EBS Ecological Evaluation Letter Report
January 2000

1. Environmental Ecological Risk Assessment Guidance:

The current EPA guidance clearly shows eight distinct steps which, in an iterative and logical path set out to solve the standard risk paradigm of exposure x toxicity = risk. That is to say that if the contaminant is toxic to the receptor (toxicity) and the contaminant is exposed to the receptor (exposure), there is potential risk. Once potential risk is determined, the degree and acceptability of that risk becomes the question solved during the ERA.

Steps 1 and 2 (Tier 1 from Navy Guidance) a considered a "screening level" risk assessment. The assessment begins with generic and conservative assessment and measurement endpoints. The purpose of steps 1 and 2 is to quickly review the conditions at the site. The output of step one is either to discontinue the investigation because conditions are acceptable, to show that the conditions are unacceptable requiring further investigation and or an early removal action, and to begin to document the chemicals suspected of causing stress. The process begins with Step 1 which seeks to document the exposure variable. Step 2 begins the documentation of risk. If step 1 shows exposure, step 2 conservatively estimates toxicity and begins characterizing risk.

Step 3 is the Baseline risk assessment (the beginning of tier 2 from the Navy guidance). Step 3-8 repeats the process in a site-specific manner using more information gathered from the site and the literature. Step 3 begins with refining exposure and toxicity information, and measurement and assessment endpoints, as well as the site conceptual model. This is the baseline problem formulation. Steps 4-7 are the workplan development, implementation, interpretation and characterization. Step 8 is the risk management phase that considers the entirety of the data and begins to make decisions on actions required. At Step 8, the site is reviewed while considering human health, fate and transport and ecological risk. The decisions regarding specific actions will be made using information gathered from the risk assessment.

2. General purpose :

This letter report is designed to address the potential impacts of several EBS areas on ecological receptors in the area. This letter report will consider site history, analytes detected/remaining, area size and the spatial distribution of sites with similar analytes. Additional information and detail regarding these sites and sampling results can be gathered from Environmental Baseline Survey Task 2 Analytical Report, Naval Training Center-Bainbridge, October 1999 and other various contractor closeout reports.

3. General Setting and Receptors:

Two soil types exist: Piedmont and coastal plain. The western portion of the NTC, closest to the Susquehanna River is a Glenville association. This is described as loamy soil derived from micaceous rock, with a gentle slope. The other area is characterized as gravelly loamy sand to clay, moderately well drained.

Surface water (streams and a lake) are used primarily for non drinking water purposes. The Susquehanna River is used for industrial, recreational and drinking water purposes. Much of the natural site vegetation outside of the stream valleys has been disturbed during construction, use and maintenance of the Naval training center. Due to the lack of maintenance in recent years much of the site has become overgrown with primary and secondary successional plant species. Building grounds, parking lots, upland fields and other similar areas have become overtaken by plant species including flowering dogwood, American chestnut, black cherry, staghorn sumac, Virginia pine, black locust, multiflora rose, poison ivy and various species of vines and grasses. Mature deciduous trees are found along the base boundary and in the undeveloped valleys throughout the NTC. These areas are characterized by the presence of American beech, red maple, tulip poplar, various hickories and oaks, and black cherry.

Small federally protected wetlands, none of which are associated with any of the following AOCs at Bainbridge were identified in a preliminary assessment. The identification was based on a 2-day field check and indications of wetlands from aerial photographs of the site, the National Wetland Inventory, and hydric soils for the Cecil County Soil Survey. It was determined that all wetlands at Bainbridge are associated with streams and are classified as forested, broad leafed deciduous, temporarily inundated or saturated wetlands. These wetlands are dominated by the presence of red maple, sugar maple, box elder, various alder and willow species, American Beech, sycamore, spicebush and river birch. A stand of white pine is along a portion of the drainage in the south east corner of the NTC. Cattails, various smartweed, sedge and grass species, and touch-me-nots dominate some wetland areas. Specimen trees on the NTC include sycamores, American holly and white, southern red pine and willow oaks.

Most of the wildlife species encountered on the NTC are commonly associated with habitats dominated by succession vegetation, such as deer, woodchuck, mice and rats, vultures, crows, starlings, blue jays, cardinals, and various other species of small birds. A single blue heron was observed in 1992. Signs indicating the presence of raccoon, fox and possibly bobcat were noted in the mature forested wetland areas. Various amphibians and reptiles including several species of salamanders, frogs, snakes and a box turtle were also observed.

The Maryland department of Natural Resources records no species in need of conservation nor any threatened nor endangered species from either state or federal lists on the Bainbridge facility.

Several trophic levels may exist in the area of Bainbridge beginning with primary producers that build the foundation of the food web. Potential trophic levels found may include 1) primary producers, 2) herbivorous invertebrates, birds and mammals, 3) carnivorous mammals 4) omnivorous birds and mammals and 5) scavengers.

4. Fate and Transport:

Fate and Transport data are necessary to formulate ecological site conceptual models and are a function of the physical and chemical properties of the COPECs. Physical and chemical properties of the COPECs govern the chemical and biological transformation processes, bioaccumulation potential and transport properties within the media in which the chemicals are founds.

When most of the analytes are located in surface and sub surface soils the physical properties of soils are relevant to the transport of the analytes. Important characteristics and properties include soil composition, and pH, soil permeability, surface topography, depth to groundwater, and groundwater flow direction/velocity. The soil characteristics along with the physical and chemical properties of the COPECs govern persistence in the environment.

Groundwater is generally found below 30 feet. In areas where COPCs are below 30ft bgs, groundwater maybe considered at transport route. Additionally, where the topography is relatively flat and there are no nearby streams or wetlands, surface runoff is not considered a primary transport route. Often, the primary route of exposure to ecological receptors at the Bainbridge sites are direct ingestion and contact with soils as well as the potential bioaccumulation of COPCs.

5. Assessment Endpoints

Protection of 1) primary producers, 2) herbivorous invertebrates, birds and mammals, 3) carnivorous mammals 4) omnivorous birds and mammals and 5) scavengers from direct and bioaccumulative exposure to chemicals in the rocky disturbed soils is an appropriate assessment endpoint at this area. Also, maintenance of these populations from the reproductive, growth and survival effects such that the community structure at this site is similar to other habitats is appropriate.

A. Transformer Storage Area

Site Information: The former transformer storage yard (roughly .25 acres) was identified due to the historical evidence of transformer storage near buildings 713 and 714. Within the local vicinity (within 2 miles) other various buildings in the vicinity and a borrow pit exist. Interviews with past employees indicated that transformers had been staged in the area. A site visit revealed the presence of concrete foundations and a gravel/soil mixture in the former locations of buildings 713 and 714. There was no visual evidence of transformer spills. During the site visit a 55 gallon drum, potentially containing creosote (EBS Task 1, 2-96) was found. The drum was in rusty condition, though no visible sign of a release was apparent. The employee interviews raised concerns regarding the presence of human exposure to PCB contamination. Additional sampling occurred in March of 1997. One of three samples detected PCBs at 0.3 ppm. This sample, 4-SS-2, was located near the concrete pad at the site.

Conclusion: A population exposure, due to the small size of this site is expected to be minimal. Any exposure to individuals at this sparsely vegetated, rocky habitat is also expected to be minimal. Based on the relatively low level of analytes detected and the minimal exposure to assessment endpoints, additional investigations, or cleanup actions are not recommended.

B. Coal Storage Area- AOC 2b

Site Information: When the facility was active, coal storage operations occurred at this area. The long-term presence of coal in the area prompted further review of the area. A streamlined human health assessment was performed following the March 1997 and July 1998 sampling events. This area was identified as an AOC due to the potential presence of elevated metals and /or polycyclic aromatic hydrocarbon (PAH) concentrations in surrounding soil.

A removal action for human health exposure was determined not to be necessary, based on low concentrations of analytes.

Conclusions: Exposure for all identified assessment endpoints is likely to be minimal. Any exposure that occurs on this rocky, sparsely vegetated site is likely to be on the individual level and not likely to effect the population or the community level. Based on the relatively low detections of analytes and the minimal exposure additional investigations and/or cleanup for this AOC are not necessary.

C. Water Towers (689 and 1054)

Site Information: Due to standard operations and maintenance of the water towers (painted with lead based paint) potential concerns for elevated lead in soils surrounding these structures exists. Both structures have been demolished.

The water tower area covers less than 0.25 acres each. The towers have been removed.

Conclusions: Exposure for all identified assessment endpoints is likely to be minimal. Any exposure that may occur on this habitat site is likely to be on the individual level and not likely to effect the population or the community level. The surrounding area of the water towers is not considered optimal habitat for the assessment endpoints due to the industrial nature of the areas. Based on the minimal exposure additional investigations and/or cleanup for this AOC are not necessary.

D. Administrative Building (Building 720)

Due standard operations and maintenance of structures constructed prior to 1974 (painted with lead based paint) potential concerns for elevated lead in soils surrounding this structure existed. The structure has been demolished.

The Building 720 area is approximately .16 acres. Future use of the area has not been determined. The current conditions are early successional species and herbaceous vegetation. Several roads are nearby as well as above ground utilities. Lead has not been detected in soils above 400 ppm.

Conclusions: Exposure for all identified assessment endpoints is likely to be minimal. Any exposure that may occur on this habitat site is likely to be on the individual level and not likely to effect the population or the community level. The surrounding area is not considered optimal habitat for the assessment endpoints at this site. Based on the lack/minimal exposure additional investigations and/or cleanup for this AOC are not necessary.

E. Substation Switch Yard- Building 628

The primary feature of this area was open switch yard where coarse stone (nominal 4-inch diameter) had been placed over the native soil to provide a work surface. Other features included one small building, concrete transformer pads, and two small clusters of trees, shrubs, and undergrowth. The site is less than 0.4 acres. The primary concern was a possible release of PCBs from transformers which had already been removed. Based on concerns regarding PCBs, twenty one cubic yards of soil were excavated along the northwest side of building 628. Following the December 1997 excavation, confirmation sampling indicated that the remaining soils had PCB concentrations below the 10 ppm action level established for the project. above 50 ppm. The area was graded to drain, then seeded and mulched. In November 1999, a review of residual human health risk by EPA caused a further cleanup at the site, in which the remaining soil concentrations of the PCB Aroclor 1254 were reduced to less that 2 ppm.

Conclusion: This sight is not in the immediate proximity of other similar sites, is small and has had the contaminated soils removed. Based on the size and type of habitat, relatively low contaminant concentrations, the reduced/lack of exposure of the original COPCs to the assessment endpoints, exposure to populations is expected to be minimal. Individuals may utilize the site. However, since surface soils containing PCBs have been removed, exposure to PCBs at the site is expected to be minimal. No further investigations or cleanup is recommended at the area.

F. Auto Hobby Shop- Building 760

This was a small (less than .2 acres) area, with pavement and soils areas. Building 760 is characterized as light industrial. Forested areas and roads are nearby. Due to the detection of petroleum products, approximately 70 yd^3 of petroleum impacted soil were excavated near Building 760. The source was from a discharge line which drained two automobile oil change pits. Visually observed stained soil and associated soil was removed. All remaining soils met the MDE cleanup criteria of 100 ppm TPH.

Conclusion: The source of the petroleum has been removed and the originating practices have ceased. Further, ground water does not appear to be impacted. Due to the size of the site, nature of the immediate surrounding area and the fact that the contaminated soils have been removed indicates that direct exposure to receptors will be minimal. Because groundwater does not appear to be impacted, downgradient receptors appear not to be impacted. Based on the minimal exposure and relatively low detections of contaminants, additional investigations and or cleanup for this area are not recommended.

G. Former Dry Cleaning Facility AOC 6

This facility was located in Building 718. USTs that stored dry cleaning solvents were located in the vicinity of the building. The tanks were removed and groundwater had been monitored. Though one COPC was detected in groundwater during the March 1997 sampling event. (1,2 –dibromo-3-chloropropopane, at 1.0 μg/l against a screening value of .0048 μg/l), this analyte was not detected in the July 1998 sampling event. MDE has since approved termination of monitoring at this site.

The building is in an industrial setting, with pavement nearby. The site is less than .25 acres. Due to the light industrial nature of the site and because the groundwater and surface soils are not impacted by contaminants, an exposure pathway to either downgradient receptors or receptors at the site is not present.

Conclusion: Any exposure to individuals to this light industrial habitat is expected to be minimal. The lack of contaminants eliminates potential toxicity for the analytes tested. Further, receptors are not likely to visit this location. Based on the lack of exposure, additional investigations, or cleanup actions are not recommended.

H. AOC 7 Former Gas Station

USTs containing various petroleum products were formerly located in the vicinity of Building 756 (approximately .25 acres). During the removal of the tanks, evidence of leakage from the tanks was observed. Groundwater monitoring wells were installed. Sampling was performed to detect the presence of TPH and BTEX. The concentration of analytes has been decreasing over time. In 1999, MDE approved the termination of groundwater monitoring at this site.

The site is in a forested area with a nearby road. The analytes detected in groundwater were not observed in surface soils. There are no nearby streams. The analytes detected volatilize and are somewhat insoluble.

Conclusions: Analytes detected in groundwater and concentrations decreasing with time decreases the probability that populations or even individuals visiting the small site will be exposed. Further, no downgradient receptor is evident. Therefore, due to the minimal direct or downgradient exposure, additional investigation or cleanup actions for ecological receptors is not recommended

I. Officer Housing

Concern for elevated lead concentrations in soil surrounding existing structures as a result of weathering of the exterior painted surfaces caused the Officer Housing area to be assessed. One building was chosen, pursuant to discussion between EPA, and the Navy. The 10 sampling locations were chosen along the dripline and drain spouts within the footprint of the building. Paint chip samples were also taken. The resulting lead concentrations ranged from 26,800 mg/kg and 97,200 mg/kg. A summary of the samples from the Housing area can be located in the Environmental Baseline Survey, Table 3-3. The area surrounding the housing includes the Tome School, several roads and a small cluster of trees and shrubs along the fenceline. The size of the site is less than .2 acres. This areas landscaping has been managed/mowed by members of the community and it is reasonable to anticipate this action will continue.

Conclusions: Exposure for all identified assessment endpoints is likely to be minimal due to the small size of the site and the residentially landscaped habitat. Further, the deed for this property indicates that "the GRANTEE covenants and agrees that lead-based paint hazards in the target housing constructed prior to 1960 will be abated in accordance with Title X before use and occupancy as a residential dwelling. Considering the poor structural condition of most of the units, a lead abatement effort would essentially become a major renovation for each unit. " Any exposure that occurs on this sparsely vegetated site is likely to be on the individual level and not likely to effect the population or the community level. Based on the minimal exposure and reasonably anticipated future actions additional investigations and/or cleanup for this AOC are not

Conclusions and Recommendations: Exposure for all identified assessment endpoints is likely to be minimal. Any exposure that occurs on this rocky, sparsely vegetated site is likely to be on the individual level and not likely to effect the population or the community level. In addition, the removal of contaminated soils further reduces the exposure to individuals using this habitat. Based on the lack/minimal exposure additional investigations and/or cleanup for this AOC are not necessary.

Ecological Screening of the Open Salvage/Storage Yard (AOC 2a)
Bainbridge Naval Training Center
Port Deposit, Maryland
January 2000

Environmental Ecological Risk Assessment Guidance:

The current EPA guidance clearly shows eight distinct steps which, in an iterative and logical path, set out to solve the standard risk paradigm of exposure x toxicity = risk. That is to say that if the contaminant is toxic to the receptor (toxicity) and the contaminant is exposed to the receptor (exposure), there is potential risk. Once potential risk is determined, the degree and acceptability of that risk is of the questions to solve during the ERA.

Steps 1 and 2 (Tier 1 from Navy Guidance) a considered a "screening level" risk assessment. The assessment begins with generic and conservative assessment and measurement endpoints. The purpose of steps 1 and 2 is to quickly review the conditions of the site to either discontinue consideration because conditions are acceptable, to show that the conditions are unacceptable requiring further investigation and or an early removal action, and to begin to document the chemicals suspected of causing stress.

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Step 3 is the Baseline risk assessment (the beginning of tier 2 from the Navy guidance). Step 3-8 repeats the process in a site-specific manner using more information gathered from the site and the literature. Step 3 begins with refining exposure and toxicity information, and measurement and assessment endpoints, as well as the site conceptual model. This is the baseline problem formulation. Steps 4-7 are the workplan development, implementation, interpretation and characterization. Step 8 is the risk management phase that considers the entirety of the data and begins to make decisions on actions required. At step 8, the site is reviewed while considering human health, fate and transport and ecological risk. The decisions regarding specific actions will be made using information gathered from the risk assessment.

Site History and Setting:

AOC 2a (the salvage yard/storage area) is approximately .27 acre rectangle. The immediate habitat is rocky disturbed brush areas. Low shrubs and grasses vegetation grow in this area. As with other locations in Bainbridge, there are deciduous trees within a local vicinity of the site.

AOC 2 consists of two discreet locations, the Open Salvage/Storage yard (AOC 2a) and the Coal Storage Areas (AOC 2b which is discussed elsewhere). Coal ash/cinders were used as paving material in the open salvage storage yard where scrap metal was stored. This area was identified as an AOC due to the potential presence of elevated metals and /or polycyclic aromatic hydrocarbon (PAH) concentrations in surrounding soil.

A removal action for human health exposure is complete. Table 1 is the list of chemicals of concern and the cleanup levels, and analytical methods for each COC.

Table 1

Chemical	HHRA Cleanup Criteria (mg/kg)	Analytical method (SW 846)
Total Antimony	27	6010
Total Lead	400	6010
Benzo(a)pyrene	2.0	6010

Sample locations 2-SS-4, 6, 7, 14 and 15 have been removed from the site.

The above cleanup criteria have been achieved at the site. Details of the confirmation study are provided in the site closeout report (OHM, 1999. "Site Clean Up and Removal Action, Volume 3, AOC 2: Salvage Yard Bins and Ash Pile").

Potential receptors:

For NTC as a whole, much of the natural vegetation outside of the stream valleys has been disturbed during construction, use and maintenance of the Naval training center. Due to the lack of maintenance in recent years much of the facility has become overgrown with primary and secondary successional plant species. Building grounds, parking lots, upland fields and other similar areas have become overtaken by plant species including American chestnut, black cherry, staghorn sumac, Virginia pine, black locust, multiflora rose, poison ivy and various species of vines and grasses. Mature deciduous trees are found along the installation. These areas are characterized by the presence of American beech, red maple, tulip poplar, various hickories and oaks, and black cherry.

Most of the wildlife species encountered on the base are commonly associated with habitats dominated by succession vegetation, such as deer, woodchuck, mice and rats, vultures, crows, starlings, cardinals, and various other species of small birds. Signs indicating the presence of raccoon, fox and possibly bobcat were noted in the mature forested wetland areas. Various amphibians and reptiles including several species of salamanders, frogs, snakes and a box turtle were also observed.

The Maryland department of Natural Resources records no species in need of conservation nor any threatened nor endangered species from either state or federal lists on the Bainbridge facility.

Several trophic levels may exist in the area of Bainbridge beginning with primary producers that build the foundation of the food web. Potential trophic levels found may include 1) primary producers, 2) herbivorous invertebrates, birds and mammals, 3) carnivorous mammals 4) omnivorous birds and mammals and 5) scavengers. Despite the potential receptors on the installation as a whole, the quality of the habitat in the immediate vicinity of AOC 2 makes use of this location limited. Although these receptors are typically found on Bainbridge, the small area with marginal habitat foraging area for the identified assessment endpoints make it unlikely to support a population found at Bainbridge. However, it should be noted that at any given time individuals from any of the described trophic levels may be found in the study area.

Fate and Transport:

Fate and Transport data are necessary to formulate ecological site conceptual models and are a function of the physical and chemical properties of the COPECs. Physical and chemical properties of the COPECs govern the chemical and biological transformation processes, bioaccumulation potential and transport properties within the media in which chemicals are found.

All of the COPECs at AOC 2 were located in surface and sub surface soils. Therefore, physical properties of soils are relevant to the transport of COPECs. Important characteristics and properties include soil composition, soil permeability, and surface topography, depth to groundwater, and groundwater flow direction and velocity. The soil characteristics along with the physical and chemical properties of the COPECs govern persistence in the environment.

Groundwater is found below 10 feet, while the primary COPCs are detected at surface to 24 inches. Therefore, groundwater is not considered a primary pathway. Further, the topography is relatively flat. Surface water runoff or soil transport is not anticipated because there are no nearby streams or wetlands. The primary route of exposure is considered direct ingestion and contact with soils and potentially the bioaccumulation of the COPCs.

Assessment Endpoints

Protection of 1) primary producers, 2) herbivorous invertebrates, birds and mammals, 3) carnivorous mammals 4) omnivorous birds and mammals and 5) scavengers from direct and bioaccumulative exposure to chemicals in the rocky disturbed soils is an appropriate assessment endpoint at this area. Also, maintenance of these populations from the reproductive, growth and survival effects such that the community structure at this site is similar to other habitats is appropriate.

Conclusions and Recommendations: Exposure for all identified assessment endpoints is likely to be minimal. Any exposure that occurs on this rocky, sparsely vegetated site is likely to be on the individual level and not likely to effect the population or the community level. In addition, the removal of soils exceeding the human health cleanup criteria further reduces the exposure to individuals using this habitat. Based on the reduced levels of analyts detected and the lack/minimal exposure additional investigations and/or cleanup for this AOC are not necessary.

Ecological Screening of the Pesticide Shop (AOC 3)
Bainbridge Naval Training Center
Port Deposit, Maryland
January 2000

Environmental Ecological Risk Assessment Guidance:

The current EPA guidance clearly shows eight distinct steps which, in an iterative and logical path, set out to solve the standard risk paradigm of exposure x toxicity = risk. That is to say that if the contaminant is toxic to the receptor (toxicity) and the contaminant is exposed to the receptor (exposure), there is potential risk. Once potential risk is determined, the degree and acceptability of that risk is of the questions to solve during the ERA.

Steps 1 and 2 (Tier 1 from Navy Guidance) is considered a "screening level" risk assessment. The assessment begins with generic and conservative assessment and measurement endpoints. The purpose of steps 1 and 2 is to quickly review the conditions of the site to either discontinue consideration because conditions are acceptable, to show that the conditions are unacceptable requiring further investigation and or an early removal action, and to begin to document the chemicals suspected of causing stress.

The process begins with Step 1 which seeks to document the exposure variable. Step 2 begins the documentation of risk. If step 1 shows exposure, step 2 conservatively estimates toxicity and begins characterizing risk.

Step 3 is the Baseline risk assessment (the beginning of tier 2 from the Navy guidance). Step 3-8 repeats the process in a site specific manner using more information gathered from the site and the literature. Step 3 begins with refining exposure and toxicity information, and measurement and assessment endpoints, as well as the site conceptual model. This is the baseline problem formulation. Step 4-7 are the workplan development, implementation, interpretation and characterization. Step 8 is the risk management phase that considers the entirety of the data and begins to make decisions on actions required. At step 8, the site is reviewed while considering human health, fate and transport and ecological risk. The decisions regarding specific actions will be made using information gathered from the risk assessment.

Site History and Setting:

Several trophic levels may exist in the area of Bainbridge beginning with primary producers that build the foundation of the food web. Potential trophic levels found may include 1) primary producers, 2) herbivorous invertebrates, birds and mammals, 3) carnivorous mammals 4) omnivorous birds and mammals and 5) scavengers. Despite the potential receptors, the quality of the habitat makes use of this location limited. Although these receptors are typically found on Bainbridge, the small area with marginal habitat foraging area for the identified assessment endpoints make it unlikely to support a population found at this Bainbridge site. However, it should be noted that at any given time individuals from any of the described trophic levels may be found in the study area.

The Pesticide shop consists of .83 acres of primarily disturbed brush and shrub in a paved area. The soil underneath appears to be rocky with sparse shrubs and weeds. The disturbed area North to Northeast of Powers Road is occasionally maintained grasses and trees. Further, several hundred meters away, are more dense populations of trees and shrubs.

There is limited wildlife in the immediate vicinity of AOC 3. The wildlife in the general vicinity would aggregate in the higher quality habitat North and northeast of the AOC. Limited but direct access to the site is available via the uncultivated grass area and Powers Rd.

A removal action for human health exposures has removed soils to 24 inches which exceed the following cleanup criteria:

Assessment Endpoints

Protection of 1) primary producers, 2) herbivorous invertebrates, birds and mammals, 3) carnivorous mammals 4) omnivorous birds and mammals and 5) scavengers from direct and bioaccumulative exposure to chemicals in the rocky disturbed soils is an appropriate assessment endpoint at this area. Also, maintenance of these populations from the reproductive, growth and survival effects such that the community structure at this site is similar to other habitats is appropriate.

Conclusions and Recommendations: Exposure for all identified assessment endpoints is likely to be minimal. Any exposure that occurs on this rocky, sparsely vegetated site is likely to be on the individual level and not likely to effect the population or the community level. In addition, the removal of soils exceeding the human health cleanup criteria further reduces the exposure to individuals using this habitat. Based on the relatively low levels of analytes detected, and the lack/minimal exposure additional investigations and/or cleanup for this AOC are not necessary.

Small Arms Range, 204; Small arms range 404; Small arms range 304/building 707
Bainbridge Naval Training Center
Ecological Evaluation
January 2000

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Steps 1 and 2) is considered a "screening level" risk assessment. The assessment begins with generic and conservative assessment and measurement endpoints. The purpose of steps 1 and 2 is to quickly review the conditions of the site to either discontinue consideration because conditions are acceptable, to show that the conditions are unacceptable requiring further investigation and or an early removal action, and to begin to document the chemicals suspected of causing stress.

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Site History and Setting:

Areas 204, 304/building 707, and 404 were all standard small arms firing ranges. Small arms projectiles are 85-95% lead, with the remaining 5-15% comprised of zinc, copper and antimony. Predominately, these metals co-locate with lead during the fate and transport process. Lead projectiles were deflected by steel plates into a sand trap. As the trap became full of lead shot, the sand was pushed out the back of the open pavilion type structure. The sand was left on surface soils where the outside conditions could have transported lead to surface waters. Based on the site history and detections of lead above the soil screening value for human health, a removal action was enacted at all of the listed sites. The removal action excavated soils until the concentration in soils was below 400 ppm. The excavation took place on a grid to 6-12 inch depths. The soil screening level was achieved by 24 inches. Approximately 5,259 tons of lead impacted soils were removed for disposal in a properly permitted landfill facility. Excavations greater than 18 inch depths were backfilled with clean, sandy soils. The area was graded. All disturbed areas were seeded with a grass mixture and mulched with chopped straw.

Potential receptors:

For the NTC in general, much of the natural site vegetation outside of the stream valleys has been disturbed during construction, use and maintenance of the Naval training center. Due to the lack of maintenance in recent years much of the NTC has become overgrown with primary and secondary successional plant species. Building grounds, parking lots, upland fields and other similar areas have become overtaken by plant species including flowering dogwood, American chestnut, black cherry, staghorn sumac, Virginia pine, black locust, multiflora rose, poison ivy and various species of vines and grasses. Mature deciduous forests are found along most the NTC boundary and in the steep undeveloped valleys throughout the base. These areas are

characterized by the presence of American beech, red maple, tulip poplar, various hickories and oaks, and black cherry.

Most of the wildlife species encountered on the base are commonly associated with habitats dominated by succession vegetation, such as deer, woodchuck, mice and rats, vultures, crows, starlings, blue jays, cardinals, and various other species of small birds. Signs indicating the presence of raccoon, fox and possibly bobcat were noted in the mature forested wetland areas. Various amphibians and reptiles including several species of salamanders, frogs, snakes and a box turtle were also observed.

The Maryland department of Natural Resources records no species in need of conservation nor any threatened nor endangered species from either state or federal lists on the Bainbridge facility.

Several trophic levels may exist in the area of Bainbridge that beginning with primary producers that build the foundation of the food web. Potential trophic levels found may include 1) primary producers, 2) herbivorous invertebrates, birds and mammals, 3) carnivorous mammals 4) omnivorous birds and mammals and 5) scavengers. Although these receptors are typically found on Bainbridge, the small areas associated with the shooting ranges 204, 304, 404, and building 707 have marginal habitat foraging area for the identified assessment endpoints making it unlikely to support a population. However, it should be noted that at any given time individuals from any of the described trophic levels may be found in the study area.

Fate and Transport:

Fate and Transport data are necessary to formulate ecological site conceptual models and are a function of the physical and chemical properties of the COPECs. Physical and chemical properties of the COPECs govern the chemical and biological transformation processes, bioaccumulation potential and transport properties within the media in which chemicals are founds. Important characteristics and properties controlling the fate and transport of contaminants include soil composition, soil permeability, and surface topography, depth to groundwater, and groundwater flow direction and velocity. The soil characteristics along with the physical and chemical properties of the COPECs govern persistence in the environment.

Lead, the primary analyte at the site is predominately from the discharge of firearms, into an sand trap. As the trap became full of lead projectiles, it was pushed out the back of the building (the building consisted of a roof and beams). The lead cation sorbs strongly to humus, metal oxides and clays. It forms insoluble metal oxides and sulfides and forms soluble complexes at high pH. Inorganic lead is present in geologic materials and soils in more than 200 minerals that can vary greatly in solubility. The majority of lead in geologic materials is in the form of galena (lead sulfide), anglesite (lead sulfate) and cerussite (lead carbonate). Organic forms of lead are rare in soils. Sediment concentrations of lead in uncontaminated estuarine and nearshore marine sediments generally fall in the range of 5 to 30 $\mu g/kg$ dry wt. (Salomons and Forstner, 1984). Freshwater may contain lower concentrations. Most of this lead is associated with fine grained sediment particles. (Krumgalz et al. 1992). Residual lead (part of the mineral matrix of sediment particles) in uncontaminated sediments, which may represent up to 80 percent of the total lead is associated primarily with aluminosilicates, sulfide minerals and barite (Loring 1982). This residual lead is immobile and not bioavailable. The non residual lead in oxidized surfical sediments appears to be associated primarily with reducible iron and manganese oxide coatings on clay particles (Luoma and Bryan, 1981) as indicated by the strong positive correlation between concentrations of aluminum (from aluminosilicate clay particles) and lead in sediments (Schropp et al., 1990).

In anoxic sediments, the most stable Valence State of lead is the +2 state (Harada and Tsunogai, 1988). Divalent lead (Pb2+) reacts with inorganic sulfide in sediment to form highly insoluble lead sulfide (PbS) (Kersten and Forstner, 1986). However, in highly reducing sediments with a redox potential (Eh) less than about -.04 volts, lead may form bisulfide complexes with sulfur. These bisulfide complexes are slightly soluble and the dissolved lead may be mixed up into the water column by sediment disturbance (Shea and MacCrehan, 1988). Most of the lead in oxidized and anoxic sediments is in insoluble and non-bioavailable forms.

Marine deposit feeding clams and polychaete worms are able to bioaccumulate lead from oxidized sediments (Luoma, 1985). The bioavailability of lead to sediments associated animals is proportional to the lead iron

concentration ratio in weak acid extracts of the sediment, indicating that the lead absorbed to most of the iron oxide coatings on sediment particles is not bioavailable. In moderately hypoxic or anoxic sediments, most of the lead is precipitated as lead sulfide and is not bioavailable (Bourgoin et al 1991). Lead is biodepleted in marine food chains relative to calcium, which behaves similarly to lead in the environment (Smith et al., 1990), meaning it does not biomagnify. Inorganic lead is moderately toxic to freshwater and marine organisms.

Lead is found at these ranges in elemental form and may have been released via the movement of the sand traps onto the surface soils. The lead projectiles may fragment allowing for greater surface area within the soil matrix. However, elemental lead quickly oxides in the open environment and becomes unavailable. If lead is ingested in birds, lead may be ground in the gizzard and released into the blood system. These lead projectiles and fragments may then be transported via surface runoff to local streams. However, the fragments remain with an oxidized coating and thereby not bioavailable in the aquatic environment. If the environment is highly acidic, lead may become soluble and move into groundwater or surface water. Once in groundwater, as with surface transport to streams, the lead may be taken up by benthic invertebrates and wading birds.

Groundwater is found below 10 feet, while the lead was detected at surface to 24 inches. Therefore, groundwater is not considered a primary pathway. However, surface water runoff to aquatic media is a possibility at two of the areas (204 and 304/building707).

Toxicology of Lead

Lead has been characterized as a poison for centuries and environmental pollution for lead is well documented (Eisler 1998). Lead has been used in the production of solder, pipes, paint, ceramics, roofing materials, caulking, and ammunition and also was used as a gasoline additive. From a geochemical perspective, lead is ubiquitous and occurs in rocks, soils, water, plants, animals and air. Lead is neither essential nor beneficial to living organisms and all data show that the biological effects of lead are adverse. Lead is a mutagen and a teratogen. When absorbed in excessive amounts, lead also a carcinogenic or cocarcinogenic, impairs reproduction, adversely impairs liver and thyroid functions, and interferes with resistance to infectious disease (EPA 1979 as cited in Eisler 1998). In general, lead is toxic in most of its chemical forms and can be incorporated into the body through inhalation, ingestion, dermal absorption, and placental transfer. Lead is a poison that accumulates in the body, and upon reaching a certain level, it starts to affect behavior, as well as hematopoietic, vascular, nervous, renal and reproductive systems (Eisler, 1998).

The biological availability and fate of lead in soil is affected by such factors as soil pH, organic content, ion exchange characteristics, and the amount of lead in the soil (National Science Foundation, 1977, as cited in ATSDR 1993). Plants and animals may bioconcentrate and bioaccumulate lead; however, Biomagnifcation has not been well documented. Several studies have shown that invertebrates can accumulate lead in their tissues; however, the variability in the extent of lead bioaccumulation suggests that the mechanisms of lead uptake range between species. Organolead compounds, such as trialkyl and tetraalkyl lead compounds are more toxic than inorganic forms and have been shown to bioconcentrate in aquatic organisms. High accumulations of lead from ambient seawater by marine plants are well documents. Although lead is bioconcentrated from water, little evidence suggests that it is transferred through the food chain (Wong and others, 1978, Branica and Konrad 1980; Settle and Patterson 1980, as cited in Eisler 1988). Lead concentrations tend to decrease with increasing trophic level in food chains in freshwater and marine habitats (Wong and others 1978 and Stewart and Schulz-Baldes 1976, as cited in Eisler 1988).

Plants

Lead is not essential for plants, and excessive amounts can cause growth inhibition as well as a reduction in photosynthesis, mitosis, and water absorption (Demayo and others 1982, as cited in Eisler 1988).

Lead is taken up passively by the roots and translocation to shoots is limited (Wallace and Romney 1977). It is bound to the outside of roots, in the apoplast, and in cell walls and organelles or absorbing roots (Koeppe 1981). In the plant, lead may exist in a naturally chelated form, or in pyro- or orthophosphate forms. The phototoxicity of lead is relatively low compared with other trace elements. It affects mitochondrial respiration and photosynthesis by disturbing electron transfer reactions (Miles and others 1972).

Invertebrates

A concentration of 12,800 mg/kg of lead in soil is associated with reductions in natural populations of decomposers, such as fungi, earthworms and arthropods (Beyer and Anderson 1985, as cited in Eisler 1988).

Amphibians and Reptiles

Environmental conditions, including pH and water hardness, and the life stage of the amphibian exposed, affect the organism's sensitivity and adverse response to exposure to metal concentrations in water. Although information concerning amphibians and metal toxicity is limited, the primary mechanism of action of metal – induced toxicity in low pH environments is believed to be body loss of sodium across the gill surface (MacDonald and Wolld 1993, as cited in Horne and Dunson 1995). Reduced rates of learning acquisition and retention were observed in tadpoles exposed to lead water concentrations (Strickler-Shaw and Taylor 1989) Limited evidence has been published on the effects of lead in amphibians; however, lead may be important as a toxicant to developing embryos (Horne and Dunson 1995).

Fish and Aquatic Organisms

Lead is toxic to most aquatic organisms; however, adverse effects are modified by environmental conditions. Fish continuously exposed to toxic concentration of dissolved lead show various signs of poisoning, including spinal curvature; anemia; degeneration of the caudal fin; destruction of spinal neurons; reduced ability to swim against a current; destruction of the respiratory epithelium; muscular atrophy; paralysis; renal pathology; growth inhibition; retardation of sexual maturity; testicular and ovarian histopathology; decreased fry survival rate and death (Eisler 1988; EPA 1979).

Birds

Absorbed lead produces a variety of effects in avian species, including damage to the nervous system, muscular paralysis, inhibition of heme synthesis, damage to kidneys, damage to the liver, and death (Mudge 1983, as cited in Eisler 1988). Sublethal lead exposure may also have adverse effects of reproduction in some avian species by decreasing plasma calcium, inhibition of growth, and reduced chick hatchability.

Mammals

Lead can have multiple effects in mammalian species. Lead may cause damage to the nervous system, hematological effects, kidney dysfunction, sterility, abortion, neonatal mortality, growth retardation, delays in maturation, and reduced body weight (Amdur and others 1991, Eisler 1988) Younger mammals may have greater sensitivity to lead toxicity because of their developing blood brain barrier. Developing capillaries in the brain allow lead levels in the blood to be transported to newly formed components of the brain (Amdur and others 1991).

Toxicology of Antimony

The analysis of tissue samples from lower trophic levels (invertebrates and small mammals) in a food chain suggests that Biomagnification did not occur and that mobility of antimony in food chains is low (Ainsworth 1988). This theory is further strengthened by an investigation that found that antimony concentrations in small mammals resulting from dietary intake were very low in all experiments in comparison to the antimony concentrations in the diet" (Ainsworth and others 1991). Consequently, food chain transfer of antimony to upper trophic level consumers appears to be negligible.

The toxic action mechanism of metals and arsenic lies in their ability to bind to thiol groups of biological molecules, destroying their function (Balazs and others 1986). Antimony occurs in the same column of the periodic table of the elements as arsenic; as a result antimony participates in bonding similar to arsenic. Compared to arsenic, antimony has a lower affinity for bonding to sulfur containing proteins and for causing protein DNA crosslinks (Gebel 1997). Consequently, antimony should possess a lower toxicity compared to

arsenic. Therefore, the screening level ecological risk assessment could use the arsenic toxicity reference value as a conservative approach to estimating risk.

Plants

Antimony is considered to be a non-essential metal and is easily taken up by plants if available in the soil in soluble forms (Kabata-Pendias and H. Pendias 1984). The only information found on phytotoxicity was a secondary reference noting undefined, qualitative phytotoxic effects on plants grown on surface soil. (Kabata-Pendias and H. Pendias 1984).

Invertebrates/Amphibians/ Reptiles/Fish and Aquatic Organisms/Birds/Mammals

Little information was identified on the effects of antimony on these receptors.

Toxicology of Copper

Copper is a naturally occurring element that is widely distributed in the environment. Copper is the main component of alloys, which include brass, bronze and gunmetal. Copper is an essential trace mineral nutrient and a toxicant (ATSDR 1990)

Copper is very mobile under oxidizing and acidic conditions and immobile in organic risk and reducing environments. Adsorption increases with pH and higher organic matter content. In aquatic systems, copper binds primarily to organic matter and forms complexes with both organic and inorganic ligands (mainly with calcium carbonate) that settle out in sediments (Kirk-Othmer 1965). Under normal pH and oxidation/reduction (redox) conditions, copper tends to be present in sediments in the form of organic complexes and coprecipitates with iron and manganese oxides and cupric carbonate complexes.

Copper is an essential nutrient and is homeostatically controlled; therefore, biomagnification is not an significant fate process for copper. Bioaccumulated copper is stored in the liver, kidney, bone marrow, and hair (Hammond and Beliler 1980, as cited in Talmage and Walton 1991). Fish can bioconcentrate copper, with BCFs ranging from tens to the hundreds. Mollusks have BCFs for copper that range up to 30,000 (Perwack and others, 1980; Chapman and others 1968; Raymount 1972)

Plants

Based on yield reductions of 14 to 28 percent in agronomic and grassland plants, 100 milligrams per kilogram of total copper in the soil is considered to be a threshold concentration for toxicity to plants (EPA and Bengtsson and Tranvik, 1989 as cited in International Copper Association 1992)

Copper is a micronutrient essential for plant nutrition and is required as a cofactor for many enzymes. Furthermore, it is an essential part of a copper protein involved in photosynthesis. Root absorption appears to be passive, perhaps in organo copper complexes (Jarvis and Whitehead 1983), and active through a specific carrier (Fernandes and Henriques 1991). When copper is adsorbed to cells in the root system, it may result in low copper soils. The form in which copper is taken into the root affects its binding (Wallace and Romney 1977). Copper can be transported in the xylem and phloem of plants complexed with amino acids.

The most common toxicity symptoms include reduced growth, poorly developed root systems, and leaf chlorosis (Wong and Bradshaw 1982). The basic deleterious effects of copper is related to the root system, where it interferes with enzyme functioning (Mukherji and Das Gupta 1972), but it also strongly interferes with photosynthesis and fatty acid synthesis (Smith and others 1985).

Invertebrates

Copper is used as an ingredient in many fungicides and insecticide applied to agricultural crops (Meister 1995). Based on yield reductions of 14 to 28 percent in agronomic and grassland plants, 100 mg/kg of total copper in soil is considered to be a threshold concentration for toxicity to soil invertebrates (EPA 1987 and Bengtsson and Tranvik 1989, as cited in ICA 1992).

Amphibians and Reptiles

Copper is highly toxic to amphibians. Environmental conditions, including pH and water hardness and the life stage of the amphibian exposed affect the organism sensitivity and adverse response to exposure to metal concentrations in water. Copper increased rates of mortality in high pH and low water hardness environments (Horne and Dunson 1995). Although information concerning amphibians and metal toxicity is limited, it is believed that the primary mechanism of action of metal induced toxicity and low pH environments is body loss of sodium across the gill surface (MacDonald and Wood 1993, as cited in Horne and Dunson 1995). Tadpoles were adversely affected when exposed to aqueous copper concentrations (Bayliss 1924, as cited in Owen 1981). Copper is toxic to certain types of frogs and salamanders during both acute and chronic exposure studies, causing embryonic curling, body loss of sodium and mortality (Horne and Dunson 1995). Earlier life stages of amphibians appear to be more sensitive to copper toxicity than later life stages (Horne and Dunson 1995). No data were identified on the effects of copper in reptiles.

Fish and Aquatic Organisms

Copper is highly toxic in aquatic environments and is a priority pollutant (EPA 1992). Copper is toxic to many fish and aquatic organisms, including mussels, stripe bass, blue gill and carp. Copper is mainly accumulated in the gill, liver filaments, stomach and intestine; however, the gill is the primary organ for concentrating copper in aquatic organisms (Harvey 1978, as cited in Owen 1981). Copper concentrations can significantly affect fish egg hatchability and reduce fry growth (EPA 1979). The age and species of organism influence the toxicity characteristics of copper. In general, younger organisms are affected at lower concentration levels.

Birds

Copper can produce toxic effects in birds. Diets containing elevated copper levels can slow the growth rate, diminish egg production, and cause developmental abnormalities in different avian species (Owen 1981).

Mammals

Toxic effects of copper have been studied on many animals, including cats, dogs cattle, sheep, rats, mice horses, guinea pigs, pigs and monkeys. Different species of animals display varying levels of sensitivity to copper. However, the main organ affected by exposure to copper is the liver, where copper primarily accumulates in subcellular organelles, causing liver cirrhosis. In addition to liver cirrhosis, copper exposure can cause necrotic kidney tubules and brain damage (Owen 1981). Acute, toxic effects of copper given orally include gastrointestinal irritation, vomiting (including blood), low blood pressure, and jaundice caused by liver necrosis and coma. Chronic exposure to copper can cause accumulation of copper in the body, leading to lesions in the liver, brain, and eye hemolytic amnesia.

Toxicology of Zinc

Zinc is essential trace element for all living organisms, and zinc deficiency can be a problem for both plants and animals. Zinc is primarily used as a protective coating for metals and in the production of alloys such as bronze and brass. Adverse effects of zinc exposure to animals include growth retardation, testicular atrophy, skin changes, and poor appetite (Prasad 1979, as cited in Eisler 1993). Most of the zinc introduced into aquatic environments is eventually partitioned into sediment. Zinc release from sediment is enhanced under conditions of high dissolved oxygen, low salinity, and low pH. Dissolved zinc usually consists of the hydrated zinc ion and various organic and inorganic complexes. In reducing conditions, organically bound zinc typically forms insoluble sulfides (MacDonald 1993)

BCFs vary widely between and within species of aquatic organism (Eisler 1993). In marine environments, the most effective zinc accumulators included red and brown algae, ostreid and carassotried oysters and scallops. Invertebrates can bioaccumulate large quantities of zinc (Jamil and Hussein 1992), which could potentially be passed, on to upper trophic level consumers. Studies show that bony structures can act as long term

repositories for zinc (Macapinlac and others 1966). Zinc concentrations have been shown to increase with increasing trophic levels from phytoplankton, but not to fish.

Plants

Zinc is and essential nutrient for plant growth in small amounts but is toxic to plants at elevated levels. Zinc can cause significant adverse effects on growth, survival, and reproductions in representative sensitive species of aquatic plants (Eisler 1993). Elevated levels of zinc in soil can cause mortality in some terrestrial plants and inhibit photosynthesis in others (Eisler 1993).

Invertebrates

Certain terrestrial and aquatic invertebrates are sensitive to zinc. Reduced growth, inhibited reproduction, and reduced survival are effects that zinc can have on both terrestrial and aquatic invertebrates.

Amphibians and Reptiles

Environmental conditions, including pH and water hardness, and the life stage of the amphibian exposed both affect the organism's sensitivity and adverse response to exposure to metal concentrations in water. Although information concerning amphibians toxicity is limited, the primary mechanism of action of metal induced toxicity and low pH environments is believed to be body loss of sodium across the gill surface (MacDonald and Wood 1993, as cited in Horne and Dunson 1995). In one study, no significant effects occurred of acute and chronic exposures of frogs and salamanders and their larvae to toxicity of zinc, unlike the other metals that were studied. (Horne and Dunson 1995)

However, another study observed that zinc caused significant adverse effects on growth, survival and reproduction in representative sensitive species of amphibians (Eisler 1993). In this study, zinc was shown to cause teratogenic effects to fish embryos (Eisler 1993).

Birds

Different species of birds have varying sensitivities to zinc exposure. Acute effects of zinc in ducks caused mortality and pancreatic degradation (Eisler 1993). Reduced growth and death were observed in poultry chicks fed diets containing elevated zinc levels. Younger stages of live appear to be more sensitive to zinc exposure. The pancreas and bone are primary target organs of zinc in birds (Eisler 1993). Decreased weight gain was observed in Japanese quail, chickens and turkeys fed diets containing zinc. (NAS 1980)

Mammals

Zinc is relatively nontoxic in mammals; however, excessive zinc intake adversely affects survival of all tested mammals and produces a wider variety of neurological, hematological, immunological, hepatic, renal, cardiovascular, developmental, and genotoxic effects (Eisler 1993). The pancreas and bone are primary target organs of zinc exposure in mammals (Eisler 1993). Toxic effects of zinc can be observed in many domestic animals, including dogs, cats, ferrets, cattle, sheep, and horses, as a result of ingesting copper, there was an increased incidence of hyporeuprosis, still births, and fetal resorptions (Ketchenson and others 1969 and Campbell and Mill 1979, as cited in Domingo 1994).

Assessment Endpoints

Protection of birds and mammals, soil and aquatic invertebrates and fish from direct exposure to chemicals in the soils and nearby streams represents is an appropriate assessment endpoint at this site. Maintenance of both the bird and the mammal, soil and aquatic invertebrates and fish populations from the reproductive, growth and survival effects such that the community structure is similar to other similar habitats is also appropriate.

Site Conceptual Model

Small Arms range 204

Located near the north west portion of the base, this site has a gentle slope southwestward direction to an unnamed tributary. Exposure to lead and other co-located metals by terrestrial invertebrates and birds has been minimized with the removal of up to 24 inches of surface soil. Transport of the lead shot to aquatic streams is possible, though the heavy brush and flat topography in the buildings immediate vicinity would have made transport more probable during heavy rain/flushing. Post removal action confirmation samples showed that the detection of lead ceased 10-20 feet prior to the stream indicating that the pathway is most likely incomplete. Background samples in the stream downgradient of the site showed no elevated detections of lead. Though the stream does not support a fish population, these background samples indicate that any benthic invertebrate population has minimal to no exposure to lead.

Small Arms Range 404

Located near Camp Barney, the small arms range has no aquatic receptors in the nearby vicinity. The building was located in a North direction. The sand may have been pushed out the North or South end of the building. The predominate pathway at this site would be direct exposure and ingestion of the lead contaminated soil. Terrestrial invertebrates and bird exposure has been minimized with the removal of up to 24 inches of surface soil.

Small Arms Range 304 and Building 707

Located near the Camp James and Drill Field, this small arms range and building707 were located near a small tributary, know as the Happy Valley Branch. The due to the sloped nature of the site, it is postulated that the sand may have actually been pushed further from the buildings than at other sites thereby enabling the transport of lead fragments from the sand to the surface soil to the nearby stream. Post removal action confirmation samples showed that the detection of lead ceased 10-20 feet prior to the stream indicating that the pathway is most likely incomplete. Background samples in the stream downgradient of the site showed no elevated detections of lead. The confirmation samples indicate that a benthic invertebrate population would have minimal exposure to lead. Terrestrial invertebrates and bird exposure has been minimized with the removal of up to 24 inches of surface soil.

Figure 1. Site Conceptual Model

Conclusions and Recommendations: Exposure for all identified assessment endpoints is likely to be minimal. Any exposure that occurs on this habitat is likely to be on the individual level and not likely to effect the population or the community level. Post removal action confirmation samples for 204 and 304/707 showed that the detection of lead ceased 10-20 feet prior to the stream indicating that the pathway is most likely incomplete. In addition, the removal of soils exceeding the human health cleanup criteria further reduces the exposure to individuals using this habitat. Based on the lack/minimal exposure additional investigations and/or cleanup for Small Arms Ranges 204, 304/707 and 404 are not necessary.

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