS boundaries and two reference locations in Sinclair Inlet (URS 1992). Sediment samples were collected synoptically for chemistry analyses. Two of the on-site stations and one of the reference stations could not be legitimately used in the analyses due to distinctly

Table 3. Maximum concentrations of contaminants of concern at waste sites located at PSNS (GeoEngineers 1986; U.S. EPA 1986a; URS 1992; and U.S. Navy 1992).

Contaminants	Water (µg/l)			Soils (mg/kg)		Sediment (mg/kg)		
	Ground water	Surface Water	AWQC [a]	Soils	Average US Soils [b]	Sediment	ERL [c]	ERM [d]
Inorganic Substances								
Antimony	ND	NR	500**	853	1	13.8	2	25
Arsenic	1,860	NR	36	1,160	5	111	8.2	70
Cadmium	174	NR	9.3	84.3	0.06	6.5	1.2	9.6
Chromium	2,140	NR	50	735	100	102	80	370
Copper	23,400	NR	2.9	10,400	30	1,709	34	270
Lead	18,200	NR	8.5	11,100	10	603	47	220
Mercury	203	NR	0.025	145	0.03	5.2	0.15	0.71
Nickel	3,210	NR	8.3	1,030	40	56.0	21	52
Silver	ND	NR	0.92**	ND	0.05	2.9	1.0	3.7
Zinc	23,900	NR	86	23,600	50	1,950	150	410
Organic Compounds								
PAHs								
Acenaphthene	ND	NR	710*	8	NA	ND	0.160	0.5
Fluorene	ND	NR	NA	63	NA	230	0.019	0.54
Phenanthrene	ND	NR	4.6**	170	NA	2,400	0.24	1.5
Anthracene	ND	NR	NA	3.9	NA	510	0.085	1.1
Fluoranthene	ND	NR	16*	68	NA	2,800	0.600	5.1
Pyrene	ND	NR	NA	60	NA	3,100	0.66	2.6
Benzo(a)anthracene	ND	NR	NA	20	NA	1,600	0.26	1.6
Chrysene	ND	NR	NA	16	NA	1,700	0.38	2.8
Benzofluoranthenes	ND	NR	NA	22	NA	2,700	NA	NA
Benzo(a)pyrene	ND	NR	NA	14	NA	ND	0.43	1.6
Indeno(1,2,3-c,d)pyrene	ND	NR	NA	36	NA	600	NA	NA
Benzo(g,h,i)perylene	ND	NR	NA	6.2	NA	700	NA	NA
Naphthalene	ND	NR	NA	260	NA	ND	0.16	2.1
2-Methylnaphthalene	ND	NR	NA	74	NA	ND	0.07	0.67
Dibenz(a,h)anthracene	ND	NR	NA	1.3	NA	96	0.063	0.26

a: Ambient water quality criteria for the protection of aquatic organisms. Marine chronic criteria are presented (EPA 1986b) because waste sites are located near marine environments.
b: Lindsay (1979).
c: Effects Range-Low (Long and MacDonald 1992).
d: Effects Range-Median (Long and MacDonald 1992).
NA: Screening guidelines not available.
ND: Not detected; detection limit not reported.
NR: Not reported.
+: Hardness-dependent criteria; 100 mg/l $CaCO_3$ assumed.
* Insufficient Data to Develop Criteria. Value Presented is the LOEL. - Lowest Observed Effect Level
** Proposed Criterion

different characteristics in grain size and total organic carbon. Pollution-tolerant taxa represented 56 to 82 percent of the taxa at ten of the twelve PSNS stations as compared to only 28 percent from the reference station. Although the source of the impairment has not yet been determined, the results suggest that benthic communities near PSNS appear stressed on the basis of richness, Shannon-Weaver Diversity Index, Swartz's Dominance Index, abundance-biomass comparisons, and relative abundance of pollution-sensitive and pollution-tolerant taxa.

Summary

A diverse group of anadromous, estuarine, and marine NOAA trust species use Sinclair Inlet for adult forage, spawning, and nursery habitat. Salmon are fished both commercially and by Indian tribes; there are also several sport fisheries in the Inlet. Puget Sound Naval Shipyard has operated on the north shore of Sinclair Inlet since 1891, resulting in trace element and PAH contamination in soils, groundwater, and sediments. These contaminants are extremely persistent in aquatic systems and may threaten sensitive life stages of NOAA trust species and their habitat.

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