111761

6.2 ECOLOGICAL ASSESSMENT

6.2.1 General Habitat Description

The Havertown PCP Site study area is located in suburban Philadelphia. This area consists of residential homes, small businesses, hospitals, educational facilities and small parks. The focus of the ecological assessment will be on Naylors Run and a portion of Cobbs Creek in the area of its confluence with Naylors Run in Haverford and Upper Darby Townships, Delaware County, Pennsylvania. Both water bodies receive large volumes of urban runoff from roads and other man-made surfaces, resulting in severe scouring and flushing during storm events. Naylors Run is largely channelized. In addition to the stream assessment, the terrestrial vegetation on each bank was recorded in an area extending perpendicular approximately ten (10) meters from each stream bank.

6.2.1.1 Terrestrial and Wetland Vegetation

The vegetation found on the NWP property is limited. Only opportunistic weed and shrub species of plants are found in isolated unmaintained area of the site. Much of the property is dirt and gravel. The Philadelphia Chewing Gum Company property is primarily asphalted with little vegetation. The vegetation on the surrounding residential properties consist of maintained lawns and sparsely wooded areas near Naylors Run. The majority of the terrestrial vegetation along Naylors Run and the portion of Cobbs Creek investigated has been disturbed. The herbs found along the banks include a mixture of common opportunistic species such as, foxtail, field pennycress, stinging nettle, various mustards, wild onion, creeping phlox, wild and domestic grasses. The grasses are the dominant vegetation, which most likely results from seeding by residents or park maintenance. Privet was the only shrub observed. Woody vines include grape and Japanese honeysuckle. Dominant trees include boxelder, red maple, silver maple, apple, and American beech.

With the exception to areas related to Naylors Run, there are no known wetlands in the vacinity of NWP. Because of this, a formal wetland delineation was not performed. During the field activities, no evidence of on-site wetlands was observed.

Potential jurisdictional wetlands are present along portions of the stream banks based on the wetland indicator statuses of plants observed at the sample stations. If the average indicator status on an individual stream bank had a value of less than three (3.0), the area is considered a potential wetland (Federal Interagency Committee for Wetland Delineation 1989). The west bank of station HV-EA-C01, and both banks of station HV-EA-C02 (Figure 6.4) have vegetation indicative of wetlands. No formal wetland delineation had been performed; only the vegetation was evaluated. If jurisdictional wetlands do exist, they are disturbed, poor in quality, and limited to the stream bank.

6.2.1.2 Aquatic Habitat

The ecology of Naylors Run and Cobbs Creek, in the area of the confluence with Naylors Run consists of a tolerant aquatic community. Low Ephemeroptera, Plecoptera and Trichoptera (EPT) populations exist in Cobbs Creek. No EPT populations were found in Naylors Run. Shredder populations, found only at the reference station, were extremely low. Fish were present at all stations except HV-EA-08. The black-nose dace was dominant.

No periphyton was observed, and slime was rare. Filamentous algae was common at all Cobbs Creek locations and abundant in Naylors Run. Macrophytes were common.

The reference station (HV-EA-C02) appears to be representative of the aquatic ecology found in steams within the watershed. A detailed description of the aquatic ecology is given in Appendix A.

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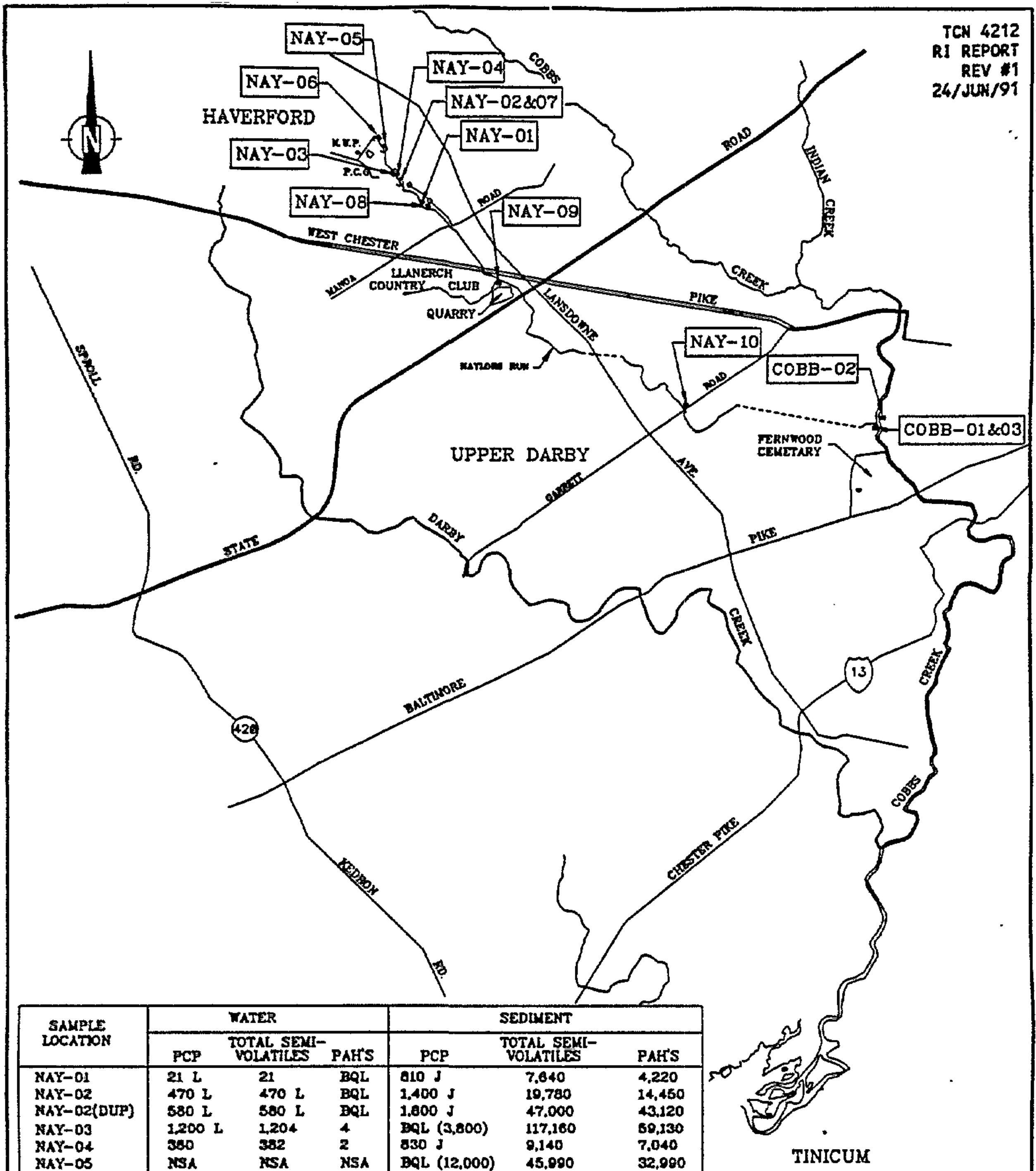

SAMPLE LOCATION	WATER			SEDIMENT		
	PCP	TOTAL SEMI-VOLATILES	PAH'S	PCP	TOTAL SEMI-VOLATILES	PAH'S
NAY-01	21 L	21	BQL	810 J	7,640	4,220
NAY-02	470 L	470 L	BQL	1,400 J	19,780	14,450
NAY-02(DUP)	580 L	580 L	BQL	1,800 J	47,000	43,120
NAY-03	1,200 L	1,204	4	BQL (3,800)	117,160	59,130
NAY-04	380	382	2	530 J	9,140	7,040
NAY-05	NSA	NSA	NSA	BQL (12,000)	45,990	32,990
NAY-06	18 J	18 J	BQL	3,000 J	120,680	111,200
* NAY-08	140	140	BQL	360 J	43,206	40,830
NAY-09	25	25	BQL	BQL (1,000)	13,708	11,503
* NAY-10	6 J	6 J	BQL	BQL (1,100)	84,634	81,110
* COBB-01	3 J	3 J	BQL	BQL (950)	5,445	5,296
COBB-01(DUP)	2 J	2 J	BQL	BQL (990)	5,822	6,308
* COBB-02	BQL (25)	BQL	BQL	BQL (1,000)	1,817	1,786

*BENTHIC MACROINVERTEBRATE SAMPLE LOCATIONS

NOTE:
UNITS ARE IN ug/kg FOR SEDIMENT
AND ug/L FOR WATER

LEGEND:

- ● SEPT 1990 SAMPLE LOCATIONS
- ■ JAN 1991 SAMPLE LOCATIONS

NSA NO SAMPLE MATERIAL AVAILABLE
BQL BELOW QUANTITATION LIMIT
(00) QUANTITATION LIMIT
J REPORTED VALUE - NOT ACCURATE OR PRECISE
L REPORTED VALUE - BIASED LOW

0 1 2
MILES

TETRA TECH, INC.

FIGURE 6-4
ECOLOGICAL SAMPLING
LOCATIONS

6.2.2 Identification of Potential Receptors

Part of the risk analysis is to identify potential receptors that may be affected by site related impacts. Potential receptors may include vegetation and/or wildlife. To determine receptors, the routes of exposure must first be identified. The following describes the routes of exposure and potential receptors within the ecological study area (Table 6-47).

6.2.2.1 Potential Terrestrial and Wetland Receptors

The potential terrestrial routes of exposure are limited. There has been no reported soil contamination downstream from the Havertown Site. The 1989 Record of Decision (ROD) selected a "no action" alternative for on-site , stating that the soils pose no significant risk. The stream substrate in Naylors Run is primarily cobble, gravel and sand. There is relatively little course particulate organic material (CPOM) or fine organic particulate material (FPOM) present within Naylors Run or Cobbs Creek. No evidence of sediment disturbance by terrestrial wildlife was observed. Ingestion or absorption of sediment is not likely to be a significant route of exposure to terrestrial organisms. Limited ingestion of contaminants may occur by waterfowl ingesting bottom sediment. Many waterfowl ingest small amounts of bottom sediment that is the stored in the gizzard to aid in digestion.

Surface water is the only route of exposure that offers potential risk to terrestrial receptors. The surface water chemical data will provide the basis for the terrestrial risk assessment. Small-to-medium sized mammals, domestic pets and birds are potential receptors by ingestion and/or absorption. Birds may be exposed indirectly by ingesting insects which have emerged from the stream. This route is not significant since there are very low aquatic insect populations in the streams. A detailed list of potential terrestrial receptors is given in Table 6-47.

TABLE 6-47

Potential Receptors in the Haverford Study Area

Common Name	Scientific Name
MAMMALS[1]	
MARSUPIALS	
OPOSSUM, VIRGINIA	Didelphis marsupialis
SHREWS	
SHREW, MASKED	Sorex cinereus cinereus
SHREW, WATER	Sorex palustris albibarbis
SHREW, SMOKY	Sorex fumeus fumeus
SHREW, LONG-TAIL	Sorex dispar
SHREW, SHORT-TAIL	Blarina brevicauda kirtlandi
MOLES	
MOLE, EASTERN	Parascalops breweri
MOLE, HAIRY-TAILED	Scalopus aquaticus aquaticus
MOLE, STAR-NOSED	Condylura cristata cristata
BATS	
BAT, LITTLE BROWN	Myotis lucifugus lucifugus
BAT, KEEN'S	Myotis keenii septentrionalis
BAT, INDIANA	Myotis sodalis
BAT, SMALL-FOOTED	Myotis subulatus leibii
BAT, SILVER-HAIRED	Lasionycteris noctivagans
BAT, PYGMY	Pipistrellus subflavus
BAT, BIG BROWN	Eptesicus fuscus fuscus
BAT, RED	Lasiurus borealis borealis
BAT, SEMINOLE	Lasiurus seminolus
BAT, HOARY	Lasiurus cinereus cinereus
RABBITS	
COTTONTAIL, EASTERN	Sylvilagus floridanus mallurus
HARE, SNOWSHOE	Lepus americanus virginianus
RODENTS	
CHIPMUNK	Tamias striatus fisheri
WOODCHUCK	Marmota monax monax
SQUIRREL, GRAY	Sciurus carolinensis
SQUIRREL, RED	Tamiasciurus hudsonicus loquax
SQUIRREL, EASTERN FLYING	Glaucomys volans volans
SQUIRREL, NORTHERN FLYING	Glaucomys sabrinus macrotis
MOUSE, DEER	Peromyscus maniculatus
MOUSE, WHITE-FOOTED	Peromyscus leucopus
WOODRAT, EASTERN	Neotoma floridana
VOLE, RED-BACKED	Clethrionomys gapperi gapperi
VOLE, MEADOW	Microtus pennsylvanicus
VOLE, ROCK	Microtus chrotorrhinus

TABLE 6-47 cont'd

Potential Receptors in the Haverford Study Area

Common Name	Scientific Name
MAMMALS cont'd	
RODENTS	
VOLE, PINE	*Pitymys pinetorum scalopsoides*
MUSKRAT	*Ondatra zibethicus macrodon*
LEMMING, SOUTHERN BOG	*Synaptomys cooperi cooperi*
RAT, NORWAY	*Rattus norvegicus norvegicus*
MOUSE, HOUSE	*Mus musculus*
MOUSE, MEADOW JUMPING	*Zapus hudsonius americanus*
MOUSE, WOODLAND JUMPING	*Napaeozapus insignis insignis*
PORCUPINE	*Erethizon dorsatum dorsatum*
CARNIVORES	
COYOTE	*Canis latrans*
FOX, RED	*Vulpes vulpes fulva*
FOX, GRAY	*Urocyon cinereoargenteus*
BEAR, BLACK	*Ursus americanus americanus*
RACCOON	*Procyon lotor lotor*
ERMINE	*Mustela erminea cicognanii*
WEASEL, LONG-TAILED	*Mustela frenata noveboracensis*
MINK	*Mustela vison mink*
SKUNK, STRIPED	*Mephitis mephitis nigra*
BOBCAT	*Lynx rufus rufus*
DEER	
DEER, WHITE-TAILED	*Odocoileus virginianus*
BIRDS[2]	
WATERFOWL	
DUCK, MALLARD	*Anas platyrhynchos*
DUCK, AMERICAN BLACK	*Anas rubripes*
GOOSE, CANADA	*Branta canadensis*
VULTURES	
VULTURE, TURKEY	*Cathartes aura*
VULTURE, BLACK	*Coragyps atratus*
HAWKS	
HAWK, COOPER'S	*Accipiter cooperii*
HAWK, RED-TAILED	*Buteo jamaicensis*
HAWK, RED-SHOULDERED	*Buteo lineatus*
HAWK, BROAD-WINGED	*Buteo platypterus*
HARRIER, NORTHERN	*Circus cyaneus*

TABLE 6-47 cont'd

Potential Receptors in the Haverford Study Area

Common Name	Scientific Name
BIRDS cont'd	
FALCONS	
MERLIN	Falco columbarius
KESTRAL, AMERICAN	Falco sparverius
GROUSE	
GROUSE, RUFFED	Bonasa umbellus
QUAIL	
BOBWHITE, NORTHERN	Colinus virginianus
PHEASANT, RING-NECKED	Phasianus colchicus
TURKEYS	
TURKEY, WILD	Meleagris gallopavo
PLOVERS	
KILLDEER	Charadrius vociferus
SANDPIPERS	
WOODCOCK, AMERICAN	Scolopax minor
PIGEONS, DOVES	
DOVE, ROCK	Columba livia
DOVE, MOURNING	Zenaida macroura
CUCKOOS	
CUCKOO, YELLOW-BILLED	Coccyzus americanus
CUCKOO, BLACK-BILLED	Coccyzus erythropthalmus
OWLS	
OWL, GREAT HORNED	Bubo virginianus
OWL, BARRED	Strix varia
OWL, EASTERN SCREECH	Otus asio
OWL, LONG-EARED	Asio otus
OWL, NORTHERN SAW-WHET	Aegolius acadicus
SWIFTS	
SWIFT, CHIMNEY	Chaetura pelagica
HUMMINGBIRDS	
HUMMINGBIRD, RUBY-THROATED	Archilochus colubris
KINGFISHERS	
KINGFISHER, BELTED	Ceryle alcyon
WOODPECKERS	
FLICKER, COMMON	Colaptes auratus
WOODPECKER, PILEATED	Dryocopus pileatus
WOODPECKER, RED-BELLIED	Melanerpes carolinus
WOODPECKER, RED-HEADED	Melanerpes erythrocephalus
WOODPECKER, HAIRY	Picoides villosus
WOODPECKER, DOWNY	Picoides scalaris

TABLE 6-47 cont'd

Potential Receptors in the Haverford Study Area

Common Name	Scientific Name
BIRDS cont'd	
FLYCATCHERS	
KINGBIRD, EASTERN	Tyrannus tyrannus
FLYCATCHER, GREAT-CRESTED	Myiarchus crinitus
PHOEBE, EASTERN	Sayornis phoebe
FLYCATCHER, YELLOW-BELLIED	Empidonax flaviventris
FLYCATCHER, ACADIAN	Empidonax virescens
FLYCATCHER, WILLOW	Empidonax trailii
FLYCATCHER, ALDER	Empidonax alnorum
FLYCATCHER, LEAST	Empidonax minimus
PEEWEE, EASTERN WOOD	Contopus virens
FLYCATCHER, OLIVE-SIDED	Contopus borealis
SWALLOWS	
SWALLOW, TREE	Tachycineta bicolor
SWALLOW, BARN	Hirundo rustica
SWALLOW, CLIFF	Hirundo pyrrhonota
MARTIN, PURPLE	Progne subis
JAYS, CROWS	
JAY, BLUE	Cyanocitta cristata
CROW, AMERICAN	Corvus brachyrhynchos
TITMICE	
CHICKADEE, BLACK-CAPPED	Parus atricapillus
TITMOUSE, TUFTED	Parus bicolor
NUTHATCHES	
NUTHATCH, WHITE-BREASTED	Sitta carolinensis
NUTHATCH, RED-BREASTED	Sitta canadensis
CREEPERS	
CREEPER, BROWN	Certhia americana
WRENS	
WREN, HOUSE	Troglodytes aedon
WREN, WINTER	Troglodytes troglodytes
WREN, CAROLINA	Thryothorus ludivicianus
THRUSHES	
MOCKINGBIRD, NORTHERN	Mimus polyglottos
CATBIRD, GREY	Dumetella carolinensis
THRASHER, BROWN	Toxostoma rufum
ROBIN, AMERICAN	Turdus migratorius
THRUSH, WOOD	Hylocichla mustelina
THRUSH, HERMIT	Catharus guttatus
THRUSH, SWAINSON'S	Catharus ustulatus

TABLE 6-47 cont'd

Potential Receptors in the Haverford Study Area

Common Name	Scientific Name
BIRDS cont'd	
THRUSHES	
THRUSH, GRAY-CHEEKED	Catharus minimus
VEERY	Catharus fuscescens
BLUEBIRD, EASTERN	Sialis sialis
KINGLETS	
GNATCATCHER, BLUE-GRAY	Polioptila caerulea
KINGLET, GOLDEN-CROWNED	Regulus satrapa
KINGLET, RUBY-CROWNED	Regulus calendula
WAXWINGS	
WAXWING, CEDAR	Bombycilla cedrorum
STARLINGS	
STARLING, EUROPEAN	Sturnus vulgaris
VIREOS	
VIREO, WHITE-EYED	Vireo griseus
VIREO, YELLOW-THROATED	Vireo flavifrons
VIREO, SOLITARY	Vireo solitarius
VIREO, RED-EYED	Vireo olivaceus
VIREO, PHILADELPHIA	Vireo philadelphicus
VIREO, WARBLING	Vireo gilvus
WOOD WARBLERS	
WARBLER, BLACK-AND-WHITE	Mniotilta varia
WARBLER, WORM-EATING	Helmitheros vermivorus
WARBLER, GOLDEN-WINGED	Vermivora chrysoptera
WARBLER, BLUE-WINGED	Vermivora pinus
PARULA, NORTHERN	Parula americana
WARBLER, YELLOW	Dendroica petechia
WARBLER, MAGNOLIA	Dendroica magnolia
WARBLER, BLACK-THROATED BLUE	Dendroica caerulescens
WARBLER, YELLOW-RUMPED	Dendroica coronata
WARBLER, BLACK-THROATED GREEN	Dendroica chrysoparia
WARBLER, CERULEAN	Dendroica cerulea
WARBLER, BLACKBURNIAN	Dendroica fusca
WARBLER, YELLOW-THROATED	Dendroica dominica
WARBLER, CHESTNUT-SIDED	Dendroica pensylvanica
WARBLER, BLACKPOLL	Dendroica striata
WARBLER, PINE	Dendroica pinus
WARBLER, PRAIRIE	Dendroica discolor
OVENBIRD	Seiurus aurocapillus

TABLE 6-47 cont'd

Potential Receptors in the Haverford Study Area

Common Name	Scientific Name
BIRDS cont'd	
WOOD WARBLERS	
WATERTHRUSH, NORTHERN	*Seiurus noveboracensis*
WATERTHRUSH, LOUISIANA	*Seiurus motacilla*
WARBLER, KENTUCKY	*Oporornis formosus*
YELLOWTHROAT, COMMON	*Geothlypis trichas*
CHAT, YELLOW-BREASTED	*Icteria virens*
WARBLER, HOODED	*Wilsonia citrina*
WARBLER, WILSON'S	*Wilsonia pusilla*
WARBLER, CANADA	*Wilsonia canadensis*
REDSTART, AMERICAN	*Myioborus pictus*
WEAVER FINCHES	
SPARROW, HOUSE	*Passer domesticus*
SPARROW, EUROPEAN-TREE	*Passer montanus*
BLACKBIRDS	
BOBOLINK	*Dolichonyx oryzivorus*
MEADOWLARK, EASTERN	*Sturnella magna*
BLACKBIRD, RED-WINGED	*Agelaius phoeniceus*
ORIOLE, ORCHARD	*Icterus spurius*
ORIOLE, NORTHERN	*Icterus galbula*
GRACKLE, COMMON	*Quiscalus quiscula*
COWBIRD, BROWN-HEADED	*Molothrus ater*
TANAGERS	
TANAGER, SCARLET	*Piranga olivacea*
FINCHES, SPARROWS	
CARDINAL, NORTHERN	*Cardinalis cardinalis*
GROSBEAK, ROSE-BREASTED	*Pheucticus sinuatus*
BUNTING, INDIGO	*Passerina cyanea*
DICKCISSEL	*Spiza americana*
FINCH, PURPLE	*Carpodacus purpureus*
FINCH, HOUSE	*Carpodacus mexicanus*
REDPOLL, COMMON	*Carduelis flammea*
SISKIN, PINE	*Carduelis pinus*
GOLDFINCH, AMERICAN	*Carduelis tristis*
CROSSBILL, RED	*Loxia curvirostra*
CROSSBILL, WHITE-WINGED	*Loxia leucoptera*
TOWHEE, RUFOUS-SIDED	*Pipilo erythrophthalmus*
SPARROW, SAVANNAH	*Ammodramus savannarum*
JUNCO, DARK-EYED	*Junco hyemalis*
SPARROW, AMERICAN TREE	*Spizella arborea*

TABLE 6-47 cont'd

Potential Receptors in the Haverford Study Area

Common Name	Scientific Name
BIRDS cont'd	
SPARROWS	
SPARROW, CHIPPING	Spizella passerina
SPARROW, FIELD	Spizella pusilla
SPARROW, WHITE-CROWNED	Zonotrichia leucophrys
SPARROW, WHITE-THROATED	Zonotrichia albicollis
SPARROW, FOX	Passerella iliaca
SPARROW, SWAMP	Melospiza georgiana
SPARROW, SONG	Melospiza melodia
BUNTING, SNOW	Plectrophenax nivalis
FISH[3]	
BLACK-NOSED DACE	Rhinichthys atratulus
WHITE SUCKER	Catostomus commersoni
MACROINVERTEBRATES[4]	
PLANARIA	Turbellaria
	Planariidae
EARTHWORMS	Oligochaeta
LEECHES	Hirudinea
	Glossiphoniidae
CRUSTACEANS	Crustacea
ISOPODS	Isopoda
	Asellidae
AMPHIPODS	Amphipoda
	Gammaridae
AQUATIC MITES	Arachnida
	Acari
SNAILS	Gastropoda
	physa sp.
CLAMS	Pelecypoda
MILLIPEDES	Diplopoda
AQUATIC INSECTS	Insecta
SPRINGTAILS	Collembola
	Entomobryidae
DRAGON/DAMSELFLIES	Odonata
	Coenagrionidae
BEETLES	Coleoptera
	Staphylinidae

TABLE 6-47 cont'd

Potential Receptors in the Haverford Study Area

Common Name	Scientific Name
MACROINVERTEBRATES cont'd	
FLIES	Diptera
	Tipulidae
	Simuliidae
	Chironomidae
	Ephydridae
CADDISFLIES	Trichoptera
	Hydropsychidae
	Philopotamidae

1. Scientific names for mammals follow Doutt, J.K., C.A. Heppenstall, and J.E. Guilday. 1977. Mammals of Pennsylvania. Pennsylvania Game Commission, Harrisburg, PA. 288 pp.

2. Scientific names for birds follow Peterson, R.T. 1980. A Field Guild to the Eastern Birds. Houghton Mifflin Company, Boston. 384 pp.

3. Scientific names following Werner, R.G. 1980. Freshwater Fishes of New York State. Syracuse University Press. Syracuse, New York. 186 pp.

4. Phylogenetic arrangement following that of Borror, D.J., C.A. Triplehorn and N.F. Johnson. 1989, An introduction to the Study of Insects, 6th ed. Saunders College Publishing, Philadelphia, PA. 875 pp.

Waterfowl have additional routes of exposure involving absorption through the skin and secondary bioaccumulated exposures from the ingestion of aquatic vegetation, invertebrates, and fish.

Vegetation is not a likely receptor, although soils along the bank of Naylors Run have not been tested. If vegetative stress is occurring, it is subtle and can not be evaluated at this time.

6.2.2.2 Aquatic Receptors

The aquatic organisms listed in Table 6-47 are considered potential receptors. This list includes all aquatic organisms found at any of the sample stations.

6.2.3 Nature and Extent of Contamination

The nature and extent of contamination can be determined from literary sources and the surface water and sediment sampling results. The surface water and sediment sampling reveals some parameters to be outside the acceptable range. The surface water contaminant levels were compared against Pennsylvania Water Quality Criteria (WQC) to determine exceedences. Pennsylvania has no sediment quality criteria. Literary sources were used to make toxicological determination where no criteria exists for a particular contaminant.

6.2.3.1 Comparison of Data to Applicable Criteria

There are a number of parameters found in the surface waters of Naylors Run which exceed the WQC. Although there are no sediment quality criteria, a number of parameters may be at levels that could potentially cause ecological impacts in Naylors Run. Many contaminants were detected at various sample locations below the laboratory quantitation limit. Estimations were given to these concentrations detected, however, these estimates are considered imprecise and can not be taken at face value. For the purpose of the ecological risk assessment, these values will be subjectively addressed, and will not be used in any risk calculation. These estimations will be denoted by a "J" after the reported value. Sample locations COBB-SED-03, COBB-AQ-03, NAY-SED-07 and NAY-AQ-07 are field duplicate samples of COBB-SED-01, COBB-AQ-01, NAY-SED-02 and NAY-AQ-02, respectively.

Inorganics

There were four heavy metals which exceeded the WQC or which occurred at levels of concern in Naylors Run. The toxicity of some metals vary according to water hardness, which calculated to a mean of 90 mg/L $CaCO_3$. Metals were only sampled in water and sediment at stations NAY-01 through NAY-06, however, no surface water sample was attainable at NAY-AQ-05 during the sampling event.

Aluminum has a WQC value based on one tenth of the lethal concentration of 50% of test organisms (LC_{50}) of the most sensitive representative aquatic organism for which a LC_{50} is attainable. Although an aluminum LC_{50} for an organism specifically found in Naylors Run or Cobbs Creek was unattainable, a LC_{50} for brown trout hatchlings of 20 ug/L aluminum would give a WQC of 2 ug/L. Aluminum was detected at levels of concern in both the surface water and sediment. Aluminum was detected in the surface water at NAY-AQ-03 (113 ug/L), NAY-AQ-04 (53.5 ug/L) and NAY-AQ-06 (147 ug/L). Detected levels in the sediment ranged from 3,250 mg/kg (NAY-SED-07) to 7,130 mg/kg (NAY-SED-05), with the average being 5,191 mg/kg.

Iron has no WQC, although it was detected at levels of concern in both the surface water and sediment. Iron was detected in the surface water at NAY-AQ-01 (112 ug/L), NAY-AQ-02 (4,170 ug/L), NAY-AQ-07 (4,240 ug/L), NAY-AQ-03 (7,920 ug/L), NAY-AQ-04 (5,590 ug/L) and NAY-AQ-06 (828 ug/L). Detected levels in the sediment ranged from 12,400 mg/kg (NAY-SED-07) to 100,000 mg/kg (NAY-SED-05), with the average being 37,386 mg/kg.

Lead detected in surface water exceeded the WQC (3.2 ug/L) at stations NAY-AQ-02 (4.6 ug/L), NAY-AQ-07 (7.4 ug/L), NAY-AQ-03 (8 ug/L), NAY-AQ-04 (3.6 ug/L) and NAY-AQ-06 (12.9 ug/L). Detected levels in sediment ranged from non-detect (NAY-SED-03) to 694 mg/kg (NAY-SED-06), with average concentration being 188 mg/kg. Lead was detected at all locations sampled except NAY-SED-03.

Manganese has a WQC of 1000 ug/L, and was detected at levels of concern in both the surface water and sediment. Manganese was detected in the surface water at NAY-AQ-01 (686 ug/L), NAY-AQ-02 (8,220 ug/L), NAY-AQ-07 (8,160 ug/L), NAY-AQ-03 (10,100 ug/L), NAY-AQ-04 (7,430 ug/L) and NAY-AQ-06 (3,570 ug/L). Detected levels in the sediment ranged from 399 mg/kg (NAY-SED-02&07) to 4,750 mg/kg (NAY-SED-04), with the average being 2,284 mg/kg.

Volatiles

There were no volatile organics detected above WQC in the surface water or present in sediment samples at levels of concern.

Semi-Volatiles

There were a number of semi-volatiles detected in the surface water at levels above WQC. There were also a number of semi-volatiles detected in the sediment samples at levels of potential concern.

Acenaphthene was not detected in any of the surface water samples. It was detected in sediment samples at locations NAY-SED-06 (1,300 ug/kg J), NAY-SED-08 (530 ug/kg), NAY-SED-09 (150 ug/kg J), NAY-SED-10 (960 ug/kg), COBB-SED-01 (49 ug/kg J) and COBB-SED-03 (33 ug/kg J). Acenaphthene was not detected in the reference station surface water or sediment samples.

Acenaphthylene was not detected in any of the surface water samples. It was detected in sediment samples at location NAY-SED-10 (80 ug/kg J). Acenaphthylene was not detected in the reference station surface water or sediment samples.

Anthracene was not detected in any of the surface water samples. Anthracene was detected in sediment samples at locations NAY-SED-01 (120 ug/kg J), NAY-SED-02 (290 ug/kg J), NAY-SED-07 (900 ug/kg), NAY-SED-03 (1,100 ug/kg), NAY-SED-04 (150 ug/kg J), NAY-SED-05 (690 ug/kg J), NAY-SED-06 (2,300 ug/kg), NAY-SED-08 (1,200 ug/kg), NAY-SED-09 (330 ug/kg J), COBB-SED-01 (110 ug/kg J) and COBB-SED-03 (99 ug/kg J). Anthracene was detected in the reference sediment sample (36 ug/kg J).

Benzo(*a*)anthracene was not detected in the surface water samples above WQC for fish and aquatic life (0.1 ug/L). Benzo (*a*) anthracene was detected in sediment samples at locations NAY-SED-01 (290 ug/kg J), NAY-SED-02 (1,000 ug/kg), NAY-SED-07 (3,100 ug/kg), NAY-SED-03 (4,500 ug/kg), NAY-SED-04 (510 ug/kg J), NAY-SED-05 (2,400 ug/kg J), NAY-SED-06 (7,500 ug/kg), NAY-SED-08 (3,200 ug/kg), NAY-SED-09 (920 ug/kg), NAY-SED-10 (5,900 ug/kg), COBB-SED-01 (490 ug/kg) and COBB-SED-03 (410 ug/kg). Benzo(*a*)anthracene was detected in the reference sediment sample (170 ug/kg J).

Benzo(*b*)fluoranthene was not detected in the surface water samples. Benzo(*b*)fluoranthene was detected in sediment samples at locations NAY-SED-01 (380 ug/kg J), NAY-SED-02 (1400 ug/kg), NAY-SED-07 (3,900 ug/kg), NAY-SED-03 (5,100 ug/kg), NAY-SED-04 (670 ug/kg J), NAY-SED-05 (3,000 ug/kg), NAY-SED-06 (11,000 ug/kg), NAY-SED-08 (2,900 ug/kg), NAY-SED-09 (1,000 ug/kg), NAY-SED-10 (4,600 ug/kg), COBB-SED-01 (470 ug/kg) and COBB-SED-03 (450 ug/kg). Benzo(*b*)fluoranthene was detected in the reference sediment sample (140 ug/kg J).

Benzo(*k*)fluoranthene was not detected in the surface water samples. Benzo(*k*)fluoranthene was detected in sediment samples at NAY-SED-01 (320 ug/kg J), NAY-SED-02 (1,200 ug/kg), NAY-SED-07 (3,800 ug/kg), NAY-SED-03 (5,900 ug/kg), NAY-SED-04 (710 ug/kg J), NAY-SED-05 (4,300 ug/kg), NAY-SED-06 (10,000 ug/kg), NAY-SED-08 (2,500 ug/kg), NAY-SED-09 (700 ug/kg), NAY-SED-10 (4,800 ug/kg), COBB-SED-01 (520 ug/kg) and COBB-SED-03 (350 ug/kg J). Benzo(*k*)fluoranthene was detected in the reference sediment sample (180 ug/kg J).

Benzo(*g,h,i*)perylene was not detected in the surface water samples. Benzo(*g,h,i*)perylene was detected in sediment samples at NAY-SED-07 (600 ug/kg J), NAY-SED-03 (640 ug/kg J), NAY-SED-06 (1,100 ug/kg), NAY-SED-08 (1,000 ug/kg), NAY-SED-09 (510 ug/kg), NAY-SED-10 (3,000 ug/kg) and COBB-SED-03 (270 ug/kg J). Benzo(*g,h,i*)perylene was not detected in the reference sediment sample.

Benzo(*a*)pyrene was not detected in the surface water samples. Benzo(*a*)pyrene was detected in sediment samples at NAY-SED-01 (340 ug/kg J), NAY-SED-02 (970 ug/kg), NAY-SED-07 (3,000 ug/kg), NAY-SED-03 (3,900 ug/kg), NAY-SED-04 (520 ug/kg), NAY-SED-05 (2,500 ug/kg J), NAY-SED-06 (7,000 ug/kg), NAY-SED-08 (2,600), NAY-SED-09 (860 ug/kg), NAY-SED-10 (5,700 ug/kg), COBB-SED-01 (490 ug/kg) and COBB-SED-03 (400 ug/kg J). Benzo(*a*)pyrene was detected in the reference sediment sample (160 ug/kg J).

Butylbenzyphthalate was not detected in any of the surface water samples above WQC (35 ug/L). It was detected in sediment samples at location NAY-SED-10 (140 ug/kg J). Butylbenzyphthalate was not detected in the reference station surface water or sediment samples.

Carbazole was not detected in the surface water samples. Carbazole was not analyzed for at locations NAY-SED-01 to NAY-SED-06, but was analyzed for and detected at NAY-SED-08 (900 ug/kg), NAY-SED-09 (230 ug/kg J), NAY-SED-10 (1,600 ug/kg), COBB-SED-01 (88 ug/kg J) and COBB-SED-03 (87 ug/kg J). Carbazole was not detected in the reference sediment sample.

Chrysene was not detected in the surface water samples. Chrysene was detected in sediment samples at locations NAY-SED-01 (440 ug/kg J), NAY-SED-02 (1,500 ug/kg), NAY-SED-07 (4,100 ug/kg), NAY-SED-03 (6,200 ug/kg), NAY-SED-04 (680 ug/kg J), NAY-SED-05 (3,800 ug/kg), NAY-SED-06 (11,000 ug/kg), NAY-SED-08 (3,300 ug/kg), NAY-SED-09 (1,100 ug/kg), NAY-SED-10 (6,800 ug/kg), COBB-SED-01 (540 ug/kg) and COBB-SED-03 (500 ug/kg). Chrysene was detected in the reference sediment sample (190 ug/kg J).

Dibenzo(*a,h*)anthracene was not detected in the surface water samples. Dibenzo(*a,h*)anthracene was detected in sediment samples at NAY-SED-07 (450 ug/kg J), NAY-SED-03 (570 ug/kg J) and NAY-SED-06 (1,400 ug/kg). Dibenzo(*a,h*)anthracene was not detected in the reference sediment sample.

Dibenzofuran was not detected in the surface water samples. Dibenzofuran was detected in sediment samples at NAY-SED-06 (900 ug/kg), NAY-SED-08 (390 ug/kg J), NAY-SED-09 (120 ug/kg J), NAY-SED-10 (680 ug/kg), COBB-SED-01 (33 ug/kg J) and COBB-SED-03 (27 ug/kg J). Dibenzofuran was not detected in the reference sediment sample.

1,2-Dichlorobenzene was not detected in the surface water samples. 1,2-Dichlorobenzene was detected in sediment sample NAY-SED-01 (2,300 ug/kg), NAY-SED-02 (2,500 ug/kg), NAY-SED-07 (2,300 ug/kg), NAY-SED-03 (55,000 ug/kg), NAY-SED-05 (6,200 ug/kg) and NAY-SED-03 (2,700 ug/kg). 1,2-Dichlorobenzene was not detected in the reference sediment sample.

1,4-Dichlorobenzene was not detected in the surface water samples. 1,4-Dichlorobenzene was detected in sediment sample NAY-SED-03 (1,100 ug/kg). 1,4-Dichlorobenzene was not detected in the reference sediment sample.

Bis(2-Chloroethyl)Ether was not detected in any of the surface water samples above WQC for fish and aquatic life (6,000 ug/L). *Bis*(2-Chloroethyl)Ether was detected in sediment samples at locations NAY-SED-02 (1,100 ug/kg), NAY-SED-07 (1,100 ug/kg), NAY-SED-03 (1,100 ug/kg), NAY-SED-04 (910 ug/kg), NAY-SED-05 (3,200 ug/kg) and NAY-SED-06 (980 ug/kg). *Bis*(2-Chloroethyl)Ether was not detected in the reference sediment sample.

Fluoranthene was not detected in any of the surface water samples above WQC for fish and aquatic life (40 ug/L). Fluoranthene was detected in sediment samples at locations NAY-SED-01 (780 ug/kg), NAY-SED-02 (2,900 ug/kg), NAY-SED-07 (8,300 ug/kg), NAY-SED-03 (11,000 ug/kg), NAY-SED-04 (1,400 ug/kg), NAY-SED-05 (6,600 ug/kg), NAY-SED-06 (21,000 ug/kg), NAY-SED-08 (7,700 ug/kg), NAY-SED-09 (1,600 ug/kg), NAY-SED-10 (15,000 ug/kg), COBB-SED-01 (780 ug/kg) and COBB-SED-03 (920 ug/kg). Fluoranthene was detected in the reference sediment sample (330 ug/kg J).

Fluorene was detected in one surface water sample (HAY-AQ-04, 2.0 ug/L). There is no WQC for fish and aquatic life for fluorene in surface water. Fluorene was detected in sediment samples at locations NAY-SED-02 (190 ug/kg J), NAY-SED-03 (920 ug/kg), NAY-SED-06 (1,800 ug/kg), NAY-SED-08 (840 ug/kg), NAY-SED-09 (220 ug/kg J), NAY-SED-10 (1,400 ug/kg), COBB-SED-01 (57 ug/kg J) and COBB-SED-03 (56 ug/kg J). Fluorene was not detected in the reference station water or sediment samples.

Indeno(*1,2,3-cd*)pyrene was not detected in the surface water samples. Indeno(*1,2,3-cd*)pyrene was detected in sediment samples at NAY-SED-07 (870 ug/kg), NAY-SED-03 (1,100 ug/kg), NAY-SED-06 (1,800 ug/kg), NAY-SED-08 (1,000 ug/kg), NAY-SED-09 (510 ug/kg), NAY-SED-10 (2,900 ug/kg) and COBB-SED-01 (260 ug/kg J) and COBB-SED-03 (240 ug/kg J). Indeno(*1,2,3-cd*)pyrene was not detected in the reference sediment sample.

2-Methylnaphthalene was not detected in any of the surface water samples. 2-Methylnaphthalene was detected in sediment samples at locations NAY-SED-08 (80 ug/kg J), NAY-SED-09 (55 ug/kg J) and NAY-SED-10 (210 ug/kg J). 2-Methylnaphthalene was not detected in the reference sediment sample.

Naphthalene was not detected in any of the surface water samples above WQC for fish and aquatic life (43 ug/L). Naphthalene was detected in sediment samples at locations NAY-SED-08 (80 ug/kg J), NAY-SED-09 (48 ug/kg J) and NAY-SED-10 (240 ug/kg J). Naphthalene was not detected in the reference sediment sample.

Phenanthrene was not detected in any of the surface water samples above WQC for fish and aquatic life (1 ug/L). Phenanthrene was detected in sediment samples at locations NAY-SED-01 (570 ug/kg J), NAY-SED-02 (2,200 ug/kg), NAY-SED-07 (5,600 ug/kg), NAY-SED-03 (9,600 ug/kg), NAY-SED-04 (1,100 ug/kg), NAY-SED-05 (3,900 ug/kg), NAY-SED-06 (20,000 ug/kg), NAY-SED-08 (6,700 ug/kg), NAY-SED-09 (1,600 ug/kg), NAY-SED-10 (13,000 ug/kg), COBB-SED-01 (590 ug/kg) and COBB-SED-03 (680 ug/kg). Phenanthrene was detected in the reference sediment sample (210 ug/kg J).

Pyrene was detected in one of the surface water samples (NAY-AQ-03, 4 ug/L; catch basin). There is no WQC for fish and aquatic life for pyrene in surface water. Pyrene was detected in sediment samples at locations NAY-SED-01 (980 ug/kg), NAY-SED-02 (2,800 ug/kg), NAY-SED-07 (6,700 ug/kg), NAY-SED-03 (8,600 ug/kg), NAY-SED-04 (1,300 ug/kg), NAY-SED-05 (5,800 ug/kg), NAY-SED-06 (14,000 ug/kg), NAY-SED-08 (7,200 ug/kg J), NAY-SED-09 (1,900 ug/kg), NAY-SED-10 (14,000 ug/kg), COBB-SED-01 (940 ug/kg) and COBB-SED-03 (900 ug/kg). Pyrene was detected in the reference sediment sample (370 ug/kg J).

Bis(2-ethylhexyl)phthalate was not detected in the surface water samples above WQC (909 ug/L). *Bis*(2-ethylhexyl)phthalate was detected in sediment samples at NAY-SED-01 (310 ug/kg J), NAY-SED-02 (330 ug/kg J), NAY-SED-07 (480 ug/kg J), NAY-SED-03 (830 ug/kg), NAY-SED-04 (360 ug/kg J), NAY-SED-05 (3,600 ug/kg), NAY-SED-06 (1,900 ug/kg), NAY-SED-08 (620 ug/kg), NAY-SED-09 (700 ug/kg J), NAY-SED-

10 (970 ug/kg), COBB-SED-01 (250 ug/kg) and COBB-SED-03 (400 ug/kg J). *Bis*(2-ethylhexyl)phthalate was detected in the reference sediment sample (200 ug/kg).

Di-*n*-butylphthalate was not detected in the surface water samples above WQC (21 Ug/L). Di-*n*-butylphthalate was detected in sediment samples at NAY-SED-08 (22 ug/kg J), NAY-SED-09 (32 ug/kg J), NAY-SED-10 (54 ug/kg J) and COBB-SED-01 (28 ug/kg J). Di-*n*-butylphthalate was detected in the reference sediment sample (31 ug/kg J).

Di-*n*-Octyl phthalate was not detected in any of the surface water samples above WQC. It was detected in sediment samples at location NAY-SED-08 (45 ug/kg J) and NAY-SED-09 (84 ug/kg J). Di-*n*-Octyl phthalate was not detected in the reference station surface water or sediment samples.

Phenol was detected in one sediment sample at NAY-SED-09 (39 ug/kg J).

Pentachlorophenol was detected in the surface water samples above WQC (13 ug/L, pH = 7.8) at NAY-AQ-01 (21 ug/L), NAY-AQ-02 (470 ug/L), NAY-AQ-07 (580 ug/L), NAY-AQ-03 (1,200 ug/L), NAY-AQ-04 (380 ug/L), NAY-AQ-06 (18 ug/L), NAY-AQ-08 (140 ug/L), NAY-AQ-09 (25 ug/L), NAY-AQ-10 (6 ug/L J), COBB-AQ-01 (3 ug/L J) and COBB-AQ-03 (2 ug/L J). Pentachlorophenol was detected in sediment samples at NAY-SEED-01 (810 ug/kg J), NAY-SEED-02 (1,400 ug/kg J), NAY-SED-07 (1,800 ug/kg J), NAY-SED-04 (830 ug/kg J), NAY-SED-06 (3,000 ug/kg J) and NAY-SED-08 (360 ug/kg J). Pentachlorophenol was not detected in the reference sediment sample (200 ug/kg).

Pesticides

Pesticides in surface water and sediment were sampled at stations NAY-SED-01 through NAY-SED-06. A number of pesticides were detected.

Aldrin was detected in the sediment at NAY-SED-07 (36 ug/kg), but was not detected in any of the surface water samples.

Beta-BHC was not detected in any of the surface water samples. *Beta*-BHC was detected in sediment samples NAY-SED-07 (28 ug/kg) and NAY-SED-03 (35 ug/kg).

Gamma-BHC was detected in a surface water sample at NAY-AQ-06 (0.054 ug/L). WQC for *gamma*-BHC is 0.08 ug/L.

Alpha-chlordane was not detected in the surface water samples above chronic WQC for fish and aquatic life (0.0043 ug/L). *Alpha*-chlordane was detected in a sediment sample at NAY-SED-03 (110 ug/kg J).

Gamma-chlordane was not detected in the surface water samples above chronic WQC for fish and aquatic life (0.0043 ug/L). *Gamma*-chlordane was detected in a sediment sample at NAY-SED-03 (130 ug/kg J).

4,4'-DDD was detected in a surface water sample above chronic WQC for fish and aquatic life (0.001 ug/L) at NAY-AQ-03 (0.38 ug.L) and NAY-AQ-04 (0.23 ug/L).

Dieldrin was detected in the surface water samples above chronic WQC for fish and aquatic life (0.0019 ug/L) at NAY-SED-01 (0.34 ug/L) and NAY-SED-02 (0.12). Dieldrin was detected in sediment at NAY-SED-01 (75 ug/kg) and NAY-SED-07 (73ug/kg).

Endrin was not detected in the surface water samples above chronic WQC for fish and aquatic life (0.0023 ug/L). Endrin was detected in sediment at NAY-SED-06 (43 ug/kg).

Endosulfan sulfate was not detected in the surface water samples. Endosulfan sulfate was detected in sediment at NAY-SED-06 (48 ug/kg) and NAY-SED-04 (51 ug/kg).

Heptachlor was not detected in the surface water samples. Heptachlor was detected in sediment at NAY-SED-03 (160 ug/kg).

Heptachlor epoxide was detected in a surface water sample at NAY-AQ-03 (0.77 ug/L). WQC for heptachlor epoxide is 0.1 ug/L. Heptachlor epoxide was detected in the sediment at NAY-SED-03 (160 ug/kg).

Dioxin

Dioxin was detected in the catch basin surface water (NAY-AQ-03, 0.299 pg/L). Dioxin was detected in the sediment at NAY-SED-01 (0.011 pg/g), NAY-SED-02 (0.044 pg/g), NAY-SED-03 (0.118 pg/g), NAY-SED-04 (0.117 pg/g), NAY-SED-05 (0.041 pg/g) and NAY-SED-06 (0.003 pg/g). Dioxin was also detected at a background sample across Eagle Road from Naylors Run at a concentration of 0.026 pg/g.

6.2.3.2 Terrestrial and Wetland Toxicity

The following section describes the toxicity associated with the potentially toxic parameters previously discussed.

Aluminum

Aluminum is primarily a neurotoxin to terrestrial wildlife. Exposure to elevated levels of aluminum may result in neurofibrillary degeneration in the brain, osteomalacia, dementia and dialysis encephalopathy (Marquis, 1989). Marquis also reported decreased brain ACHE activity in rat pups when exposed to 0.12% aluminum chlorohydrate at 8, 15 and 22 days post-weaning.

Iron

Iron

Iron is an essential trace element for the formation of hemoglobin, myoglobin and other enzyme systems (NAS, 1980). High concentrations, however, are known to be toxic. Several studies have been done on the toxic effects of iron on domestic birds. Chickens exposed to 200 mg/kg iron and 5 mg/kg copper in their diet showed decreased weight gain and increased mortality (McGhee *et al.*, 1965 in NAS, 1980). Rickets was documented in young chickens exposed to 4500 mg/kg iron (Daebold and Elvehjem, 1935 in NAS, 1980). Iron showed no adverse affects on turkeys at 440 mg/kg iron (Woerpel and Balloun, 1964 in NAS, 1980). NAS (1980) suggests the maximum dietary level of iron in poultry to be 1000 mg/kg. Puls (1988) recommends a maximum concentration of iron in drinking water of 0.4 mg/l for livestock and poultry.

Iron also has been documented to have toxic effects on mammals. Rabbits exposed to 750 mg ferrous sulfate/kg body weight showed acute hepatic congestion and fatal effects in 24-48 hours (Luiongo and Bjornson, 1954). The acute oral LD_{50} in mice is 306 mg/kg for ferrous sulfate and 429 mg/kg for ferrous gluconate (NAS, 1980).

Lead

Little information is present on the toxicity of lead to wildlife, however, some information is present on domestic and laboratory animals. Survival was reported reduced at acute oral lead doses of 5 mg/kg body weight (BW) in rats, at chronic oral doses of 5 kg/mg BW in dogs, and at dietary level of 1.7 mg/kg BW in horses (Eisler, 1988). Based on his literature review, Eisler (1988) proposed a lead criteria for the protection of waterfowl to be >2 mg/kg fresh liver weight.

Manganese

There are little data on manganese toxicity for terrestrial animals. Chronic poisoning in dogs, rabbits, rats and monkeys is known to cause gross pathology in the liver and diffuse lesions in the cerebrum (Turner, 1955). Levels of 50-125 mg/kg in the diet of baby pigs has caused manganese-iron antagonism, resulting in interference in hemoglobin formation.

Semi-Volatiles

Fluorene is not known to be carcinogenic nor mutagenic (McCann *et al.*, 1975). Fluorene detected in surface water samples did not exceed 2.0 ug/L and therefore is not considered a potential threat to terrestrial wildlife.

Pentachlorophenol (PCP) has the ability to interfere with the production of high energy phosphate compounds essential for cell respiration. PCP is fetotoxic and teratogenic. PCP is rapidly accumulated and excreted with little tendency to persist in living organisms (Eisler, 1989). Mammals have been reported to actively avoid PCP tainted food (Eisler, 1989). PCP intoxication in birds includes in excessive drinking and regurgitation, rapid breathing, wing shivers and twitching, jerkiness, shakiness, ataxia, tremors and spasms (Hudson *et al.*, 1984). Signs often appear in as fast as ten minutes (Hudson *et al.*, 1984). Hudson *et al.* (1984) reported the acute oral LD_{50} for mallard ducks is 380 mg/kg body weight. Laboratory rats (*Rattus* spp.) eliminate approximately 75% of all PCP in the urine in an unconjugated form (EPA, 1980). The acute oral LD_{50} for domestic dogs is 150-200 mg/kg body weight. The maximum concentration of PCP in the surface water (1,200 ug/L) was found within the catch basin. Taking into consideration the concentration needed to cause toxicity in mammals and the rapid excretion of PCP by mammals, PCP does not pose a significant threat to terrestrial wildlife. In contrast, Eisler (1989) suggested PCP levels exceeding 1.0 mg PCP/kg feed for birds should be viewed as presumptive evidence of significant environmental PCP contamination. The potential for avian exposure to surface water PCP concentrations warrants modeling.

4,4'DDD

4,4'DDD has an acute oral LD_{50} for rats of 3.4 g/kg body weight (Pesticide Dictionary, 1976). 4,4'DDD was detected in one surface water sample (NAY-AQ-04) at a concentration of 0.23 ug/L.

Dieldrin

Signs of dieldrin intoxication in birds include tail feathers spread and pointed either upward or downward, hyperexcitability, jerkiness in gait, ataxia, dyspnea, myasthenia, fluffed feathers, immobility, terminal wing-beat convulsions or opisthotonos. The 8-day dietary LC_{50} for mallard ducklings is 91.0 ppm; the LD_{50} for the house sparrow is 47.6 mg/kg PCP; the LD_{50} for the domestic goat is 100-200 mg/kg (Hudson *et al.*, 1984). Dieldrin was not detected in surface water at levels exceeding 0.34 ug/L.

Heptachlor Epoxide

Heptachlor epoxide is a soluble breakdown product of heptachlor. It has greater mobility than heptachlor.

Dioxin

The following are 2,3,7,8-TCDD LD_{50} for waterfowl and terrestrial wildlife: mallard ducks, 108^+ ug/kg BW (Hudson *et al.*, 1984); rat, 22-45 ug/kg BW (Kociba and Schwertz, 1982a,b); dog, 100-200 ug/kg BW (Kociba and Schwertz 1982a,b); and mouse, 114-284 ug/kg BW (Kociba and Schwertz 1982a,b). Eisler (1986) recommended that concentrations in excess of 10-12 pg/g in food items should be considered significant to birds and wildlife. Dioxin total 2,3,7,8 TCDD equivalent levels (dioxin TE) in the surface water did not exceed 0.299 ppt.

6.2.3.3 AQUATIC TOXICITY

Inorganics

Aluminum

Aluminum may be both physically and metabolically toxic to aquatic life, however, the dominant toxicological property has yet to be universally agreed on. Dietrich and Schlatter (1989) reported two forms of toxicity occurring in rainbow trout when exposed to aluminum concentrations greater than 200 ug/L at pH 5.4. Metabolic toxicity included electrolyte loss, possibly due to the interaction of aluminum with enzymes at the epithelial tight junction in the gills. The physical toxicity was caused by labile aluminum covering the gill epithelium resulting in the impairment of gas exchange.

Brown trout eggs appear to be tolerant to low pH and elevated levels of aluminum. The hatchlings, however, appear to be highly sensitive, with an acute LC_{50} of less than 20 ug/L aluminum (Weatherly *et al.*, 1990). Cleveland *et al.* (1989) reported a 30 day no-observed-effect-level (NOEL) for juvenile brook trout to be 29 ug/L at pH 5.6 and 57 ug/L at pH 6.6. Aluminum will tend to flocculate when pH reaches a critical value of 5.2 (Skelly and Loy 1973). Thompson *et al.* (1988) reported a LC_{50} of 3800 ug/L for rainbow trout larvae in waters with a pH of 5.0.

Corn *et al.* (1989) investigated the effects of aluminum and pH on five amphibians (northern leopard frog, *Rana pipiens*; boreal toad, *Bufo boreas*; chorus frog, *Pseudacris triseriata*; tiger salamander, *Ambystoma tigrinum*; and the wood frog, *Rana sylvatica*). The 24 hr. LC_{50} pH for the various embryos ranged from 4.2-4.8. The 24 hr. LC_{50} Al for the various embryos ranged from 100-400 ug/L.

Iron

As previously mentioned, iron is necessary for animal life. Ferrous (Fe^{+2}) and ferric (Fe^{+3}) iron are the important forms to aquatic life, with Fe^{+3} being dominant at lower pH. Ferrous iron is highly soluble, while ferric iron has a low solubility. Precipitates of iron, typically iron hydroxide ($Fe[OH]_3$), can coat fish gills and mechanically inhibit oxygen uptake. Iron precipitates can also cover sediments and vegetation, suffocating fish eggs and benthic organisms and limiting attachment sites for many aquatic insects. Tackett and Wieserman (1972) reported this mechanism being lethal to eggs and fry at a level of 1000 ug/l iron at low flow. Iron flocculates at the critical value of pH 4.3 (Skelly and Loy, 1973).

High iron concentrations have been known to decrease macroinvertebrate abundance and diversity (Letterman and Mitsch, 1978). Warnick and Bell (1969) reported an acute (96 hr.) LC_{50} value of 320 ug/l iron for the mayfly *Ephemerella subvaria* at a water hardness of 48 mg/l. The stonefly *Acroneuria lycorias* and the caddisfly *Hydropsyche betteni* have a reported 50% mortality rate when exposed for 7 days to 16 mg/l iron. This suggests that stoneflies and caddisflies are more tolerant to iron than mayflies, an inference supported by the present investigation.

The lowest concentration fatal to brook trout (within 24 hrs.) was 133 mg/l (Duodroff and Katz, 1953). EPA (1985f) reported a chronic value for brook trout of 9690 ug/l. Brenner *et al.* (1976) reported minor toxicity in the common shiner being exposed to ferric hydroxide. Toxicity was caused by initial changes in serum protein, glucose, sodium, and potassium ions.

In contrast many organisms have adapted to high ferric conditions. *Euglena mutabilis* is known to thrive in ferric waters and may be used to improve water quality in acidic and ferric waters by producing oxygen to reduce acidity

(Lieb, 1971).

Lead

Adverse affects of lead on aquatic biota, reported at waterborne lead concentrations of 1.0 - 5.1 ug/L, include reduced survival, impaired reproduction, reduced growth and high bioconcentration from medium (Eisler 1988). Lead was detected in five surface water sample locations above WQC for aquatic life. Lead was detected in the sediments at values as high as 694 mg/kg. Lead is considered a contributor to ecological stress in Naylors Run.

Manganese

Little detailed information regarding manganese toxicity is available, although it is recognized as a highly toxic metal. Manganese is known to increase the mortality in fish eggs at levels of 1000 ug/l (Lewis, 1976).

Semi-Volatiles

A large array of semi-volatile contaminants were detected in the surface water and/or the sediments samples in Naylors Run. Semi-volatiles detected include acenaphthene, acenaphthylene, anthracene, benzo(*a*)anthracene, benzo(*b*)fluoranthene, benzo(*k*)fluoranthene, benzo(*g,h,i*)perylene, benzo(*a*)pyrene, *bis*(2-chloroethyl)ether, butylbenzylphthalate, carbazole, chrysene, dibenzo(*a,h*)anthracene, dibenzofuran, 1,2-dichlorobenzene, 1,4-dichlorobenzene, di-*n*-butylphthalate, fluoranthene, fluorene, indeno(*1,2,3-cd*)pyrene, 2-methylnaphthalene, naphthalene, phenanthrene, pyrene, *bis*(2-ethylhexyl)phthalate, di-*n*-butylphthalate, and pentachlorophenol. The majority of the contaminants appear to be bound in the sediment.

Polycyclic aromatic hydrocarbons (PAHs) are known to induce microsomal enzymes and hemoproteins that constitute the mixed function oxidase (MFO) system, especially compounds of higher molecular weight (Melius *et al.*, 1979; Carlson *et al.* 1979). The MFO is metabolic detoxifying system found in the livers of mammals, fish and the equivalent organs in many aquatic invertebrates. Release and conversion of PAHs in organisms can be quite rapid, many times less than four days (Carlson *et al.*, 1979). Once induced, the MFO has the ability to convert PAHs into carcinogens facilitating toxicity. Benzo(*a*)pyrene is known to strongly induce the MFO, thus facilitating the conversion of other PAHs (Carlson *et al.*, 1979).

Although there is a large volume of information on semi-volatile toxicity to mammals, little information is available on aquatic organisms. Acenaphthene, acenaphthylene, benzo(*a*)anthracene, benzo(*a*)pyrene, chrysene and dibenzo(*a,h*)anthracene are known to be mutagenic to aquatic organisms (Krishnan *et al.*, 1979, McCann *et al.*, 1975). Benzo(*a*)anthracene, benzo(*a*)pyrene, chrysene and dibenzo(*a,h*)anthracene are known to be carcinogens to aquatic organisms (McCann *et al.*, 1975). In contrast, anthracene, fluoranthene, fluorene, naphthene, phenanthrene and pyrene have been reported to not be carcinogenic nor mutagenic to aquatic organisms. Pyrene, however, is reported to be a human carcinogen (Kanazawa *et al.*, 1975, McCann *et al.*, 1975).

Many phthalate esters are known to be metabolized by aquatic microorganisms, several invertebrates and several fish species. Short chained phthalates, such as dibutylphthalate, are metabolized more rapidly than long chained phthalates, such as di-ethylhexylphthalate (Melancon, 1979). Toxicity is, therefore, dependent on the species of phthalate and its metabolite.

PCP, 1,2-dichlorobenzene and 1,4-dichlorobenzene are readily metabolized by a number of aquatic organisms. The cleaving of the chlorine bonds and the reactive double bonds are the points on the molecule which are responsible for the toxicity.

Semi-volatile toxicity in aquatic invertebrates is dependent on the compound and organism. The following is a collection of toxicity values associated with invertebrates and semi-volatiles: 24-hr. LC_{50} *Parhyale hawaiensis* (Amphipoda), 15 mg naphthalene/L; *Gammarus pulex* (Amphipoda) perturbation level, 8,000 mg phenanthrene/L; 24-hr. EC_{50} *Daphnia magna* (Cladocera), 3.7 mg butylbenzylphthalate/L (Lee and Nicol 1978, Meinck *et al.*, 1970 and Gledhill *et al.*, 1980, respectively). Herbes and Risi (1978) reported Daphnia Pulex having a bioaccumulation factor (BF) for anthracene of 760.

Semi-volatile toxicity in fish is also dependent on the compound and fish species. The following is a collection of toxicity values associated with fish and semi-volatiles: 24-hr. non-observed-effect-level (NOEL) trout (Salmonidae), 5 mg anthracene/L; 96-hr. LC_{50} fathead minnow, 2.1-5.3 mg butylbenzylphthalate/L, 0.6 mg PCP/L, and 33.7 mg and 1,4-dichlorobenzene/L; and 72-hr. LC_{100} and LC_0 fathead minnow, 10 mg/L and 3 mg/L, respectively (Meinck *et al.*, 1970; Gledhill *et al.*, 1980; Curtis *et al.*, 1979; Mattson *et al.*, 1976; and Dow Chemical Company 1974, respectively). Carlson *et al.*, (1979) reported the BF value of 1,000-5,000 for the following compounds: anthracene, fluoranthene, fluorene, phenanthrene, and pyrene.

Historically PCP has been the contaminant driving the Remedial Investigation. For this reason, PCP will now be separately addressed. Eisler (1989) noted PCP adversely affected growth, survival and reproduction at media concentrations of 8 to 80 ug PCP/L in algae and higher plants, at 3 to 100 ug PCP/L in invertebrates, and <1 to 68 ug PCP/L in fish. Eisler recommends that PCP levels in surface water should not exceed 3.2 ug/L to protect aquatic life.

It should be noted that PCP, especially in sediments, constitutes only a fraction of the total semi-volatile contamination in the study area, and henceforth will be treated accordingly. The additive and potentially synergistic toxicity of the semi-volatile compounds to aquatic organisms is complicated and toxicity will be discussed in terms of total semi-volatiles, not individual compounds.

Pesticides

Eleven pesticides were detected in the surface water and/or sediment samples in Naylors Run. A brief discussion on the toxicity of these compounds follows.

Aldrin is an insecticide with an extremely high bioaccumulation potential. Aquatic invertebrates have been reported bioaccumulating aldrin 100,000 fold when exposed to 16 ng/L for 3 days (Johnson and Finley, 1980). Sanders (1969) reported a 96-hr. LC_{50} for *Gammarus lacustris* (Amphipoda) being 9,800 ug/L. Sanders and Cope (1968) reported an 96-hr. LC_{50} for the stonefly *Pteronarcys californica* being 1.3 ug/L. No aldrin was detected in the surface water samples, but was detected in one sediment sample (NAY-SED-07) at 36 ug/L.

Little information was found on *beta*-BHC, however, there is information on its isomer *alpha*-BHC. *Alpha*-BHC has a reported BF of 60-90 in crustaceans and 500 in fish (Greiner, 1970). The guppy *Lebistes reticulatus* has a 96-hr. LC_{50} of greater than 1.4 mg *alpha*-BHC/L (Greiner 1970).

Chlordane is an insecticide which is very toxic to aquatic organisms. Both the *alpha* and *gamma* isomers are fractions of the chlordane product (Thomas et al., 1978). The following are some 96-hr. LC_{50} values for chlordane: *Gammarus lacustris*, 26 ug/L; *Pteronarcys californica*, 15 ug/L; and fathead minnow 52 ug/L (Sanders, 1969; Sander and Cope, 1968; and Henderson *et al.* 1959, respectively). Cardwell *et al.* (1977) reported the lowest concentration leading to chronic toxicity for *Chironomus* sp. (Diptera) being 1.7 ug chlordane/L. Although chlordane was not detected in any surface water sample, it was detected in one sediment sample (NAY-SED-03) at 110 ug/kg.

4,4'DDD has been used as an insecticide (Johnson and Finley, 1980). The following are some 96-hr. LC_{50} values for 4,4'DDD: *Asellus* sp. (Isopoda), 16 ug/L; *Gammarus fasciatus* (Amphipoda), 0.6 ug/L; *Pteronarcys* sp., 380 ug/L; fathead minnow 4,400 ug/L; and largemouth bass (*Micropterus salmoides*) 42 ug/L (Johnson and Finley 1980). 4,4'DDD was detected in a surface water sample at the level of 0.23 ug/L.

Dieldrin is an insecticide which is extremely toxic to some stoneflies. The following are some 96-hr. LC_{50} values for dieldrin: *Gammarus lacustris*, 460 ug/L; stoneflies, *Pteronarcella badia*, 0.5 ug/L and *Claassenia sabulosa*, 0.58 ug/L; and the fathead minnow 16 ug/L (Sanders, 1969; Sanders and Cope, 1968; and Henderson *et al.*, 1959).

Endrin is an insecticide which is extremely toxic to aquatic organisms. The following are some 96-hr. LC_{50} values for endrin: *Gammarus lacustris*, 3.0 ug/L; stoneflies, *Pteronarcella badia*, 0.54 ug/L, *Pteronarcys* sp., 0.25 ug/L, *Claassenia* sp., 0.08 ug/L; mayfly, *Baetis* sp., 0.90 ug/L; crane fly, *Tipula* sp., 12 ug/L; fathead minnow 1.8 ug/L; and black bullhead, *Ictalurus melas*, 1.1 ug/L (Sanders, 1969; Sanders and Cope, 1968; Henderson *et al.*, 1959; and Johnson and Finley, 1980). Endrin was detected in only one sediment sample (NAY-SED-06) at a level of 43 ug/mg.

Heptachlor is an insecticide which is extremely toxic to aquatic organisms. The following are some 96-hr. LC_{50} values for heptachlor: *Gammarus lacustris*, 29 ug/L; stoneflies, *Pteronarcys* sp., 1.1 ug/L, *Pteronarcella* sp., 0.9 ug/L, *Claassenia* sp., 2.8 ug/L; fathead minnow, 23 ug/L; and largemouth bass, 10 ug/L (Johnson and Finley, 1980). Heptachlor was detected in only the catch basin (NAY-SED-03) sediment sample at the level of 160 ug/kg.

There is little toxicological data on heptachlor epoxide. Heptachlor epoxide is a metabolite of heptachlor. The 96-hr. LC_{50} values found were 20 ug/L for the rainbow trout and 5.3 ug/L for the bluegill (Mayer and Ellersieck, 1986).

Dioxin

The dioxin group consists of over 75 PCDD isomers, the most toxic being 2,3,7,8-TCDD. Some isomers are extremely toxic while others are relatively innocuous (Eisler, 1986). In order to limit the complexity of this group, all dioxin will be discussed in terms of dioxin TE. There is little information on dioxin toxicity to aquatic invertebrates. Eisler (1986) mentioned that dioxin bioaccumulation is dependent on concentration in the water column and duration of exposure. Yockim *et al.* (1978) reported aquatic invertebrates, plants and amphibians were fairly resistant to 2,3,7,8-TCDD compared to fish, e.g. algae, daphnids and snails exposed for 32 days to solutions containing 2.4 to 4.2 ppt of 2,3,7,8-TCDD showed no impairment of growth, reproduction, or food consumption although they had significant bioaccumulation of dioxin.

In contrast, sensitive teleosts (bony fish) exhibit reduced growth and fin necrosis at concentrations as low as 0.1 pg/ml of 2,3,7,8-TCDD during 24 to 96 hour exposures (Eisler 1986). Death occurred at levels of 1.0 ppt and higher. Norris and Miller (1974) reported smaller and younger fish appear to die sooner than older and larger fish when exposed to significant levels of dioxin. Eisler (1986) recommends that water levels should not exceed 0.01 ppt 2,3,7,8-TCDD based on laboratory results. This level was exceeded in the surface water sample at NAY-AQ-03 (catch basin) where the dioxin TE concentration was 0.299 ppt. Sediments taken from the catch basin had the equivalent toxicity concentration of 0.118 ug/kg. In 1989, fish tissue samples were taken approximately five (5) miles downstream of the Havertown PCP Site in Cobbs Creek in a national bioaccumulation study performed for the EPA (Tetra Tech, 1990). The reported dioxin TE values report for fish tissue were 1.31 ppt for black bullhead and 7.03 ppt in white sucker (*Catostomus commersoni*, Tetra Tech, 1990). Dioxin in Naylors Run must be considered a potential threat. The Havertown PCP Site may be one of the historic sources of dioxin in Cobbs Creek.

Summary of Toxicity

Terrestrial vegetation and mammals appear to be uninfluenced by the levels of contaminants found the surface waters of Naylors Run. The potential for PCP toxicity to birds species exists and will be further evaluated.

Potential toxicity to the aquatic community within Naylors Run and immediately downstream of its confluence with Cobbs Creek appears high. Aluminum, iron, lead, and manganese are considered minor contributors to overall toxicity in the study area. The total semi-volatile concentrations in both the surface waters and sediments are by far the dominant contributors to the toxicity of the aquatic community. Total pesticides is considered a minor contributor to the overall aquatic toxicity. Total dioxin is also a contributing factor to the over aquatic toxicity. The extent of potential impairment will be discussed in the following exposure assessment (Section 6.2.4).

6.2.4 Exposure Assessment

The purpose of the exposure assessment is to measure or estimate the potential intensity, frequency, and duration of exposures of an agent(s) of concern to identified receptors. Each identified route of exposure is evaluated separately, with the summation of the route(s) used to evaluate the total exposure of an agent to the appropriate receptor(s). Total exposure is then compared to known levels occurring in the environment from which potential ecological risk is evaluated.

6.2.4.1 Terrestrial and Wetland Assessment

No detailed terrestrial sampling for mammals or birds were performed in the Naylors Run study area. Therefore, modeling of selected species will be performed to evaluate the terrestrial ecological risk. The selected species are the song sparrow (*Melospiza melodia*) and the female mallard (*Anas platyrhynchus*). The song sparrow represents a strictly terrestrial species that is expected to have limited exposure to the surface water in Naylors Run by ingestion and bathing. The mallard is a species that would be expected to have significant exposure to the surface water, plus limited sediment, aquatic vegetation, and benthic organism ingestion. A female was selected since her dietary needs increase during egg-laying periods.

Calculating Daily Ingestion Rates

Calder and Braun (1983) developed an allometric equation for water ingestion for birds based on the measured body weights and drinking water values from Calder (1981) and Skadhauge (1975). The equation is as follows:

$$WI\ (L/day) = 0.059\ Wt^{0.67}(kg),$$

where WI is water ingestion in liters per day and Wt is the average weight of the bird in kilograms. The WI value includes water ingested through the consumption of vegetation and invertebrates. For the purpose of this evaluation, it will be assumed that the water intake will be soley from the surface water in order to evaluate the worst case scenario. This assumption will result in higher calculated exposure estimates than are actually occurring.

The average weight of a song sparrow is 0.0164 kg (Bartholomew and Cade, 1963). Using this value, the average water consumption of a song sparrow is calculated to be 3.8×10^{-3} L/day.

The average weight of a female mallard is 1.14 kg (Fergus, N.D.). Using this weight, the average water consumption of a female mallard is 0.064 L/day. The rate of food consumption of the mallard can be calculate by dividing its free-living metabolic rate (FMR) by the metabolized energy (ME) in its food (Nagy, 1987). Nagy developed an equation based on doubly-labeled water measurements of CO_2 production in free-living animals. The equation is as follows:

$$\log \text{FMR (kcal/day)} = 0.0594 + 0.749 \log \text{Wt (g)}.$$

From this equation the FMR for the mallard is 223 kcal/day. From the data reported by Golley (1961) and Robbins (1983), Nagy (1987) calculated the average value for ME efficiency for omnivorous birds to be 3.35 kcal/g. By dividing the FMR by the ME, the rate of food consumption for a female mallard was calculated to be 0.0667 kg/day. To address the worst case, it will be assumed that the ingested food is obtained solely from Naylors Run.

There are no data available on absorption rates through the skin of birds. For the song sparrow this route of exposure is compensated by the high estimate of water consumption. For the mallard this route of exposure can not be assessed. The mallard also has the potential for significant sediment ingestion. This route can not be assessed either, however, the food ingestion modeling is an over-estimation that will offer some compensation.

Calculating Daily Exposure Rates

To determine the daily exposure rates of water ingestion for terrestrial birds and waterfowl, the daily intake rates will be multiplied by the levels of contaminants found at each station. The daily exposure rate per body weight (DER/BW) by water ingestion is calculated by dividing the BW into DER. The four heavy metals and dioxin will be addressed separately, while semi-volatiles and pesticides will be addressed each as a group.

To address food consumption, the estimate food contaminant concentration will be calculated by multiplying the contaminant levels found in the sediment by the appropriate BF. When no BF is available, contaminants will be multiplied

by an estimated BF. The daily exposure rate of food ingestion is then calculated by multiplying the estimated food contaminant concentrations by the daily food consumption rate. The daily rate per body weight (DER/BW) by food ingestion is calculated by dividing the Wt into DER. Table 6-48 summarizes the exposure calculations for terrestrial birds and waterfowl.

Exposure Assessment for Terrestrial and Wetland Receptors

Results from the exposure assessment modeling indicate the potential for significant ecological impairment due to the contaminants found in Naylors Run. Each of the heavy metals used in the modeling can stand alone as a potential ecological threat in the worst case scenario.

Many of the individual detected semi-volatiles would not be considered a significant threat, however, when these compounds are combined they constitute the most significant risk in Naylors Run. The greatest threat by semi-volatile toxicity is in the area between Eagle Road and the former catch basin. Significant concentrations are present as far downstream as NAY-10. Past this point, concentrations are significantly lower and the ecological risk is significantly reduced.

Total pesticide toxicity appears relatively low, except to sensitive species. Concentrations are relatively low, and the distribution patterns indicate no particular source of contamination. However, heptachlor appears to have originated at the point of ground water discharge.

TABLE 6-48

DAILY EXPOSURE RATES FOR TERRESTRIAL BIRDS AND WATERFOWL

Exposure Due To Water Intake

Parameter	WQC (ug/L)	Highest Conc. Detected (ug/L)	Daily Exposure Song Sparrow (mg/day)	Daily Exposure Mallard (mg/day)	Daily Exposure Per BW Song Sparrow (mg/kg BW)	Daily Exposure Per BW Mallard (mg/kg BW)
Aluminum	$0.1xLC_{50}$	147	0.559	9.41	34.1	8.25
Iron	1,500	7,920	30.1	507	1,840	445
Lead	3.2	12.9	0.050	0.827	3.05	0.725
Manganese	---	10,100	38.4	646	2,340	567
Total S.V.	---	1,207	4.59	77.2	280	67.7
4,4'DDD	0.001	0.38	0.00144	0.0243	0.0878	0.0213
Dieldrin	0.0019	0.34	0.00129	0.0218	0.0787	0.0191
Hept. epox.	0.1	0.77	0.00293	0.0493	0.179	0.0432
Dioxin TE	1.0x10E-8	0.000299	1.30x10E-6	1.90x10E-5	7.93x10E-5	1.67x10E-5

Exposure Due To Food Intake

Parameter	Highest Concentration Detected (ug/kg)	Estimated Bioaccumul. Factor	Estimated Food Concentration (mg/kg)	Daily Exposure Mallard (mg/day)	Daily Exposure Per Body Weight (mg/kg BW)
Aluminum	7,130	5	35,700	2,380	2,088
Iron	100,000	2	200,000	13,300	11,700
Lead	694	5	3,470	231	203
Manganese	4,750	5	23,800	1,590	1,390
Total S.V.	117,680	1,000	117,680	7,850	6,890
Tot. Pest.	110	1,000	110	7.34	6.44
Dioxin TE	0.118	2,000	0.118	0.00787	0.00690

TABLE 6-48 cont'd

DAILY EXPOSURE RATES FOR TERRESTRIAL BIRDS AND WATERFOWL

Total Daily Exposure

Parameter	Total Daily Exposure Song Sparrow Per Body Weight (mg/kg BW)	Total Daily Exposure Mallard Per Body Weight (mg/kg BW)	Location of Highest Concentration
Aluminum	34.1	2,100	NAY-SED-05
Iron	1,840	12,100	NAY-SED-05
Lead	3.05	204	NAY-SED-06
Manganese	2,340	1,960	NAY-SED-04
Total S.V.	280	6,960	NAY-SED-06
Total Pesticides	0.346	6.48	NAY-SED-01
Dioxin TE	7.93x10E-5	6.92x10E-3	NAY-SED-03

Calculation Values:

Average Weight of a Song Sparrow = 0.0164 kg
Average Weight of a Mallard = 1.14 kg
Daily Water Requirement for the Song Sparrow = 0.0038 L/day
Daily Water Requirement for the Mallard = 0.064 L/day
Average Free-Living Metabolic Rate for the Mallard = 223 kcal/day
Average Metabolized Energy Efficiency In the Food of Omnivorous Birds = 3.35 kcal/g
Average Daily Rate of Food Consumption for a Female Mallard = 0.0667 kg/day (Dry Weight)

Dioxin TE is found throughout the sediments in the upper reaches of Naylors Run. The highest concentration is found at the ground water discharge (NAY-03), which appears to be the only location where sensitive organisms may be at risk.

6.2.4.2 Aquatic Assessment

Benthic macroinvertebrate sampling and stream habitat assessments were performed within Naylors Run and at its confluence with Cobbs Creek. This data was the basis for the assessment of the aquatic community within Naylors Run and Cobbs Creek.

Reference Station Assessment

As previously discussed in (Section 4.4 Ecological Results) the reference station is representative of unimpacted streams in the vicinity of the Havertown PCP Site. Cobbs Creek has a habitat that is supportive of an aquatic community, but the banks are subject to erosion and scouring due to heavy loading from surface street run-off. CPOM was present in low amounts. FPOM was nearly absent in most of the stream.

The aquatic community consisted of a very tolerant community. A high family biotic index, high contribution of a dominant family, low EPT numbers, and low shredder populations were observed. Despite these poor metrics, the observed community is thought to be typical of the area. Surface run-off may contain low levels of contaminants, such as semi-volatiles, which are typical in urban streams. The chemical results support this assumption. The aquatic community compared very closely with that reported by Coyne and Sheaffer (1975).

Naylors Run Assessment

The majority of the habitat found in Naylors Run was comparable to the reference station. The only noticeable differences were the lower volumes of water and the extreme channelization found in approximately 60% of the run. Naylors Run also appears to be serving as a conduit for a significant volume of urban run-off. Without the urban run-off, the average flow would presumably be much lower.

The benthic community ranges from moderately impaired at the lower reaches of the run, to severely impaired further upstream. Much of the impairment is due to the continual exposure to low levels of contaminants from urban run-off.

Taxa richness is half of that found in the reference station. Despite the low diversity, Naylors Run shows improvement compared to a past study performed by Coyne and Sheaffer (1975). Coyne and Sheaffer reported no aquatic life within the run. An *in situ* bioassay performed by Coyne and Sheaffer (1975) placed snails (*Physa* sp.) at various locations in Naylors Run, all of which were dead within twenty-four hours at all stations. The present investigation observed organisms in the same genus present at each sample station along with other organisms.

EPT, scraper, and shredder numbers were low to non-existent within Naylors Run. The community loss index values did not reflect the absence of these groups, indicating populations of the more tolerant species similar to the reference station.

Exposure Assessment

The concentrations of the inorganic contaminants found within Naylors Run were compared against toxicological data from the literature. Aluminum, iron, lead and manganese appear to be at levels potentially toxic to aquatic life. The highest concentrations were found between the catch basin and Eagle Road. Metals were not sampled in the lower reaches of Naylors Run, although an iron flocculent was observed on the cobble at NAY-08. A white flocculent was observed in the same vicinity on the detritus. It was not determined whether the white flocculent was organic or inorganic in nature. Little decomposition of the leafy matter was present at this station, therefore, the flocculent was not likely to be of a microbial nature.

Elevated concentrations of semi-volatile compounds were detected in both the surface water and sediments of Naylors Run. The concentrations in the surface water rapidly decreased with distance downstream from the Havertown PCP Site. The sediment concentrations were at significant levels throughout most of Naylors Run, with the greatest concentrations occurring at NAY-06, followed by NAY-03. Between these two locations, there is flow only during storm events. Because of this, a large aquatic community would not be expected. The third highest concentrations of semi-volatiles are found at NAY-10, with values which were approximately two thirds the concentration found at NAY-06. Despite the high concentrations, a surprisingly high population of black-nose dace was present and the benthic community appears only moderately stressed compared to the reference station. This community appears to be somewhat tolerant to the elevated levels of semi-volatiles.

The pesticides detected in the headwaters of Naylors Run were sparsely distributed and in relatively low concentrations. Although the concentrations are low, it is likely that the pesticides are a minor contributor to the overall toxicity of Naylors Run.

Dioxins were found in Naylors Run at low concentrations. Invertebrates, when compared to fish, are relatively resistant to dioxin toxicity. Due to the overall toxic potential of dioxins, it can not be eliminated as a minor contributor to the overall toxicity in Naylors Run.

Exposure Summary

To summarize the exposure assessment of Naylors Run, the contaminants within the Run are significantly impairing the aquatic community, although the impairment is less than historically reported. The sediment is by far the major route of exposure. Semi-volatiles, as a whole, are the contaminants of greatest concern based on sheer concentrations. Minor contributors include a number of pesticides, aluminum, iron, lead, manganese, and dioxin.

Terrestrial birds and waterfowl may have significant exposure to contaminants. It should be noted, however, that the exposure estimates represent the worst case scenario. Actual exposures would most likely be significantly lower.

6.2.5 Assessment of Risk

The assessment of risk considers contaminant location, toxicity, receptors and exposure potential, and formulates the best estimate of ecological risk based on information and experience. By combining these factors, a subjective risk estimation can be made. By applying the theoretical risks to actual conditions, a realistic risk assessment can be formed.

6.2.5.1 Threatened and Endangered Species

There were no Federal or State threatened, endangered, or species of special concern observed within the Naylors Run portion of the Havertown PCP Site study area. This does not rule out the possibility that they may exist on the site, but since no listed species are suspected to be on the site, these species will not be directly addressed in the risk assessment.

6.2.5.2 Terrestrial and Wetland Assessment of Risk

There was no observed site-related stress to terrestrial vegetation in the study area. The vegetation along Naylors Run, however, has been conspicuously influenced by urbanization. Any site-related stress to vegetation would be subtle and difficult to evaluate.

Potential toxicants to terrestrial and wetland wildlife were determined to be a complex mixture of semi-volatiles, heavy metals, pesticides and dioxin. Modeling has indicated the potential for toxicity to occur in terrestrial birds by route of surface water ingestion. The potential for absorption of toxicants from the surface water through the skin could not be modeled due to the lack of necessary information. The area of risk to terrestrial birds would be limited to the stretch of Naylors Run from Eagle Road to the vacinity of sample station NAY-02, after which Naylors Run is channelized. Much of this stretch only has running water during storm events and standing water following storm events. Actual toxicity would be difficult to determine since the home ranges of birds are much larger than the area around Naylors Run.

Potential exposure of waterfowl to site contaminants was modeled. The model indicated that the potential exists for toxicity by ingesting contaminated water and food from Naylors Run. Toxicity by the absorption of toxicants through the skin or direct ingestion of sediments were identified as possible routes, but they could not be modeled due to the lack of necessary information. Again, the greatest risk would occur in the headwaters near the Havertown PCP Site, but this area is poor habitat for waterfowl. Mallards were observed at the confluence of Naylors Run and Cobbs Creek. This area is not identified as a high risk due to the reduced concentrations of contaminants. Risk to waterfowl is also reduced because their diet is not necessarily restricted to aquatic foods. The modeling assumed the worst case scenario in which all dietary needs came from the location with the highest contaminant concentrations. By taking all these factors into consideration, it can be concluded that the potential for minor chronic toxicity could exist to waterfowl.

6.2.5.3 Aquatic Assessment of Risk

After reviewing data obtained from chemical sampling, benthic macroinvertebrate collection, and the stream habitat evaluation, Naylors Run has an impaired aquatic community. Impairment is greater closer to the PCP Site. No single factor is responsible for the impairment, but rather the cause appears to be cumulative.

Semi-volatile compounds appear to be the most important contaminants, but aluminum, iron, lead, manganese, pesticides, and dioxin are also contributors to the overall impairment. Semi-volatiles have been detected at levels of significant concern as far downstream as about 1.7 miles from the confluence of Naylors Run and Cobbs Creek. Although the levels at this location remain elevated, the aquatic community shows definite signs of improvement. Cobbs Creek below the confluence shows signs of impairment as compared to the reference station located above the confluence. From this, it must be concluded that Naylors Run still impacts Cobbs Creek to some degree. However, this does not necessarily identify the Havertown PCP site as the source of the contamination. This contamination may be from the historic contamination of the sediment of Naylors Run.

Previous investigations reported Naylors Run as having a deficient aquatic community and having high levels of contaminants. It appears that the conditions within Naylors Run have improved, however, the aquatic community in Naylors Run still appears to be stressed. Cobbs Creek below the confluence with Naylors Run also shows signs of improvement.

6.2.5.4 Reference Station Evaluation

The reference station was assessed as representative of the natural stream conditions of the area. The aquatic community consisted of a relatively tolerant community. This can be attributed to the "fair" habitat offered by this section of Cobbs Creek, and low levels of contaminants that probably result from urban run-off. A number of semi-volatiles typical of automobile emissions and oils were detected at low levels in the sediment at the reference station. Severe erosion and signs of scouring similar to those at Naylors Run, but to a lesser degree, were observed at the reference site.

6.2.5.5 Source of Ecological Risk

There is a significant body of documentation that identifies the Havertown PCP Site as a historical source of contamination of Naylors Run. It is not clear as to the extent of risk that the Havertown PCP site still presents to Naylors Run. PCP appears not to be the single major factor, rather total semi-volatiles appear to be most important, with heavy metals and dioxin also contributing. Historically, ground water discharge was thought to be the major source of contamination in Naylors Run. This source has been partially addressed by the construction of the oil/separator.

Chemical data suggest that the present source of much of the contamination may be surface runoff from the Havertown PCP Site and the surrounding properties. The semi-volatiles and metals found in the sediments, especially NAY-SED-06, qualitatively compare well with those found in the on-site soil samples taken during the R.E. Wright Inc. RI (1988). Out of the twenty-seven (27) compounds found in the soils on the NWP property at sample location S-6 and S-8, twenty-three (23) of the compounds are found in the sediments at NAY-SED-06. Contaminants could potentially migrate via storm sewers and road sides towards Naylors Run near NAY-SED-06 and NAY-SED-04, however, NAY-SED-04 may have also been exposed to past ground water discharge near the former catch basin. Only six (6) compounds found at NAY-SED-06 were not found in the two soil samples from NWP (acenaphthene, bis(2-chloroethyl)ether, dibenzofuran, 1,2-dichlorobenzene, endrin, and endosulfan sulfate).

Acenaphthene is commonly found in coal tar and oils. Dibenzofuran is commonly found in gas exhaust. Isomers of dichlorobenzene is found in metal polishes and solvents, as well as, pesticides. Endrin and endosulfan sulfate are pesticides. Many if not all of these contaminants could be found in urban run-off. Lead is also a common contaminant found near roadways. Additionally, NAY-SED-06 is in close proximity to an abandoned gas station. The gas station may be a potential source of many of the contaminants found at NAY-SED-06.

Cobbs Creek is expected to receive qualitatively similar urban run-off from road surfaces to that received by Naylors Run. Assuming that compounds found in Cobbs Creek are primarily urban run-off related, the Cobbs Creek sediment data above the Naylors Run confluence could be used qualitatively to identify potential non-site related semi-volatile compounds. Table 6-49 compares soil and sediment data found on-site at NWP, at Naylors Run and Cobbs Creek. During storm events, Naylors Run acts as a conduit for urban run-off. Significant concentrations of chemicals could potentially be introduced into Naylors Run in this fashion. Such contaminants would be related to oils and salts found on road surfaces, as well as, domestic pesticides used for residential weed and pest control.

In summary, there are three potential sources that may be contributing to the contamination in Naylors Run; surface soils from NWP, run-off from a previous gas station, and urban run-off from roadways and fields. There is not enough data to definitively identify these as present or historic sources. The correlation between the surface soil from NWP and the sediments in Naylors Run warrant further investigation.

TABLE 6-49
ON-SITE AND OFF-SITE COMPARISON OF SOILS AND SEDIMENTS

COMPOUNDS	NWP (Wright,	SOILS 1988)	NAYLORS (Tetra Tech	RUN 1990)	COBBS CREEK (Tetra Tech 1990)
	S-6 Surface Sample (ug/kg)	S-6 Depth 17" (ug/kg)	NAY-SED-04 (ug/kg)	NAY-SED-06 (ug/kg)	COBB-SED-02 (ug/kg)
ARSENIC	280	426	1.6 B	21.5	ND
CHROMIUM	240	506	426	562	ND
COPPER	107	203	9.7 B	139	ND
LEAD	26	69	12	804	ND
ZINC	627	1,650	95.5	243	ND
IRON	10,900	13,000	29,600	56,500	ND
ALUMINUM	5,430	8,430	6,110	6,320	ND
MANGANESE	440	415	4,750	6,600	ND
ACENAPHTHENE	BQL	BQL	BQL	1,300	BQL
ANTHRACENE	BQL	BQL	150 J	2,300	36 J
BENZO(A)ANTHRACENE	BQL	8,200	510 J	7,500	170 J
BENZO(A)PYRENE	120 J	5,000	620 J	7,000	160 J
BENZO(B)FLUORANTHENE	330 J	19,000	670 J	11,000	140 J
BENZO(G,H,I)PERYLENE	BQL	2,300	BQL	5,100	BQL
BENZO(K)FLUORANTHENE	330 J	19,000	710 J	10,000	160 J
BIS(2-CHLOROETHYL) ETHER	BQL	BQL	910	960	BQL
BIS(2ETHYLHEXYL) PHTHALATE	280 J	7,200	360 J	1,900	BQL
BUTYLBENZYLPHTHALATE	120 J	730	BQL	BQL	BQL
CHRYSENE	130 J	8,900	880 J	11,000	190 J
DIBENZ(A,H)ANTHRACENE	BQL	1,200	BQL	1,400	BQL
DIBENZOFURAN	BQL	BQL	BQL	900	BQL
1,2-DICHLOROBENZENE	BQL	BQL	780	2,700	BQL
1,4-DICHLOROBENZENE	BQL	BQL	780	BQL	BQL
FLUORENE	BQL	BQL	BQL	1,600	BQL
FLUORANTHENE	150 J	30,000	1,400	21,000	330 J
INDENO(1,2,3-CD) PYRENE	BQL	2,500	BQL	1,600	BQL
NAPHTHALENE	BQL	1,400	BQL	BQL	BQL
PHENANTHRENE	46 J	21,000	1,100	20,000	210 J
PYRENE	140 J	35,000	1,300	14,000	370 J
2-METHYLNAPHTHALENE	BQL	3,600	BQL	BQL	BQL
PCP	1,000	160,000	530 J	3,000	BQL
DI-N-OCTYLPHTHALATE	140 J	BQL	BQL	BQL	BQL
DI-N-BUTYLPHTHALATE	BQL	BQL	BQL	BQL	31 J
ENDRIN	BQL	BQL	BQL	43	ND
ENDOSULFAN SULFATE	BQL	BQL	51	48	ND
CHLORDANE	BQL	1,000	BQL	BQL	ND
TE FOR 2,3,7,8-TCDD (ppt)	3.238 (1'DEPTH)	23.345 (0'DEPTH)	117	3	ND

BQL - Below Quantitation Limits J - Value May Be Inaccurate ND - No Data
BOLD- Potentially Originating From Urban Run-Off B - Not Detected Substantially Above Level in Blank

▨ Potentially Originating From NWP Soils

6.2.5.6 Conclusion

Naylors Run shows signs of impairment, but there is evidence of improvement from historical conditions. If point sources are eliminated, Naylors Run could further improve, but due to channelization, severe flushing during storm events, and urban run-off, Naylors Run is not expected to become a high quality aquatic community. This conclusion is supported by the results of the benthic collection at the reference station, where impacts due to the Havertown PCP site are not present. It should also be noted that despite the improvement of Naylors Run, a stress aquatic community is still evident in Naylors Run. More information regarding the source(s) of contamination is needed to further characterize the ecological risk associated with Naylors Run.

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