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Engineering Evaluation/ Cost Analysis (EE/CA) Report for Installation Restoration Site 5 - Swale 2 Indian Head Division Naval Surface Warfare Center

Indian Head, Maryland

Northern Division
Naval Facilities Engineering Command
Contract Number N62472-90-D-1298
Contract Task Order 0157

May 1994

Halliburton NUS
CORPORATION

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ENGINEERING EVALUATION/COST ANALYSIS (EE/CA) REPORT FOR INSTALLATION RESTORATION SITE 5 - SWALE 2 INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER INDIAN HEAD, MARYLAND

COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

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1.0 INTRODUCTION

The Northern Division of the Naval Facilities Engineering Command has issued Contract Task Order Number 0157 (CTO 0157) to Halliburton NUS Corporation (Halliburton NUS), under the Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract No. N62472-90-D-1298. CTO 0157 is for the engineering and design of a removal action for Installation Restoration (IR) Site 5 at the Indian Head Division, Naval Surface Warfare Center (NSWC) in Indian Head, Maryland.

CTO 157 consists of tasks to: (1) Prepare an Engineering Evaluation/Cost Analysis (EE/CA) regarding proposed remediation alternatives for the non-time critical removal of silver contaminated soil; and, (2) prepare engineering plans and specifications for the implementation of the selected removal action alternative.

This EE/CA report is based on the results of the sampling and analysis work that was performed by Halliburton NUS at Site 5 in February, 1994. The results of that sampling and analysis activity are summarized in the Field Sampling Report issued by Halliburton NUS in April, 1994 (Reference 6). Information reported in the Field Sampling Report supports the delineation of silver contaminated soils. The EE/CA provides analyses to support decisions for the selection of an appropriate technology that will prevent, minimize, and mitigate potential impacts to human health and the environment.

Background information and a review of the analytical data from IR Site 5 are presented in this section. Impacts of silver contamination at IR Site 5 are presented in Section 2.0. Removal action objectives are presented in Section 3.0. Removal action alternatives are presented and analyzed in Sections 4.0 and 5.0, respectively. A comparative analysis of the alternatives and recommendations are contained in Section 6.0.

1.1 SITE DESCRIPTION

Indian Head Division, Naval Surface Warfare Center (NSWC) is located 25 miles south of Washington, DC. adjacent to the town of Indian Head, in west-central Charles County, Maryland. The primary mission of Indian Head Division NSWC is the development and production of propellent and explosive ingredients and formulants used in ordnance devices.

The project site (IR Site 5) is located on the southwestern side of Building 731, which is located on Voegeli Road at the NSWC (Figure 1-1). The site consists of two depressions emanating from the southeast

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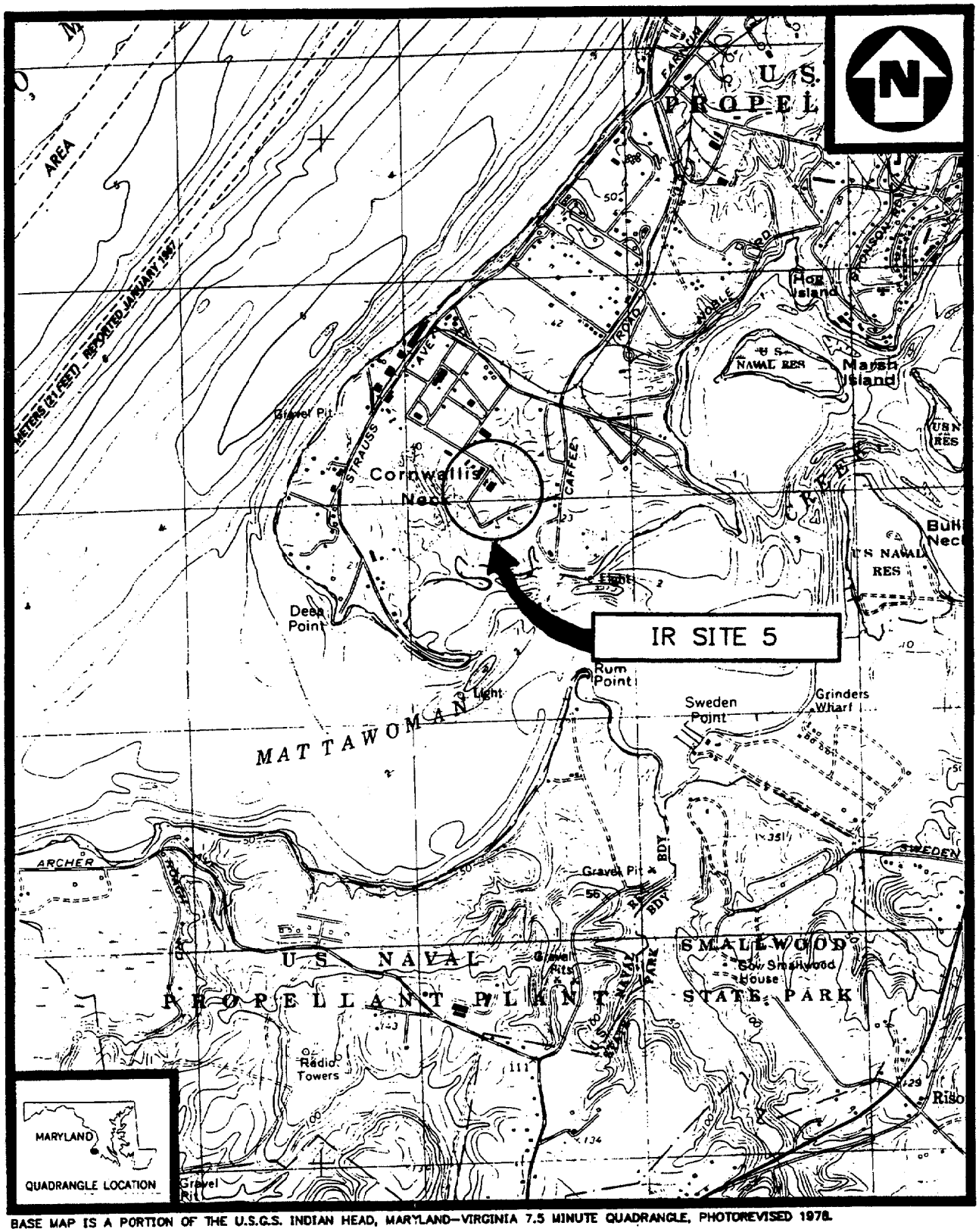

BASE MAP IS A PORTION OF THE U.S.G.S. INDIAN HEAD, MARYLAND—VIRGINIA 7.5 MINUTE QUADRANGLE, PHOTOREVISED 1978.

LOCATION MAP OF INDIAN HEAD PENINSULA

INDIAN HEAD, MARYLAND

FIGURE 1-1

0 2000 4000

SCALE IN FEET

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(Swale 1) and southwest (Swale 2) corners of Building 731. Soils in these swales were contaminated by silver-ladened photographic processing wastewaters released from Building 731 between 1953 and 1965. Photographic operations are still performed in Building 731, however, the spent fixer is now collected and the silver is recovered.

1.2 PROJECT BACKGROUND

A removal action was performed on Swale 1 during the period from November, 1992 to January, 1993. The removal action included the excavation of soils and sediments exhibiting silver concentrations greater than 10 mg/kg; treatment of the excavated soils through solidification/stabilization; and, placement of the treated material into an earthen explosion barrier as part of Military Construction (MILCON) Project 059. The results of the removal action were documented by ABB Environmental Services, Inc., in a Removal Action Findings Report (Reference 1).

Previous sampling at IR Site 5 (Reference 2) indicated that some soils and sediments in Swale 2 also exceeded the 10 mg/kg level. In February, 1993, Halliburton NUS conducted additional field sampling to further delineate the horizontal and vertical extents of silver contamination within Swale 2. A review of this field sampling activity is presented in the Field Sampling Report (Reference 9).

1.3 ANALYTICAL RESULTS

Two primary objectives of the NUS Field Sampling Activity were:

- Determine the horizontal and vertical extents of silver contamination, above the 10 mg/kg total silver action level, within Swale 2. The 10 mg/kg total silver remediation goal was established during previous discussions between the Navy and the State of Maryland for Swale 1 at IR Site 5.

- Determine the hazardous nature of the contamination by analyzing four samples with the highest total silver concentrations for toxicity characteristics using the Toxicity Characteristic Leaching Procedure (TCLP).

Analytical results for each sampling location are indicated on Figure 1-2.

The extent of Swale 2 silver contamination, above the 10 mg/kg total silver action level, was approximated based on the results of analyses for these samples. (Figure 1-3).

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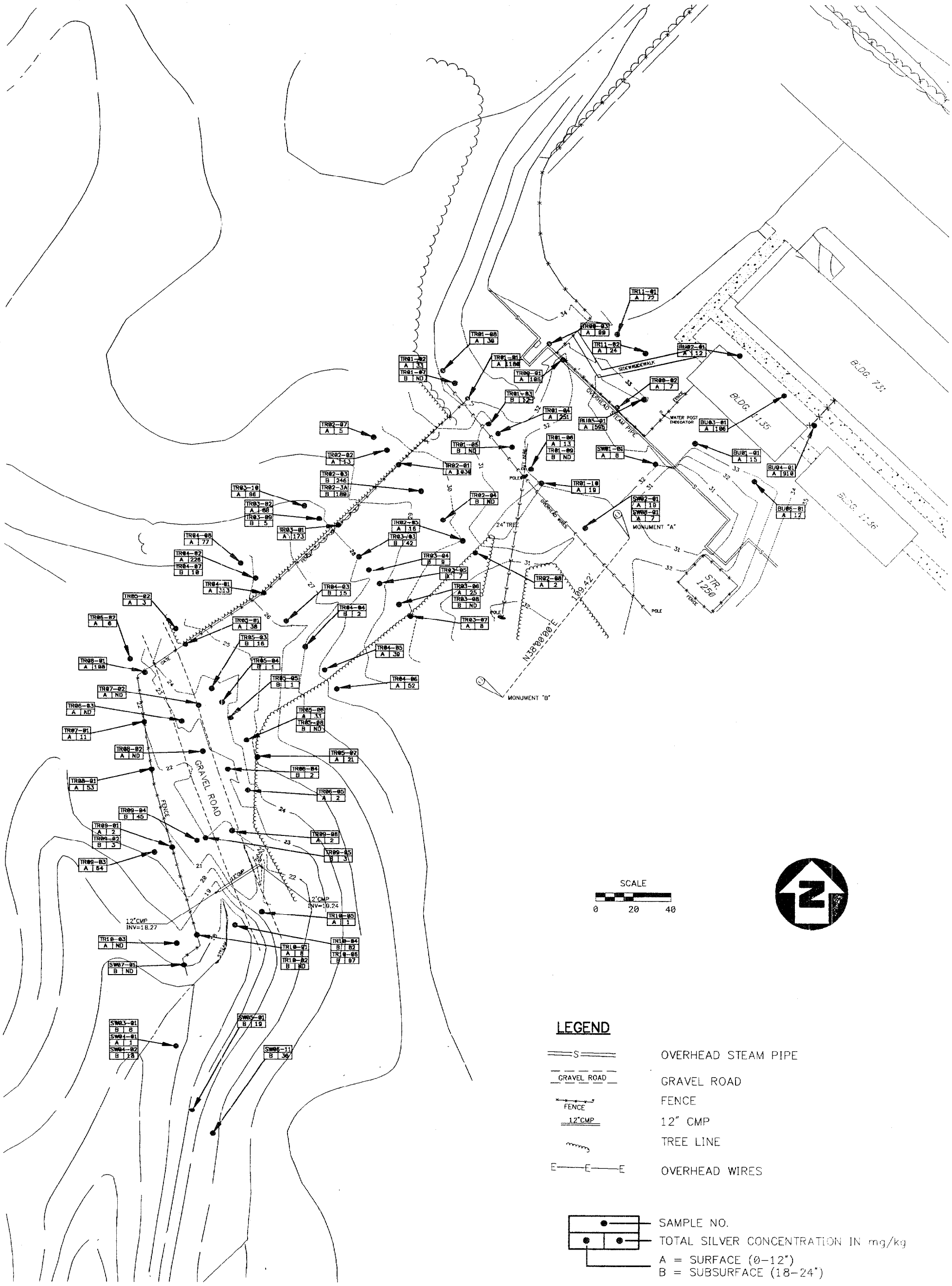

TOTAL SILVER CONCENTRATIONS
IR SITE 5
INDIAN HEAD DIVISION, NSWC
INDIAN HEAD, MARYLAND

FIGURE 1-2

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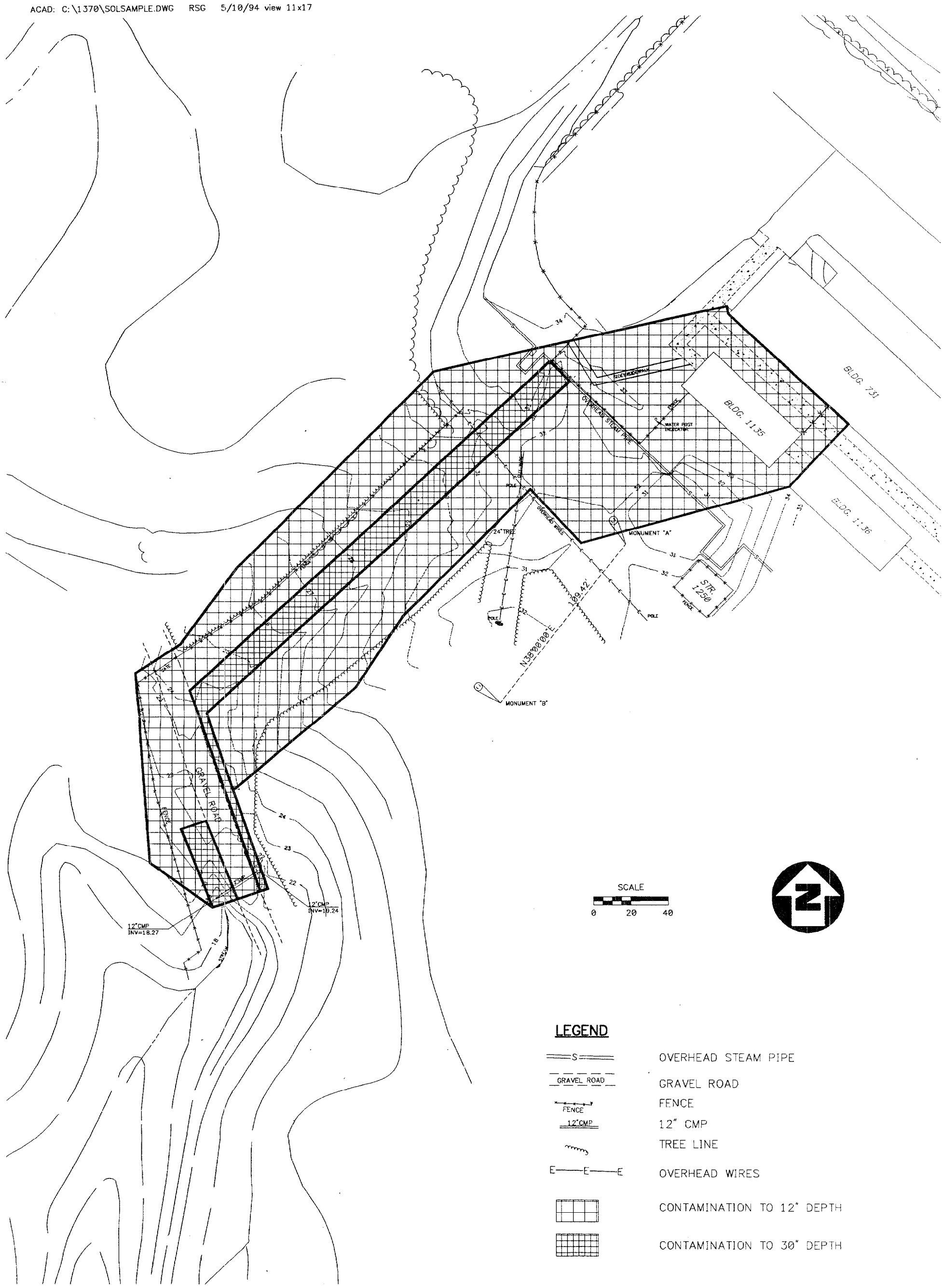

ESTIMATED LIMITS OF SILVER CONTAMINATION
IR SITE 5
INDIAN HEAD DIVISION, NSWC
INDIAN HEAD, MARYLAND

FIGURE 1-3

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Analytical results for the TCLP analysis are presented in Table 1-1. Analyses were performed on four samples with the highest total silver concentrations. TCLP results indicate that the soil at IR Site 5 do not exhibit the characteristic of toxicity as defined in 40 Code of Federal Regulation (CFR) 261.24. The silver concentrations, in all four samples, were less than the 5.0 mg/L regulatory level.

TABLE 1-1

SOIL SAMPLE RESULTS - TCLP, SILVER
IR SITE 5 - SWALE 2
INDIAN HEAD, MARYLAND

Sample Number	Location	Tracking Number	Total Silver (mg/kg)	TCLP (mg/L)	Regulatory Level (mg/L)
TR01-01	Located 49 feet south of corner of Fence M and K forming Transect 01. This transect is perpendicular to Fence M. Sample was collected at fence.	TR01-01-01	1,180	0.04U*	5.0
TR01-04	Located 25 feet east of Fence M on Transect 01.	TR01-04-01	251	0.102	5.0
TR02-01	Located 51 feet south of Transect 01, forming Transect 02. This sample was collected at Fence M on Transect 02.	TR02-01-01	1,030	0.04U*	5.0
TR04-01	Located 200 feet south of the corner of Fence M and Fence K, forming Transect 04. This sample was collected at the fence.	TR04-01-01	313	0.0477	5.0

* U = Non detect concentration.

2.0 IMPACTS OF SILVER CONTAMINATION AT SITE 5

Silver, which is a naturally occurring metal in the environment, is present in greatest amounts at IR Site 5 in the oxidized form as a result of release from a photographic processing facility. Although there are four oxidation states of silver (0, 1+, +2, and +3), the most common states are the 0 and +1 forms. Silver occurs primarily as bromides, chlorides, and iodides under oxidizing conditions (ATSDR 1990).

Silver contamination at IR Site 5 was investigated with regard to human and ecological impacts. Both direct and indirect human exposure pathways were assessed, and both terrestrial and aquatic ecosystems were investigated as part of this EE/CA. The results of that assessment and investigation are presented in this section of the EE/CA report.

2.1 HUMAN HEALTH IMPACTS

Information about the toxicity of silver in humans is drawn largely from evidence obtained during observation of individuals receiving silver containing medications (IRIS 1994). Silver has been used for centuries as an astringent agent and disinfectant. It has been employed in the treatment of syphilis, used as a material for prostheses, and as a fungicide, among other medical uses. Commercially, silver is used as a chemical catalyst in photographic materials and electrical components, and as dental amalgam.

Argyria, the only considerable critical health effect of low to moderate exposure to silver, is a medically benign but permanent bluish-grey discoloration of the skin. Evidence suggests that the silver is somewhat uniformly deposited in the skin tissue and that silver stimulates the production of melanin. Affected skin areas exposed to sunlight are further discolored by the reduction of silver in the dermis.

The development of modern antibiotics has eliminated most medical uses of silver. Consequently, reported cases of argyria have declined significantly. However, an abundance of toxicological information regarding silver and associated effects is available. Because of the low dosages used for therapeutic benefits, argyria is the predominant effect reported for silver toxicity in humans.

Animal studies have reported other toxic effects associated with exposure to silver at higher concentrations. Cardiovascular toxicity and hepatotoxicity are noted in rats subjected to silver in drinking water. Olcott (1950) administered 0.1% (88.9 mg/kg-day) silver in water to rats and noted statistically significant increases

in the incidence of ventricular hypertrophy. Post mortem examination indicated significant pigmentation, but the hypertrophy could not be attributable to the discoloration.

Hepatic necrosis and ultrastructural changes in the liver have been noted by Wagner, et al. (1975, 1967, and 1968) in selenium and Vitamin E-deficient rats. However, significant tolerance to silver exposure, to dosages as high as 140 mg/kg-day (0.01% Ag in water), was noted by the researchers for rats without selenium or Vitamin E deficiencies.

Radioactive silver tracer studies in rats indicate that intramuscularly administered silver accumulates in the liver and is discharged in bile to the gastrointestinal tract to be purged in fecal material. Lower dosages (amount not specified) resulted in over 95% removal in the feces. Higher doses (0.4 and 4.0 mg/Kg-day) in the form of silver nitrate resulted in accumulation of silver primarily in the liver and GI tract and decreasing removal efficiency (Scott and Hamilton, 1950). Other studies have concluded that subjects with high exposure to selenium are more susceptible to argyria (Berry and Galle, 1982).

Silver is not classified with regard to human carcinogenicity. However, some animal studies that have been conducted have resulted in the generation of localized sarcomas at the point of implantation or injection of metallic silver. The results of these studies are questionable and not supported by other studies. Inert materials (such as plastic and ivory) implanted subcutaneously (e.g. under the skin) in test species have demonstrated the occurrence of solid-state carcinogenicity in the form of local fibrosarcomas. Also, two other studies (Schmahl and Steinhoff, 1960 and Furst and Schlauder, 1977) utilizing colloidal suspensions and metal powders of silver injected subcutaneously and intramuscularly, respectively, indicated no significant incidence of tumor formation. Consquently, the USEPA has concluded that there is no evidence of carcinogenicity in humans due to silver exposure, despite extensive and frequent therapeutic usage.

2.1.1 Direct Human Exposure to Silver at Site 5

Direct exposure with silver in surface soils at Site 5 can be realized by ingestion of site soils, inhalation and ingestion of fugitive dusts from the site, and via dermal contact with the soils. Contact with the sediment in the swale is not likely in view of the fact that site access is restricted and that significant accumulation of water and sediments does not regularly occur as evidenced by the presence of extensive vegetation in the swale. It is assumed that the conservative soil evaluations will sufficiently characterize exposure to sediment.

According to the EPA Integrated Risk Information System, silver is not classifiable with regard to human carcinogenicity. Potential noncarcinogenic health risks associated with silver are evaluated by utilizing the

Reference Dose (RfD). An RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. RfDs are developed for chronic and/or sub-chronic human exposure to hazardous chemicals and are based on the assumption that thresholds exist for certain toxic effects. The RfD is usually expressed as an acceptable dose (mg) per unit body weight (kg) per unit time (day). The RfD is derived by dividing the no-observed-adverse-effect level (NOAEL) or the lowest-observed-adverse-effect level (LOAEL) by an uncertainty factor (UF) times a modifying factor.

The silver action levels for IR Site 5 presented in this EE/CA Report are for human exposure to silver assuming an occasional trespass scenario. This occasional trespass scenario assumes that an adult receptor (military/industrial land use scenario) is exposed to the soil via incidental ingestion (at a rate of 50 mg/day) and dermal exposure. The action levels are based on the person being exposed to silver in the soil for 50 days per year over a 30 year period. The levels are based on a oral RfD of 5×10^{-3} mg/kg/day. Given the exposure assumptions of a trespass scenario, the silver concentrations in soil must exceed the calculated action levels before deleterious health effects will occur. Using guidance provided in Risk Assessment Guidance for Superfund - Volume I (Part A) (USEPA, December 1989) for the oral and dermal exposure routes and a fugitive dust emissions model developed by Cowherd, et al. (1985) for fugitive dust emissions, the following action levels for occasional receptors at IR Site 5 are as follows:

- 51,100 mg/kg of silver for incidental ingestion
- 102,200 mg/kg of silver for dermal contact
- 1×10^6 mg/kg of silver for inhalation of fugitive dust

The result obtained for fugitive dust emission (i.e, 10^6 mg/kg) corresponds to that of pure silver. This result indicates that silver dust emitting from the site at the fugitive dust emission rate calculated for soil will not pose a significant health risk to occasional receptors at Site 5.

Maximum silver concentrations in the soils collected at IR Site 5 do not exceed these action levels. Therefore, no action is required at IR Site 5 based on a direct human exposure pathway. Action level calculations are presented in Appendix C of this EE/CA Report.

2.1.2 Indirect Human Exposure to Silver at IR Site 5

Humans could be indirectly exposed to the silver contamination at IR Site 5 through consumption of fish. However, it is unlikely that this exposure could result in a significant exposure to silver to any given receptor. This conclusion is supported by several factors, listed below:

- Sediments in the swale are not discharged at any significant rate to the Mattawoman Creek.
- Silver concentrations in soil do not currently pose a threat to human receptors.
- Silver bioaccumulation in aquatic species is not significant (BCF = 0.5 l/kg; USEPA 1991).
- Significant silver contamination in soil is not believed to have migrated beyond the limits of IR Site 5.

In conclusion, no significant indirect exposure routes for the silver contamination at IR Site 5 exist for human receptors.

2.2 ECOLOGICAL IMPACT

Surface water and sediment sampling, per se, was not performed at IR Site 5, therefore, a direct evaluation of the effects of silver contamination on ecological receptors cannot be made. However, a qualititative evaluation of the potential risks can be presented. Previous studies performed in this area indicate that silver contamination extends to downstream environments (Reference 2). These environments include wetlands and estuarine habitats, both considered to be potentially sensitive to chemical contamination.

Ecological impacts associated with silver contamination of aquatic habitats have not been studied in considerable detail when compared to other, more toxic metals such as mercury. However, the toxic nature of this inorganic compound in nature has been ascertained. In freshwater aquatic environments, comparatively low concentrations of silver can adversely affect receptors, and a chronic Ambient Water Quality Criteria (AWQC) value of 0.12 μg/L has been established. In marine environments, chronic toxicity data are not available, and an acute AWQC of 2.3 μg/L has been established.

2.2.1 Aquatic Ecosystems

No permanent aquatic environments exist at IR Site 5. However, aquatic organisms may be present, and therefore, exposed to contaminants at downslope drain locations. In addition, the consumption of contaminated prey items may represent a significant exposure route to higher trophic organisms such as fish. Dietary exposure may similarly be important for wading birds such as the great blue heron (Ardea herodias), whose diet is comprised largely of aquatic organisms (Scott, 1987), and semi-aquatic mammals such as the raccoon (Procyon lotor), mink (Mustela vison), and river otter (Lutra canadensis) all of which feed heavily on crustaceans, molluscs, and, in the case of mink and otter, fish (Webster et al., 1985).

2.2.2 Terrestrial Ecosystems

In the forested areas surrounding the drainage ditch, downstream wetlands, and Mattawoman Creek, terrestrial animals such as white-tailed deer (Odocoileus virginianus) and a number of birds of prey [e.g., osprey (Pandion haliaetus) and northern harrier (Circus cyaneus)] may be exposed to silver by feeding on contaminated biota or through the incidental ingestion of soil or sediment. This is not expected to be a significant route of exposure however, because these species are wide ranging and spend only a small portion of their lives feeding in this relatively small area.

2.3 SUMMARY OF SILVER IMPACTS AT IR SITE 5

As previously described, the silver contamination in the soils at IR Site 5 does not appear to present a problem with regard to direct exposure to humans. Although the area in the vicinity of and downstream of IR Site 5 is actively fished, it is not believed that the consumption of fish contaminated with silver poses a significant risk to human health because silver does not have a tendency to accumulate in biological tissue. No data are available to evaluate the effects that may be incurred by aquatic environments directly exposed to media containing silver from the site. The risk to organisms that feed on aquatic organisms are not likely to be high as a result of the low bioaccumulation tendencies of silver. The potential risk to terrestrial wildlife is also considered to be low because of the limited areal extent of silver contamination in soil, as well as the relatively low concentrations detected at the site.

3.0 REMOVAL ACTION OBJECTIVE

Prior to implementation of a removal action, the site must be evaluated to determine if site conditions justify a removal action. Paragraph (b)(2) of Section 300.415 of the NCP lists the following factors that should be considered when determining the appropriateness of a removal action:

(1) Actual or potential exposure to hazardous substances or pollutants or contaminants of nearby populations, animals, or food chain.

(2) Actual or potential contamination of drinking water supplies or sensitive ecosystems.

(3) Hazardous substances or pollutants or contaminants in drums, barrels, tanks, or other bulk storage containers, that may pose a threat of release.

(4) High levels of hazardous substances or pollutants or contaminants in soils largely at or near the surface, that may migrate.

(5) Weather conditions that may cause hazardous substances or pollutants or contaminants to migrate or be released.

(6) Threat of fire or explosion.

(7) The availability of other appropriate Federal or state response mechanisms to respond to the release.

(8) Other situations or factors which may pose threats to public health or welfare or the environment.

The above factors were considered during the EE/CA process. As described in Section 2.0, the silver contamination at IR Site 5 does not present a direct risk to human health. However, there has been no investigative work to assess what effect, if any, the silver contamination has on the biota and ecosystems down-gradient from IR Site 5 and potential human exposure through fish consumption. Currently, actions at locations downgradient of IR Site 5 are not included under the scope of this removal action.

The area of IR Site 5 contained within the investigation area (approximately 600 feet long and 120 feet wide) is known to contain varying concentrations of silver. Previously conducted investigations have indicated that silver is also present in the surface water of downstream environments and can be assumed to be present in the sediments. These media may be serving as a source for continuing downstream area contamination in the wetlands and estuarine environments near Mattawoman Creek.

The objective of this removal action is to eliminate the potential for further releases of silver into the downstream environment by removing the source of contamination and to expedite the completion of total site cleanup. All removal action alternatives under consideration must eliminate existing and potential future sources of silver contamination and should not interfere with any future remedial actions at the site. The scope of this removal action is limited to the silver contamination in the area immediately adjacent to Building 731.

3.1 REMOVAL ACTION SCHEDULE

Removal action, if appropriate, will begin after completion of removal action design. Major factors that will influence the removal action schedule include: completion of design; procurement of a remediation contractor; approval of a treatment/disposal option; permitting requirements; and weather.

3.2 ARARs AND TBC CRITERIA

One of the primary concerns during the development of removal action alternatives for hazardous waste sites under CERCLA is the degree of human health and environmental protection afforded by a given remedy. Section 121 of CERCLA requires that primary consideration be given to alternatives that attain or exceed applicable, or relevant and appropriate requirements (ARARs). The purpose of this requirement is to make CERCLA response actions consistent with other pertinent Federal and state environmental requirements. ARARs and TBC criteria were reviewed in order to develop and assess the removal action alternatives.

ARARs may include the following:

- Any standard, requirement, criterion, or limitation under Federal environmental law.
- Any promulgated standard, requirement, criteria, or limitation under a state environmental or a facility-siting law that is more stringent than the associated Federal standard, requirement, criterion, or limitation.

A requirement may be either "applicable" or "relevant and appropriate," but not both. Definitions of the two types of ARARs as well as other "to be considered" (TBC) criteria are given below:

- Applicable Requirements - Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or state law that directly and fully address a hazardous substance, pollutant, contaminant, remedial action, or location.

- Relevant and Appropriate Requirements - Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or state law, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, or location, address problems or situations sufficiently similar (relevant) to those encountered at the site, that their use is well suited (appropriate) to the particular site. Requirements must be relevant and appropriate to be an ARAR.

- To Be Considered (TBC) Criteria - TBC Criteria are non-promulgated, non-enforceable guidelines or criteria that may be useful for developing remedial action, or necessary for determining what is protective to human health and/or the environment. Examples of TBC criteria include EPA Drinking Water Health Advisories, Carcinogenic Potency Factors, and Reference Doses.

Section 121(d)(4) of CERCLA allows the selection of a remedial alternative that will not attain all ARARs if any of six conditions for a waiver of ARARs exist. These conditions are as follows: (1) the remedial action is an interim measure whereby the final remedy will attain the ARAR upon completion; (2) compliance will result in greater risk to human health and the environmental than other options; (3) compliance is technically impracticable; (4) an alternative remedial action will attain the equivalent of the ARAR; (5) for state requirements, the state has not consistently applied the requirement in similar circumstances; and (6) compliance with the ARAR will not provide a balance between protecting public health, welfare, and the environment at the facility with the availability of Superfund money for response at other facilities (fund-balancing). Since a removal action is an interim measure, complete compliance with ARARs is not required. Compliance with ARARs and TBCs, will be accomplished to the maximum extent practicable.

ARARs fall into three categories, based on the manner in which they are applied. The characterization is not perfect, as many requirements are combinations of the three types of ARARs. These categories are as follows:

- Contaminant-specific - Health- and/or risk-based numerical values or methodologies that establish concentration or discharge limits for particular contaminants. Examples of contaminant-specific ARARs include Maximum Contaminant Levels (MCLs) and Clean Water Act (CWA) water quality criteria. Contaminant-specific ARARs and TBSs are presented in Table 3-1.

- Location-specific - Restrictions based on the concentration of hazardous substances or the conduct of activities in specific locations. These may restrict or preclude certain remedial actions or may apply only to certain portions of a site. Examples of location-specific ARARs include RCRA location requirements and floodplain management requirements. Location-specific areas and TBCs are presented in Table 3-2.

- Action-specific - Technology- or activity-based controls or restrictions on activities related to management of hazardous waste. Action-specific ARARs and TBCs are presented in Table 3-3.

In general, the contaminant-specific ARARs and TBCs are considered during the assessment of risks to human health and the environment. These ARARs and TBCs are also considered in the development of remedial action objectives. The action-specific ARARs and TBCs, which affect the implementation and/or operation of the remedial alternatives, are primarily used to assess the feasibility of remedial technologies and alternatives.

3.2.1 Classification of Silver-Contaminated Soil

ARARs for silver contamination are presented in Table 3-1. As shown in these tables, no ARARs were identified that specifically address silver contaminated soil and establish cleanup levels. However, if the soils are excavated and sent off site for disposal because of contamination, they will be considered wastes. The contaminated soils do not exhibit any other characteristics identified in RCRA Subpart C regulations and are therefore not classified as hazardous.

3.3 REMOVAL ACTION OBJECTIVE AND RATIONALE

There are no identified direct human exposure pathways associated with IR Site 5 that pose an unacceptable risk at this time. The objective of the EE/CA removal action at IR Site 5 is the removal of all contaminated soils at concentrations above 10 mg/kg in order to eliminate the potential for release of silver into the downstream aquatic environment. The 10 mg/kg cleanup level is an agreed upon level between the Navy and the State of Maryland. The same cleanup level was used for remediating Swale 1 and is also appropriate for Swale 2. The removal action goal is protective of public health and the environment.

TABLE 3-1

CONTAMINANT-SPECIFIC ARARS AND TBCS
IR SITE 5 - SWALE 2
INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

ARAR/TBC	Requirement	Requirement Synopsis	Comments
Federal Requirements Surface Water	Safe Drinking Water Act (SDWA) - Maximum Contaminant Levels (MCLs and non-zero MCLGs) (40 CFR 141.11-141.16)	MCLs have been promulgated for a number of common organic and inorganic contaminants. These levels regulate contaminant concentration in public drinking water supplies.	When the risks to human health due to consumption of groundwater were assessed, concentrations of concern were compared to their MCLs. The secondary MCL for Silver is 0.01 mg/L.
Federal Requirements Surface Water	SDWA Maximum Contaminant Level Goals (MCLGs) (40 CFR 141)	MCLGs are health-based limits and do not consider cost or feasibility. As health goals, MCLGs are established at levels at which no known or anticipated adverse effects on the health of persons occur and which allow for an adequate margin of safety.	If technically feasible, these levels are to be considered when other human health threats at the site justify setting lower cleanup levels. No MCLG exists for silver.
Federal Requirements Surface Water	Clean Water Act (CWA) - Ambient Water Quality Criteria (AWQC) - Protection of Freshwater Aquatic Life, Human Health - Fish Consumption	AWQC are developed under the Clean Water Act (CWA) as guidelines from which states develop water quality standards. A more stringent AWQC for aquatic life may be found relevant and appropriate rather than an MCL, when protection of aquatic organisms is being considered at a site.	The CWA will be considered when determining cleanup levels. The AWQC established for silver for the protection of aquatic life is 0.12 μg/L (freshwater chronic value).
Criteria, Advisories, and Guidance to be Considered - Surface Water	EPA Risk Reference Doses (RfDs)	EPA RfDs are levels established to characterize risks due to exposure to contaminants in surface water sediment, as well as other media.	EPA RfDs were used to characterize risks due to exposure to contaminants in surface water and sediment, as well as other media.

TABLE 3-1 (Continued)
CONTAMINANT-SPECIFIC ARARS AND TBCS
IR SITE 5 - SWALE 2
INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

ARAR/TBC	Requirement	Requirement Synopsis	Comments
Criteria, Advisories, and Guidance to be Considered - Surface Water	EPA Carcinogen Assessment Group Potency Factors	EPA Carcinogenic Potency Factors are used to compute the individual incremental cancer risk resulting from exposure to carcinogens.	These factors were used to assess health risks from carcinogens present at the site.
Criteria, Advisories, and Guidance to be Considered - Surface Water	EPA Health Advisories and Acceptable Intake Health Assessment Documents	Intended for use in qualitative public health evaluation of remedial alternatives.	To be used, if adequate data exist, in assessing health risks from ingesting surface water and sediment at the site.
FDA Action Limit	No FDA Action Limit has been published for silver.		Edible portion only (excludes head, scales, viscera, and inedible bones).

TABLE 3-2

LOCATION-SPECIFIC ARARS AND TBCS
IR SITE 5 - SWALE 2
INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

ARAR/TBC	Requirement	Requirement Synopsis	Comments
Federal Requirements Wetlands/Floodplain	Clean Water Act (CWA) 404 (33 USC 1344 40 CFR 230)	Applies to dredge and fill activities. Under this requirement, no activity that adversely affects a wetland shall be permitted if a practicable alternative that has less effect is available.	This requirement is applicable to any action that may affect wetlands.
Federal Requirements Wetlands/Floodplain	Fish and Wildlife Coordination Act	This regulation requires that any Federal agency that proposes to modify a body of water must consult with the U.S. Fish and Wildlife Services. This is addressed under CWA regulations at 40 CFR 230.	If an alternative modifies a body of water, the U.S. Fish and Wildlife Services must be consulted.
Federal Requirements Wetlands/Floodplain	Endangered Species Act of 1973 (16 USC 1531 et seq.); 36 CFR 800	This regulation requires action to conserve endangered species or threatened species, including consultation with the Department of the Interior.	This requirement is applicable to any remedial action that may involve endangered species.

TABLE 3-3

ACTION-SPECIFIC ARARS AND TBCS
IR SITE 5 - SWALE 2
INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

ARAR/TBC	Requirement Synopsis	Comments
Federal Requirements RCRA Facility Standards and Land Disposal Restrictions (40 CFR 264)	Facility standards specify design, groundwater monitoring, and closure, and post-closure care for specific types of facilities. Land disposal restrictions exist for specified wastes without approved treatment.	Any onsite remedial alternatives must conform, to the extent feasible to the governing technical standards.
Federal Requirements CWA - National Pollutant Discharge Elimination System (NPDES) (40 CFR 122, 125)	Any point-source discharge must meet NPDES permitting requirements, which include compliance with corresponding water quality standards; establishment of a discharge monitoring system; and completion of regular discharge monitoring records.	Process water used on site and discharged to a surface water body will need to comply with the water quality standards.
Federal Requirements Occupational Safety and Health Administration (OSHA) Regulations for Worker Safety (29 CFR 1910)	Contains safety and health standards for workers at hazardous waste sites.	The implementation of all proposed cleanup alternatives will meet OSHA standards. The requirements are applicable for all actions at the site.
Federal Requirements CWA Dredge and Fill Regulations (40 CFR 230)	This regulation outlines requirements for discharge of dredged or fill material. Under this requirement, no activity that affects a wetland shall be permitted if a practicable alternative exists; all impacts must be mitigated.	During the detailed analysis of alternatives, the effects on wetlands must be evaluated. This requirement would be applicable to any dredging or filling.
Federal Requirements Clean Air Act (CAA) National Ambient Air Quality Standards (NAAQS) for Total Suspended Particulates (40 CFR 129.105, 750)	This regulation specifies maximum primary and secondary 24-hour concentrations for particulate matter.	Fugitive dust emissions from site excavation activities will be maintained below 260 μ/m^3 (primary standard) by dust suppressants, if necessary. This requirement will be applicable if any excavation occurs.

TABLE 3-3 (Continued)
ACTION-SPECIFIC ARARS AND TBCS
IR SITE 5 - SWALE 2
INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

ARAR/TBC	Requirement Synopsis	Comments
Federal Requirements Protection of Archaeological Resources (32 CFR Part 229, 229.4;43 CFR Part 107, 171.1-171-5)	This regulation develops procedures for the protection of archaeological resources.	If archaeological resources are encountered during soil excavation, they must be reviewed by Federal and state archaeologists. This requirement is applicable to any excavation on site.
Federal Requirements Department of Transportation (DOT) Rules for Transportation of Hazardous Materials (49 CFR Parts 107, 171.1-171.5)	This regulation outlines procedures for the packaging, labeling, manifesting, and transporting of hazardous materials.	Hazardous materials will be packaged, manifested, and transported to a licensed off site disposal facility in compliance with these regulations. These regulations are applicable for any action that includes off site transportation of hazardous materials.

4.0 REMOVAL ACTION ALTERNATIVES

This section reviews the EE/CA removal action alternatives for IR Site 5, Swale 2. Although these removal actions vary in effectiveness, implementability, and cost, they are all viable alternatives and address silver contamination contained in Swale 2. The area to be addressed by the EE/CA removal action is shown on Figure 1-3 of this report. Four removal action alternatives were considered:

- Alternative 1: Excavation, stabilization, and placement of contaminated soil at NSWC
- Alternative 2: Excavation and placement of contaminated soil at NSWC
- Alternative 3: Consolidation and capping of the silver contaminated soil
- Alternative 4: Excavation and offsite disposal of contaminated soil

4.1 ALTERNATIVE 1: EXCAVATION, STABILIZATION, AND PLACEMENT OF CONTAMINATED SOIL AT NSWC

Under this alternative, silver contaminated soil would be excavated from Swale 2 and batch-stabilized using a cement-based or pozzolanic-based stabilizing agent. The stabilized soil would then be loaded and transported by truck to the Rum Point Gravel Pit at NSWC, where it would be placed as backfill and covered with 12 inches of low permeability soil, 12 inches of clean soil, and 6 inches of topsoil.

4.2 ALTERNATIVE 2: EXCAVATION AND PLACEMENT OF CONTAMINATED SOIL AT NSWC

This alternative is the same as Alternative 1 except that the excavated soil would not be stabilized prior to placement in the Rum Point Gravel Pit.

4.3 ALTERNATIVE 3: CONSOLIDATION AND CAPPING OF THE CONTAMINATED REGION

In this remediation alternative, silver contaminated soil within Swale 2 would not be removed from the site. Silver contaminated soil within the contaminated region identified on Figure 1-3 would be consolidated in the central portion of the swale. In this way, excavation would be primarily confined to the surface layer, and the removal of deeper contaminated soil would be significantly reduced to a few localized areas. The consolidated soils would be graded to minimize surface water runoff. The soils would be capped with an impervious layer to prevent infiltration of rain water.

4.4 ALTERNATIVE 4: EXCAVATION AND OFFSITE DISPOSAL OF CONTAMINATED SOIL

Under this alternative silver-contaminated soil would be excavated and transported to an offsite disposal facility.

5.0 ANALYSIS OF REMOVAL ACTION ALTERNATIVES

Analysis for the four removal action alternatives with regard to effectiveness, implementability, and cost are presented in this section of the report.

Effectiveness is the ability of the alternative to reduce the risks of the site and includes:

- Protectiveness - Protectiveness includes protecting the community and workers during the removal action, threat reduction and potential exposure to remaining risks, time until protection is achieved, compliance with ARARs and other criteria, environmental impacts (overall protection of human health and the environment), and long-term reliability for providing continued protection.

- Ability to Achieve Removal Objectives - This factor considers the ability to achieve the desired level of treatment or cleanup and any residual effect concerns.

Implementability is the ability of the alternative to be carried out at the site and includes:

- Technical Feasibility - The ability to physically implement the alternative as designed and in a manner that complies with the removal action objective.

- Availability - The availability of equipment, material, personnel, and facilities to implement the alternative, and provide any necessary post-removal site control.

- Administrative Feasibility - Acceptance of the alternative by the state and community and the ability to obtain the necessary approvals.

The costs associated with these alternatives include: (1) engineering (treatability studies, design, permitting, health and safety, sampling and analysis, inspection, etc.), and (2) construction costs. Appendix A contains pertinent cost calculations for the four remediation alternatives. Calculations to determine the various volumes of soil to be handled in each of the four remediation alternatives are included in Appendix B.

5.1 ALTERNATIVE 1: EXCAVATION, STABILIZATION AND PLACEMENT

Under this alternative, all of the silver contaminated soil within the boundaries shown in Figure 1-3 would be removed from the site. Approximately 1,706 yd^3 would be excavated and batch-stabilized with a cement-based or pozzolanic-based stabilizing agent. The stabilized soil would be transported by truck to the Rum Point Gravel Pit at the NSWC, and used as backfill. Following placement of this material, it will be covered with 2 feet of clean soil and 6 inches of topsoil. The gravel pit is approximately 15 miles from IR Site 5.

Effectiveness - Exposure risks created by the existing state of the silver contaminated swale are significantly reduced by this removal action. Risk reduction is completely effected in a relatively short timeframe, with little or no maintenance required to maintain this risk level.

Implementability - This technically unsophisticated remediation alternative is a well understood, widely used and accepted method of waste disposal. The manpower and equipment required to accomplish a high level of cleanup under this alternative are readily available.

Cost - The cost for this alternative is primarily comprised of construction expenses. Total cost for this alternative is approximately $573,020.

5.2 ALTERNATIVE 2: EXCAVATION AND PLACEMENT

Under this alternative, all of the silver-contaminated soil in Swale 2 would be removed from the site. Contaminated soil would not be stabilized prior to transporting it to the NSWC Rum Point Gravel Pit. The contaminated soil would be placed as backfill and covered with 2 feet of clean soil and 6 inches of topsoil.

Effectiveness - Exposure risks created by the existing state of the silver contaminated swale are significantly reduced by this removal action. Risk reduction is completely effected in a relatively short timeframe, with little or no maintenance required to retain this risk level for the long-term.

Implementability - This technically unsophisticated remediation alternative is a well understood, widely used and accepted method of waste disposal. The manpower and equipment required to accomplish a high level of cleanup under this alternative are readily available.

Cost - Cost for this alternative is primarily comprised of construction expenses. Total cost for this alternative is approximately $261,504.

5.3 ALTERNATIVE 3: CONSOLIDATION AND CAPPING

Silver contaminated soil would not be removed from Swale 2 under this remedial action alternative. Contaminated soil within the boundaries shown in Figure 1-3 would be consolidated within a 15 to 20 foot centralized section along the entire length of the drainage area. The consolidated soil would be placed to achieve a 2 to 1 slope and would be capped by the following layers:

- 1 foot layer of low permeability soil (10^{-7} cm/sec)
- 1 foot layer of clean backfill
- 6 inch layer of topsoil
- revegetated

Approximately 1,490 yd^3 of soil would be relocated to the central portion of the swale by this activity.

Effectiveness - Exposure risks created by the existing state of the silver contaminated portion of the swale are reduced by this removal action in a relatively short span of time. A considerable amount of periodic maintenance will be required, however, for this minimal level of risk to the preserved.

Implementability - This technically unsophisticated remediation alternative is a well understood and widely used as a method of waste containment. The manpower and equipment required to accomplish a high level of cleanup under this alternative is readily available. Regulatory acceptance of this alternative could be difficult due to the need to monitor the long-term effectiveness of the cap.

Cost - Costs for this alternative contain both fixed and recurring components. While the initial costs for consolidating the soil and constructing the cap are relatively low at approximately $253,174, the ongoing expenses incurred for cap security and maintenance may eventually exceed this construction expense.

5.4 ALTERNATIVE 4: EXCAVATION AND OFFSITE DISPOSAL

Under this alternative silver-contaminated soil would be excavated, transported to a commercial landfill and disposed. Approximately 1,706 yd^3 would be excavated and transported to the disposal facility.

Effectiveness - Exposure risks at the site created by the existing state of the silver-contaminated swale are significantly reduced by this removal action. Risk reduction is completely effected in a relatively short time frame with no further maintenance required.

Implementability - This technically-unsophisticated remediation alternative is a well-understood, widely-used and accepted method of waste disposal. The manpower and equipment needed to achieve a high level of remediation success under this alternative are readily available.

Cost - The expense for implementing this alternative is comprised primarily of construction costs, transportation costs, and the tipping fee assessed by the commercial landfill. The total cost for this alternative is approximately $514,397.

6.0 SUMMARY AND RECOMMENDED ALTERNATIVES

6.1 COMPARATIVE ANALYSIS

The performance evaluations for each of the four remediation alternatives considered for use at IR Site 5, Swale 2 are summarized according to Effectiveness, Implementability, and Cost in Table 6-1. The final selection of a remediation alternative for IR Site 5, Swale 2 is made by identifying the most effective alternative which can be readily implemented for the lowest cost.

Excavation and onsite or offsite disposal alternatives are considered more effective than the on-site consolidation and capping alternative. On-site capping maintains a risk of future release to the sensitive environments of the downstream marshes and an aquatic environment at IR Site 5. The excavation, stabilization and onsite disposal alternative is considered slightly more effective than either the excavation and onsite disposal or excavation and offsite disposal alternatives since stabilization provides added protection against silver migration within the disposal area. The location of the Rum Point Gravel Pit and the low potential for silver to leach from the soils make the excavation options highly effective for meeting the removal action objectives. By depositing the excavated soil in an offsite commercial disposal facility, the availability for future development of the Rum Point Gravel Pit at the NSWC is not limited by the presence of the silver-contaminated soil. Site contamination is confined to an established, offsite disposal facility engineered and licensed to accept this waste.

All four alternatives are technically feasible. The techniques are commonly used and there are many sources for equipment and personnel capable of implementing any one of these alternatives. The administrative feasibility of excavation and onsite disposal, with or without stabilization, of the silver contaminated soil is high. Based on TCLP results, the silver-contaminated soil is not considered hazardous and there are no direct exposure human health effects, therefore the soil could be used as backfill. In addition, the administrative feasibility of offsite disposal is high, although additional costs associated with disposal fees and transportation would be incurred. The administrative feasibility of on-site consolidation and capping is considered low from a regulatory acceptance perspective. The ability to ensure the cap's integrity is maintained over time is a potential source of concern for the Maryland Department of the Environment.

TABLE 6-1

COMPARISON OF ALTERNATIVES FOR EFFECTIVENESS
SITE 5 - SWALE 2
INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

Alternative	Effectiveness	Implementability	Cost
1. Excavation, Stabilization, and Placement at the Rum Point Site	High	High	$573,020
2. Excavation and Placement at the Rum Point Site	Moderate/High	High	$261,504
3. Consolidation and Capping	Moderate	Moderate	$310,524[1]
4. Excavation and Offsite Disposal	Moderate/High	High	$514,397

(1) Includes present value for $5,000 annual maintenance expense at 6% over 20 years ($57,350).

Costs are also shown on Table 6-1. Excavation, stabilization, and onsite disposal is the most expensive alternative. Initial costs of the on-site consolidation and capping are the lowest, however, cap maintenance costs over a 20 year period are considerable. Excavation and onsite disposal at the Rum Point Gravel Pit is the least total cost alternative.

6.2 RECOMMENDATION

Excavation and onsite disposal at the Rum Point Gravel Pit is the proposed removal action alternative. This alternative is effective in meeting the objectives of the removal action and is protective of the environment. Excavation and onsite disposal is easily implemented at a reasonable cost and the removal action can be completed in a short period of time. Additionally, the added protectiveness of stabilization is not required based on the leachability of silver from the soil.

REFERENCES

1. ABB Environmental Services (ABB-ES), 1993. Removal Action Findings Report.

2. ABB Environmental Services (ABB-ES), 1991. Draft Site Characterization and Remediation Evaluation Report.

3. Agency for Toxic Substances and Disease Registry (ATSDR), February 16, 1990. Toxicological Profile for Silver. Atlanta, GA.

4. USEPA, October 1980. Ambient Water Quality Criteria for Silver. Office of Water Regulations and Standards, Washington, D.C. EPA 440/5-80-071.

5. USEPA, December 1989. Risk Assessment Guidance for Superfund - Volume I, Human Health Evaluation Manual (Part A). Interim Final. EPA/540/1-89/002. Office of Emergency and Remedial Response, Washington, D.C. 20450.

6. USEPA, 1991. Origin of Human Health Criteria. Office of Water, Washington, D.C.

7. USEPA, December 1991. Risk Assessment Guidance for Superfund - Volume I, Human Health Evaluation Manual (Part B), "Development of Risk-based Preliminary Remediation Goals". Interim. OSWER Directive 9285.7-01B. Office of Emergency and Remedial Response, Washington, D.C. 20450.

8. USEPA, 1993. Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA. Office of Emergency and Remedial Response. EPA/540-R-93-057. August 1993.

9. Halliburton NUS Environmental Corporation, 1994. Field Sampling Report for Site 5 - Swale 2.

APPENDIX A

COST ESTIMATES

NAVAL SURFACE WARFARE CENTER
Indian Head, Maryland
Alternative 1: Excavation, Stabalization and Placement at Rum Point Dump Site

ITEM	QUANTITY	UNIT	UNIT COST Sub.	UNIT COST Mat.	UNIT COST Labor	UNIT COST Equip	TOTAL COST Sub.	TOTAL COST Mat.	TOTAL COST Labor	TOTAL COST Equip	TOTAL DIRECT COST	COMMENTS
Mobilization/Demobilization												
1) Office Trailer	1	Mos.	$500.00				$500	$0	$0	$0	$500	
2) Equipment Mobilization	1	LS	$12,500.00				$12,500	$0	$0	$0	$12,500	
3) Equipment Demobilization	1	LS	$9,000.00				$9,000	$0	$0	$0	$9,000	
Decontamination Facilities												
1) Decon Services	1	Mos.	$1,000.00				$1,000	$0	$0	$0	$1,000	
2) Decon Water Disposal	1500	Gal.	$0.20				$300	$0	$0	$0	$300	
3) Personnel Decon Pad												
a) Concrete Pad - 4"	2	CY.		$70.00	$125.00	$5.00	$0	$140	$250	$10	$400	
b) Curb	40	LF.		$3.07	$1.99	$0.05	$0	$123	$80	$2	$204	
4) Clean Water Storage Tank	1	LS		$1,000.00	$200.00		$0	$1,000	$200	$0	$1,200	1000 Gallon
Access Road												
1) Access Road	810	SY.		$6.00	$0.90	$0.90	$0	$3,660	$549	$549	$4,758	
CLEARING												
1) Clear & Grub	0.5	Acre			$920.00	$1,100.00	$0	$0	$460	$550	$1,010	
SWALE REMEDIATION												
1) Treatability Study	1	LS	$30,000.00				$30,000	$0	$0	$0	$30,000	
2) Excavation	1706	CY.			$4.00	$5.00	$0	$0	$6,824	$8,530	$15,354	
3) Stabilization	1706	CY.	$60.00				$102,360	$0	$0	$0	$102,360	
4) Hauling Stabilized Soil	1706	CY			$2.39	$7.50	$0	$0	$4,077	$12,795	$16,872	
5) Place, Spread & Compact	1706	CY			$0.84	$2.67	$0	$0	$1,433	$4,555	$5,988	
6) Deliver and Spread Clean Cover												
at Rum Point Dump Site												
a)12 in. Low Permeability Soil	500	CY		$18.50	$0.84	$2.67	$0	$9,250	$420	$1,335	$11,005	
b) 12 in. Clean Backfill	500	CY		$15.00	$0.84	$2.67	$0	$7,500	$420	$1,335	$9,255	
c) 6 in. Topsoil	250	CY		$20.00	$0.84	$2.67	$0	$5,000	$210	$668	$5,878	
7) Seed Clean Cover	13.4	MSF		$24.60	$8.40	$6.68	$0	$330	$113	$90	$532	
SWALE RESTORATION												
1) Place, Spread, Compact - Clean Backfill	993	CY		$15.00	$0.84	$2.67	$0	$14,895	$834	$2,651	$18,380	
2) Place, Spread, Compact - 6 in Topsoil	713	CY		$20.00	$0.84	$2.67	$0	$14,260	$599	$1,904	$16,763	
3) Revegetation	8	MSF		$24.60	$8.40	$6.68	$0	$197	$67	$53	$317	
Total							$155,660	$56,354	$16,536	$35,026	$263,577	
Burden @ 30% Labor Cost									$4,961		$4,961	
Labor @ 10% Labor Cost									$1,654		$1,654	
Material @ 10% Material Cost								$5,635			$5,635	
SubContract @ 10% of Sub. Cost							$15,566				$15,566	
Total Direct Cost							$171,226	$61,990	$23,150	$35,026	$291,392	
Indirects @ 75% of Total Dir. Lab. Cost									$17,363		$17,363	
Profits @ 10% of Total Direct Cost											$29,139	
Total											$337,894	
Health & Safety Monitoring @ 10%											$33,789	
Total Field Cost											$371,683	
Contingency @ 20% Total Field Cost											$74,337	
TOTAL CONSTRUCTION COST											$446,020	
Engineering Cost: Permitting, Design Engineering, Health & Safety Plan, Sampling & Analysis, Report Preparation											$127,000	
TOTAL PROJECT COST: ALT. #1											$573,020	

NAVAL SURFACE WARFARE CENTER
Indian Head, Maryland
Alternative 2: Excavation and Placement at Rum Point Dump Site

ITEM	QUANTITY	UNIT	UNIT COST Sub.	UNIT COST Mat.	UNIT COST Labor	UNIT COST Equip	TOTAL COST Sub.	TOTAL COST Mat.	TOTAL COST Labor	TOTAL COST Equip	TOTAL DIRECT COST	COMMENTS
Mobilization/Demobilization												
1) Office Trailer	1	Mos.	$500.00				$500	$0	$0	$0	$500	
2) Equipment Mobilization	1	LS	$12,500.00				$12,500	$0	$0	$0	$12,500	
3) Equipment Demobilization	1	LS	$9,000.00				$9,000	$0	$0	$0	$9,000	
Decontamination Facilities												
1) Decon Services	1	Mos.	$1,000.00				$1,000	$0	$0	$0	$1,000	
2) Decon Water	1500	Gal.	$0.20				$300	$0	$0	$0	$300	
3) Personnel Decon Pad												
a) Concrete Pad - 4"	2	CY.		$70.00	$125.00	$5.00	$0	$140	$250	$10	$400	
b) Curb	40	LF.		$3.07	$1.99	$0.05	$0	$123	$80	$2	$204	
4) Clean Water Storage Tank	1	LS		$1,000.00	$200.00		$0	$1,000	$200	$0	$1,200	1000 Gallon
Access Road												
1) Access Road	610	SY.		$6.00	$0.90	$0.90	$0	$3,660	$549	$549	$4,758	
CLEARING												
1) Clear & Grub	0.5	Acre			$920.00	$1,100.00	$0	$0	$460	$550	$1,010	
SWALE REMEDIATION												
1) Excavation	1706	CY.			$4.00	$5.00	$0	$0	$6,824	$8,530	$15,354	
2) Hauling Excavated Soil	1706	CY			$2.39	$7.50	$0	$0	$4,077	$12,795	$16,872	
3) Place, Spread & Compact	1706	CY			$0.84	$2.67	$0	$0	$1,433	$4,555	$5,988	
4) Deliver and Spread Clean Cover												
at Rum Point Dump Site												
a)12 in. Low Permeability Soil	500	CY		$18.50	$0.84	$2.67	$0	$248	$11	$36	$295	
b) 12 in. Clean Backfill	500	CY		$15.00	$0.84	$2.67	$0	$201	$11	$36	$248	
c) 6 in. Topsoil	250	CY		$20.00	$0.84	$2.67	$0	$0	$0	$0	$0	
5) Seed Clean Cover	13.4	MSF		$24.60	$8.40	$6.68	$0	$330	$113	$90	$532	
SWALE RESTORATION												
1) Place, Spread, Compact - Clean Backfill	993	CY		$15.00	$0.84	$2.67	$0	$120	$7	$21	$148	
2) Place, Spread, Compact - 6 in Topsoil	713	CY		$20.00	$0.84	$2.67	$0	$0	$0	$0	$0	
3) Revegetation	8	MSF		$24.60	$8.40	$6.68	$0	$197	$67	$53	$317	
Total							$23,300	$6,018	$14,082	$27,227	$70,627	
Burden @ 30% Labor Cost									$4,225		$4,225	
Labor @ 10% Labor Cost									$1,408		$1,408	
Material @ 10% Material Cost								$602			$602	
SubContract @ 10% of Sub. Cost							$2,330				$2,330	
Total Direct Cost							$25,630	$6,620	$19,715	$27,227	$79,192	
Indirects @ 75% of Total Dir. Lab. Cost									$14,786		$14,786	
Profits @ 10% of Total Direct Cost											$7,919	
Total											$101,897	
Health & Safety Monitoring @ 10% of Total											$10,190	
Total Field Cost											$112,087	
Contingency @ 20% Total Field Cost											$22,417	
TOTAL CONSTRUCTION COST											$134,504	
Engineering Cost: Permitting, Design Engineering, Health & Safety Plan, Sampling & Analysis, Report Preparation											$127,000	
TOTAL PROJECT COST: ALT. #2											$261,504	

NAVAL SURFACE WARFARE CENTER													
Indian Head, Maryland													
Alternative 3: Consolidation and Capping													
												TOTAL	
ITEM	QUANTITY	UNIT	UNIT COST					TOTAL COST				DIRECT	COMMENTS
			Sub.	Mat.	Labor	Equip		Sub.	Mat.	Labor	Equip	COST	
Mobilization/Demobilization													
1) Office Trailer	1	Mos.	$500.00					$500	$0	$0	$0	$500	
2) Equipment Mobilization	1	LS	$12,500.00					$12,500	$0	$0	$0	$12,500	
3) Equipment Demobilization	1	LS	$9,000.00					$9,000	$0	$0	$0	$9,000	
Decontamination Facilities													
1) Decon Services	1	Mos.	$1,000.00					$1,000	$0	$0	$0	$1,000	
2) Decon Water	1500	Gal.	$0.20					$300	$0	$0	$0	$300	
3) Personnel Decon Pad													
a) Concrete Pad - 4"	2	CY.		$70.00	$125.00	$5.00		$0	$140	$250	$10	$400	
b) Curb	40	LF.		$3.07	$1.99	$0.05		$0	$123	$80	$2	$204	
4) Clean Water Storage Tank	1	LS		$1,000.00	$200.00			$0	$1,000	$200	$0	$1,200	1000 Gallon
Access Road													
1) Access Road	610	SY.		$6.00	$0.90	$0.90		$0	$3,660	$549	$549	$4,758	
CLEARING													
1) Clear & Grub	0.5	Acre			$920.00	$1,100.00		$0	$0	$460	$550	$1,010	
SWALE REMEDIATION													
1) Excavation	853	CY.			$4.00	$5.00		$0	$0	$3,412	$4,265	$7,677	
2) Low Permeable Soil Layer - 12"	484	CY		$18.50	$0.00	$0.00		$0	$8,954	$0	$0	$8,954	
a) Place, Spread & Compact	484	CY			$0.84	$2.67		$0	$0	$407	$1,292	$1,699	
3) Backfill Layer - 12"	968	CY		$15.00	$0.00	$0.00		$0	$14,520	$0	$0	$14,520	
a) Place, Spread & Compact	968	CY			$0.84	$2.67		$0	$0	$813	$2,585	$3,398	
4) Topsoil Layer - 6"	242	CY		$20.00	$0.00	$0.00		$0	$4,840	$0	$0	$4,840	
a) Place, Spread & Compact	242	CY			$0.63	$0.57		$0	$0	$152	$138	$290	
5) Revegetation	8	MSF		$24.60	$8.40	$6.68		$0	$197	$67	$53	$317	
Total								**$23,300**	**$33,434**	**$6,390**	**$9,444**	**$72,568**	
Burden @ 30% Labor Cost										$1,917		$1,917	
Labor @ 10% Labor Cost										$639		$639	
Material @ 10% Material Cost									$3,343			$3,343	
SubContract @ 10% of Sub. Cost								$2,330				$2,330	
Total Direct Cost								**$25,630**	**$36,777**	**$8,946**	**$9,444**	**$80,797**	
Indirects @ 75% of Total Dir. Lab. Cost										$6,709		$6,709	
Profits @ 10% of Total Direct Cost												$8,080	
Total												**$95,586**	
Health & Safety Monitoring @ 10% of Total												$9,559	
Total Field Cost												**$105,145**	
Contingency @ 20% Total Field Cost												$21,029	
TOTAL CONSTRUCTION COST												**$126,174**	
Engineering Cost: Permitting, Design Engineering, Health & Safety Plan, Sampling & Analysis, Report Preparation												$127,000	
TOTAL PROJECT COST: ALT. #3												**$253,174**	

NAVAL SURFACE WARFARE CENTER													
Indian Head, Maryland													
Alternative 4: Excavation and Off-Site Disposal													
ITEM	QUANTITY	UNIT	UNIT COST					TOTAL COST				TOTAL DIRECT COST	COMMENTS
			Sub.	Mat.	Labor	Equip		Sub.	Mat.	Labor	Equip		
Mobilization/Demobilization													
1) Office Trailer	1	Mos.	$500.00					$500	$0	$0	$0	$500	
2) Equipment Mobilization	1	LS	$12,500.00					$12,500	$0	$0	$0	$12,500	
3) Equipment Demobilization	1	LS	$9,000.00					$9,000	$0	$0	$0	$9,000	
Decontamination Facilities													
1) Decon Services	1	Mos.	$1,000.00					$1,000	$0	$0	$0	$1,000	
2) Decon Water	1500	Gal.	$0.20					$300	$0	$0	$0	$300	
3) Personnel Decon Pad													
a) Concrete Pad - 4"	2	CY.		$70.00	$125.00	$5.00		$0	$140	$250	$10	$400	
b) Curb	40	LF.		$3.07	$1.99	$0.05		$0	$123	$80	$2	$204	
4) Clean Water Storage Tank	1	LS		$1,000.00	$200.00			$0	$1,000	$200	$0	$1,200	1000 Gallon
Access Road													
1) Access Road	610	SY.		$6.00	$0.90	$0.90		$0	$3,660	$549	$549	$4,758	
CLEARING													
1) Clear & Grub	0.5	Acre			$920.00	$1,100.00		$0	$0	$460	$550	$1,010	
SWALE REMEDIATION													
1) Excavation	1706	CY.			$4.00	$5.00		$0	$0	$6,824	$8,530	$15,354	
2) Haul & Dispose Soil at Off-Site Facility	1706	CY	$110.00					$187,660	$0	$0	$0	$187,660	
SWALE RESTORATION													
1) Place, Spread, Compact - Clean Backfill	993	CY		$15.00	$0.84	$2.67		$0	$0	$0	$0	$0	
2) Place, Spread, Compact - 6 in Topsoil	713	CY		$20.00	$0.84	$2.67		$0	$0	$0	$0	$0	
3) Revegetation	8	MSF		$24.60	$8.40	$6.68		$0	$0	$0	$0	$0	
Total								**$210,960**	**$4,923**	**$8,363**	**$9,641**	**$233,886**	
Burden @ 30% Labor Cost										$2,509		$2,509	
Labor @ 10% Labor Cost										$836		$836	
Material @ 10% Material Cost									$492			$492	
SubContract @ 10% of Sub. Cost								$21,096				$21,096	
Total Direct Cost								**$232,056**	**$5,415**	**$11,708**	**$9,641**	**$258,820**	
Indirects @ 75% of Total Dir. Lab. Cost										$8,781		$8,781	
Profits @ 10% of Total Direct Cost												$25,882	
Total												**$293,482**	
Health & Safety Monitoring @ 10% of Total												$29,348	
Total Field Cost												$322,831	
Contingency @ 20% Total Field Cost												$64,566	
TOTAL CONSTRUCTION COST												$387,397	
Engineering Cost: Permitting, Design Engineering, Health & Safety Plan, Sampling & Analysis, Report Preparation												$127,000	
TOTAL PROJECT COST: ALT. #4												$514,397	

APPENDIX B

SUPPORTING CALCULATIONS - REMOVAL ACTION

CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT: CTO 157	JOB NUMBER: 1370 * 0210
SUBJECT: VOLUME CALCULATION	
BASED ON: ACAD C:\1370\SOLSSAMPLE DWG	DRAWING NUMBER: FIGURE 1-2
BY: KFD / CHECKED BY: [signature]	APPROVED BY: / DATE: 5-3-94

CALCULATIONS BASED ON PLANIMETER AREA READINGS FOR FULL-SCALE COPY OF FIGURE 1-2. (See next page)

AREA TO 12 = 38,499.61 SF → PLANIMETER - 96.25 in^2

$VOLUME_{12''}$ = 38,499.61 CF

= 1,426 CY

AREA TO 30" = 5,039.82 SF → PLANIMETER - 12.60 in^2

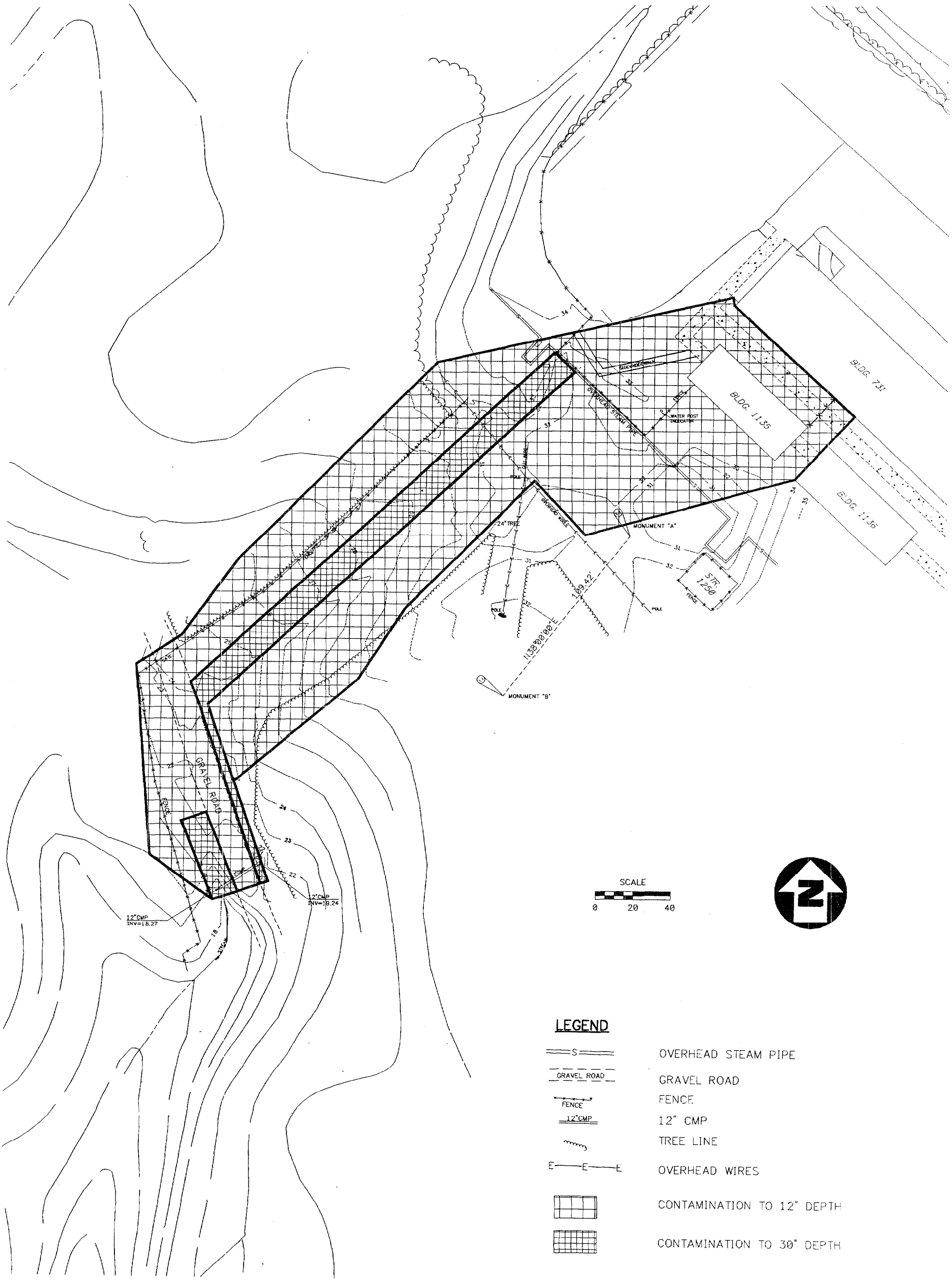
$VOLUME_{\Delta 18''}$ = 5,039.82 · 1.5 = 7,559.73 CF

= 280 CY

TOTAL = 1,706 CY

AREA = 38,500 SF

ACAD: C:\1370\SOLSAMPLE.DWG RSG 5/10/94 view 11x17



ESTIMATED LIMITS OF SILVER CONTAMINATION
IR SITE 5
INDIAN HEAD DIVISION, NSWC
INDIAN HEAD, MARYLAND

HALLIBURTON NUS CORPORATION

004DA032

CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT: US NAVY - INDIAN HEAD, MD	JOB NUMBER: 1370
SUBJECT: DISPOSAL AREA CALCULATIONS.	
BASED ON:	DRAWING NUMBER:

BY	CHECKED BY	APPROVED BY	DATE
SWR	JH		4/25/94

ONSITE DISPOSAL AREA: (FROM FIGURE ON PAGE 2 OF 2)

BASED ON PLANIMETER, AREA = 8.37 SQ IN
SCALE = 1": 40'

AREA ACTUAL = 1600 SF : 1 SQ IN
= 1600 SF x 8.37 = 13392 SQ FT

VOLUME OF CLEAN BACKFILL @ DISPOSAL AREA:

BASED ON 2 FT DEPTH

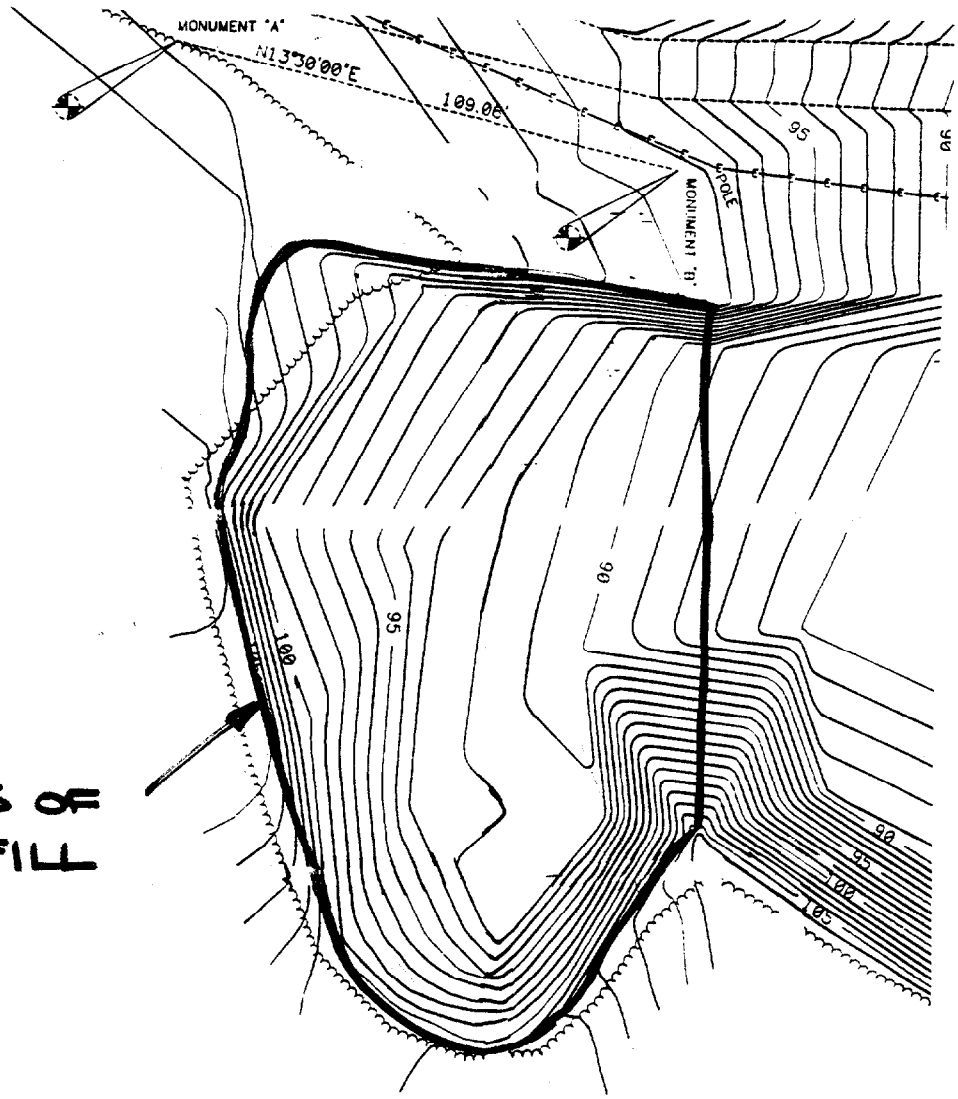
13392 x 2 = 26784 CF
= 992 CY
⇒ USE 1000 CY

VOLUME OF TOPSOIL @ DISPOSAL AREA:

13392 x .5 = 6696 CF
= 248 CY
⇒ USE 250 CY

CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT: US NAVY - INDIAN HEAD, MD	JOB NUMBER: 1370
SUBJECT: DISPOSAL AREA CALCULATIONS	
BASED ON:	DRAWING NUMBER:
BY: SLR	CHECKED BY:
APPROVED BY:	DATE: 4/25/94



LIMITS OF BACKFILL

SCALE
1" = 40'

APPENDIX C

RISK ASSESSMENT CALCULATIONS

CALCULATION WORKSHEET Order No. 19116 (01-91) PAGE 1 OF 3

CLIENT NSWC INDIAN HEAD - CTO 157 - SITE 5		JOB NUMBER 1454	
SUBJECT CALCULATION OF SOIL PRELIMINARY REMEDIATION GOALS			
BASED ON USEPA, RAGS (Part B), December 1991.		DRAWING NUMBER	
BY NORMAN STRAUB	CHECKED BY	APPROVED BY	DATE 04-01-94

PURPOSE:

Calculate site-specific risk-based preliminary remediation goals for soil exposure by adult maintenance receptors via incidental ingestion exposure route.

ASSUMPTIONS:

- Ingestion from all outdoor activities are considered.
- Receptors exposed under maintenance conditions.

RELEVANT EQUATIONS:

- Risk-based Preliminary Remediation Goal

For noncarcinogens:

$$C_{soil}\ (mg/Kg) = \frac{THI \times RfD \times BW \times AT \times 365}{IR_{soil} \times EF \times ED \times CF}$$

Where:
- C_{soil} = Chemical-specific PRG concentration in soil (mg/Kg)
- THI = Target Hazard Index (unitless)
- RfD = Chemical-specific reference dose (mg/Kg-day)
- BW = Receptor body weight (Kg)
- ED = Exposure duration (yr)
- 365 = Conversion factor (days/yr)
- IR_{soil} = Soil ingestion rate (mg/day)
- EF = Exposure frequency (days/yr)
- CF = Conversion factor (10^{-6} Kg/mg)
- AT = Averaging time = ED (yr)

For carcinogens:

$$C_{soil}\ (mg/Kg) = \frac{TR \times BW \times AT \times 365}{CSF \times IR_{soil} \times EF \times ED \times CF}$$

Where:
- C_{soil} = Chemical-specific PRG concentration in soil (mg/Kg)
- TR = Target cancer risk (unitless)
- BW = Receptor body weight (Kg)
- LT = Receptor lifetime (yr)
- 365 = Conversion factor (days/yr)
- CSF = Chemical-specific cancer slope factor $(mg/Kg\text{-}day)^{-1}$
- IR_{soil} = Soil ingestion rate (mg/day)
- EF = Exposure frequency (days/yr)
- ED = Exposure duration (yr)
- CF = Conversion factor (10^{-6} Kg/mg)

CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT NSWC INDIAN HEAD - CTO 157 - SITE 5		JOB NUMBER 1454	
SUBJECT CALCULATION OF SOIL PRELIMINARY REMEDIATION GOALS			
BASED ON USEPA, RAGS (Part B), December 1991.		DRAWING NUMBER	
BY	CHECKED BY	APPROVED BY	DATE 04/01/94

SAMPLE CALCULATION:

For silver at Site 5, a reference dose of 5×10^{-3} mg/Kg-day is reported. The following maintenance receptor exposure input parameters are used. No carcinogenic effects are reported for silver.

Parameter	Value	Units	Source/Rationale
THI	1.0	unitless	Target hazard index of unity
RfD	5×10^{-3}	mg/Kg-day	IRIS, December 1993
IR	50	mg/day	USEPA, March 25, 1991
ED	25	years	USEPA, March 25, 1991
EF	50	days/yr	Estimate based on weekly maintenance
BW	70	Kg	USEPA, March 25, 1991

- Noncarcinogenic PRG for silver

For noncarcinogens:

$$C_{soil}\ (mg/Kg) = \frac{THI \times RfD \times BW \times ED \times 365}{IR_{soil} \times EF \times ED \times CF}$$

Substituting;

$$C_{soil}\ (mg/Kg) = \frac{(1.0)\ (5 \times 10^{-3} mg/Kg\text{-}day)\ (70\ Kg)\ (25\ yrs)\ (365\ days/yr)}{(50\ mg/day)\ (50\ days/yr)\ (25\ yrs)\ (10^{-6}\ Kg/mg)}$$

$$C_{soil} = 51100\ mg/Kg$$

CLIENT NSWC INDIAN HEAD - CTO 157 - SITE 5		JOB NUMBER 1454	
SUBJECT CALCULATION OF SOIL PRELIMINARY REMEDIATION GOALS			
BASED ON USEPA, RAGS (Part B), December 1991.		DRAWING NUMBER	
BY AJS	CHECKED BY KMS	APPROVED BY	DATE 04/01/94

REFERENCES:

USEPA, December 1991. Risk Assessment Guidance for Superfund - Volume I, Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals). Interim. OSWER Directive 9285.7-01B. Office of Emergency and Remedial Response, Washington, D.C., 20460.

USEPA, March 25, 1991. Risk Assessment Guidance for Superfund - Volume I, Human Health Evaluation Manual Supplemental Guidance - "Standard Default Exposure Factors". Interim Final. OSWER Directive 9285.6-03. Office of Emergency and Remedial Response, Washington, D.C., 20460.

Integrated Risk Information System (IRIS), On Line. December, 1993.

USEPA, December 1989. Risk Assessment Guidance for Superfund - Volume I, Human Health Evaluation Manual Part A. EPA/540/1-89/002.

CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT NSWC INDIAN HEAD - CTO 157 - SITE 5		JOB NUMBER 1454	
SUBJECT CALCULATION OF SOIL PRELIMINARY REMEDIATION GOALS			
BASED ON USEPA, RAGS (Part B), December 1991.		DRAWING NUMBER	
BY NORMAN STRAUB	CHECKED BY	APPROVED BY	DATE 04/01/94

PURPOSE:

Calculate site-specific risk-based preliminary remediation goals for soil exposure by adult maintenance receptors via dermal contact exposure route.

ASSUMPTIONS:

- Dermal uptake from all outdoor activities are considered.
- Receptors exposed under maintenance conditions.

RELEVANT EQUATIONS:

- Risk-based Preliminary Remediation Goal

For noncarcinogens:

$$C_{soil}\ (mg/Kg) = \frac{THI \times RfD \times BW \times AT \times 365}{SA \times AF \times ABS \times EF \times ED \times CF}$$

Where:
- C_{soil} = Chemical-specific PRG concentration in soil (mg/Kg)
- THI = Target Hazard Index (unitless)
- RfD = Chemical-specific reference dose (mg/Kg-day)
- BW = Receptor body weight (Kg)
- ED = Exposure duration (yr)
- 365 = Conversion factor (days/yr)
- SA = Receptor skin surface area (cm^2)
- AF = Soil-to skin adherence factor (mg/cm^2)
- ABS = Fraction of contaminant absorbed through skin
- EF = Exposure frequency (days/yr)
- CF = Conversion factor (10^{-6} Kg/mg)
- AT = Averaging time = ED (yr)

For carcinogens:

$$C_{soil}\ (mg/Kg) = \frac{TR \times BW \times AT \times 365}{CSF \times SA \times AF \times ABS \times EF \times ED \times CF}$$

Where:
- C_{soil} = Chemical-specific PRG concentration in soil (mg/Kg)
- TR = Target cancer risk (unitless)
- BW = Receptor body weight (Kg)
- AT = Receptor lifetime (yr)
- 365 = Conversion factor (days/yr)
- CSF = Chemical-specific cancer slope factor $(mg/Kg\text{-}day)^{-1}$
- SA = Receptor skin surface area (cm^2)
- AF = Soil-to skin adherence factor (mg/cm^2)
- ABS = Fraction of contaminant absorbed through skin
- EF = Exposure frequency (days/yr)
- ED = Exposure duration (yr)
- CF = Conversion factor (10^{-6} Kg/mg)

CALCULATION WORKSHEET Order No. 19116 (01-91) PAGE ____ OF ____

CLIENT NSWC INDIAN HEAD - CTO 157 - SITE 5		JOB NUMBER 1454	
SUBJECT CALCULATION OF SOIL PRELIMINARY REMEDIATION GOALS			
BASED ON USEPA, RAGS (Part B), December 1991.		DRAWING NUMBER	
BY	CHECKED BY	APPROVED BY	DATE 04/01/94

SAMPLE CALCULATION:

For silver at Site 5, a reference dose of 5×10^{-3} mg/Kg-day is reported. The following maintenance receptor exposure input parameters are used. No carcinogenic effects are reported for silver.

Parameter	Value	Units	Source/Rationale
THI	1.0	unitless	Target hazard index of unity
RfD	1×10^{-3}	mg/Kg-day	Oral RfD (5×10^{-3} mg/kg-day; IRIS, December 1993) adjusted for absorption (ABS = 20%).
SA	5000	cm^2/event	Estimate based on 95th %-ile adult male trunk and arms
AF	1.0	mg/cm^2	USEPA, January 1992
ABS	0.01	fraction	Estimate based on toxicity profile
ED	30	years	USEPA, March 25, 1991
EF	50	events/yr	Estimate based on weekly maintenance
BW	70	Kg	USEPA, March 25, 1991

- Noncarcinogenic PRG for silver

For noncarcinogens:

$$C_{soil}\ (mg/Kg) = \frac{THI \times RfD \times BW \times ED \times 365}{SA \times AF \times ABS \times EF \times ED \times CF}$$

Substituting;

$$C_{soil}\ (mg/Kg) = \frac{(1.0)\ (1 \times 10^{-3} mg/Kg\text{-}day)\ (70\ Kg)\ (25\ yrs)\ (365\ days/yr)}{(5000\ cm^2/event)\ (1.0\ mg/cm^2)\ (0.01)\ (50\ events/yr)\ (25\ yrs)\ (10^{-6}\ Kg/mg)}$$

$$C_{soil} = 102200\ mg/Kg$$

CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT NSWC INDIAN HEAD - CTO 157 - SITE 5		JOB NUMBER 1454	
SUBJECT CALCULATION OF SOIL PRELIMINARY REMEDIATION GOALS			
BASED ON USEPA, RAGS (Part B), December 1991.		DRAWING NUMBER	
BY	CHECKED BY	APPROVED BY	DATE 04/01/94

REFERENCES:

USEPA, January 1992. Dermal Exposure Assessment: Principles and Applications. Interim. EPA/600/8-91/011B. Office of Research and Development, Washington, D.C., 20460.

USEPA, December 1991. Risk Assessment Guidance for Superfund - Volume I, Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals). Interim. OSWER Directive 9285.7-01B. Office of Emergency and Remedial Response, Washington, D.C., 20460.

USEPA, March 25, 1991. Risk Assessment Guidance for Superfund - Volume I, Human Health Evaluation Manual Supplemental Guidance - "Standard Default Exposure Factors". Interim Final. OSWER Directive 9285.6-03. Office of Emergency and Remedial Response, Washington, D.C., 20460.

Integrated Risk Information System (IRIS), On Line. December, 1993.

USEPA, December 1989. Risk Assessment Guidance for Superfund - Volume I, Human Health Evaluation Manual Part A. EPA/540/1-89/002.

CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT	JOB NUMBER		
NSWC INDIAN HEAD - CTO 157 - SITE 5	1454		
SUBJECT			
CALCULATION OF SOIL PRELIMINARY REMEDIATION GOALS FOR INHALATION			
BASED ON	DRAWING NUMBER		
USEPA, RAGS (Part B), December 1991			
BY NORMAN STRAUB	CHECKED BY KMS	APPROVED BY	DATE 04/01/94

PURPOSE:

Calculate site-specific risk-based preliminary remediation goals for soil exposure by adult maintenance receptors via inhalation of fugitive dust exposure route.

ASSUMPTIONS:

- Inhalation of outdoor air considered.
- Receptors exposed under maintenance conditions.

RELEVANT EQUATIONS:

- Risk-based Preliminary Remediation Goal

For noncarcinogens:

$$C_{air}\ (mg/m^3) = THI \times \left(\frac{RfD_{inh} \times BW \times AT \times 365}{0.125 \times InhR \times F_i \times EF \times ED} + \frac{RfD_{ing} \times BW \times AT \times 365}{0.625 \times InhR \times F_i \times EF \times ED}\right)$$

Where:

C_{air}	=	Chemical-specific PRG concentration in air (mg/m^3)
THI	=	Target Hazard Index (unitless)
RfD_{inh}	=	Chemical-specific inhalation reference dose (mg/Kg-day)
RfD_{ing}	=	Chemical-specific oral reference dose (mg/Kg-day)
BW	=	Receptor body weight (Kg)
ED	=	Exposure duration (yr)
365	=	Conversion factor (days/yr)
InhR	=	Inhalation rate (m^3/day)
F_i	=	Fraction of time spent at site (unitless)
EF	=	Exposure frequency (days/yr)
AT	=	Averaging time = ED (yr)

CLIENT		JOB NUMBER	
SUBJECT NSWC INDIAN HEAD - CTO 157 - SITE 5		1454	
BASED ON CALCULATION OF SOIL PRELIMINARY REMEDIATION GOALS FOR INHALATION		DRAWING NUMBER	
BY USEPA, RAGS (Part B), December 1991.	CHECKED BY	APPROVED BY	DATE 04/01/94

For carcinogens:

$$C_{air}\ (mg/m^3) = TR \times \left(\frac{BW \times AT \times 365}{0.125 \times CSF_{inh} \times InhR \times F_i \times EF \times ED} + \frac{BW \times AT \times 365}{0.625 \times CSF_{ing} \times InhR \times F_i \times EF}\right.$$

Where:
- C_{air} = Chemical-specific PRG concentration in air (mg/m^3)
- TR = Target cancer risk (unitless)
- BW = Receptor body weight (Kg)
- AT = Receptor lifetime (yr)
- 365 = Conversion factor (days/yr)
- CSF_{inh} = Chemical-specific inhalation cancer slope factor $(mg/Kg\text{-}day)^{-1}$
- CSF_{ing} = Chemical-specific oral cancer slope factor $(mg/Kg\text{-}day)^{-1}$
- InhR = Inhalation rate (m^3/day)
- F_i = Fraction of time spent at site (unitless)
- EF = Exposure frequency (days/yr)
- ED = Exposure duration (yr)

- Calculation of soil PRG

$$C_{soil}\ (mg/Kg) = \frac{C_{air}}{(x)(CF)}$$

Where:
- C_{soil} = Chemical-specific PRG concentration in soil (mg/Kg)
- x = Respirable soil emissions concentration (mg/m^3)
- CF = Conversion factor (10^{-6} Kg/mg)

SAMPLE CALCULATION:

For silver at Site 5, a reference dose of 5×10^{-3} mg/Kg-day is reported. The following maintenance receptor exposure input parameters are used. No inhalation reference dose or carcinogenic effects are reported for silver.

Parameter	Value	Units	Source/Rationale
THI	1.0	unitless	Target hazard index of unity
RfD	5×10^{-3}	mg/Kg-day	IRIS, December 1993
InhR	20	m^3/day	USEPA, March 25, 1991
F_i	0.33	unitless	8 hour working day
EF	50	days/yr	Estimate based on weekly maintenance
ED	25	years	USEPA, March 25, 1991
BW	70	Kg	USEPA, March 25, 1991

CLIENT		JOB NUMBER	
SUBJECT NSWC INDIAN HEAD - CTO 157 - SITE 5		1454	
BASED ON CALCULATION OF SOIL PRELIMINARY REMEDIATION GOALS FOR INHALATION		DRAWING NUMBER	
BY USEPA, RAGS (Part B), December 1991.	CHECKED BY	APPROVED BY	DATE 04/01/94

- Noncarcinogenic PRG for silver

For noncarcinogens:

$$C_{air}\ (mg/m^3) = THI \times \left(\frac{RfD_{inh} \times BW \times ED \times 365}{0.125 \times InhR \times F_I \times EF \times ED} + \frac{RfD_{ing} \times BW \times ED \times 365}{0.625 \times InhR \times F_I \times EF \times ED}\right)$$

$$C_{air}\ (mg/m^3) = (1.0) \times \left(\frac{(5 \times 10^{-3}\ mg/Kg\text{-}day) \times (70\ Kg) \times (25\ yr) \times (365\ day/yr)}{0.625 \times (20\ m^3/day) \times (0.33) \times (50\ day/yr) \times (25\ yr)}\right)$$

$$C_{air} = 0.619\ mg/m^3$$

- Soil PRG for silver

$$C_{soil}\ (mg/Kg) = \frac{0.619\ mg/m^3}{(2.67 \times 10^{-3}\ mg/m^3)\ (10^{-6}\ Kg/mg)} = 232{,}000{,}000\ mg/Kg$$

CLIENT		JOB NUMBER	
SUBJECT NSWC INDIAN HEAD - CTO 157 - SITE 5		1454	
BASED ON CALCULATION OF SOIL PRELIMINARY REMEDIATION GOALS FOR INHALATION		DRAWING NUMBER	
BY	CHECKED BY	APPROVED BY	DATE 04/01/94
USEPA, RAGS (Part B), December 1991.			

REFERENCES:

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CLIENT NSWC INDIAN HEAD - CTO 157 - SITE 5		JOB NUMBER	
SUBJECT CALCULATION OF FUGITIVE DUST EMISSION RATES			
BASED ON COWHERD, et al., September 1984.		DRAWING NUMBER	
BY NORMAN STRAUB NAS	CHECKED BY KMS	APPROVED BY	DATE 04/01/94

PURPOSE:

Estimate fugitive dust emission rates using model developed by the Exposure Assessment Group of the U.S. EPA's Office of Research and Development. The model used provides "order of magnitude" estimates of respirable dust concentrations (< 10 μm) due to wind erosion and mechanical resuspension.

ASSUMPTIONS:

- Fugitive dusts are assumed to be generated from limited and unlimited sources of respirable particles. The greatest generation rates are used as a conservative estimate of the emission rate.
- Meteorological data for Norfolk, Virginia used for the site, located at Indian Head, Maryland.
- Receptor exposed to dusts originating only from wind erosion. Mechanical resuspension and agitation not considered.
- Fugitive dusts are assumed to be ingested (as sputum) at a rate of 62.5% and absorbed through the lungs at a rate of 12.5% relative to the rate of material inhaled (Schaum, 1984)

RELEVANT EQUATIONS:

- Emission rate of respirable contaminant particles (R_{10})

$$R_{10} = \alpha \; E_{10} \; A$$

Where: R_{10} = Emission rate of contaminant as respirable particle (mg/hr)
α = Mass fraction of contaminant in soil (unitless)
E^{10} = Respirable particulate (<10μm) emission rate (mg/m^2-hr)
A = Source areal extent (m^2)

- Emission rate from surface with limited erosion potential (E_{10})

$$E_{10} = 0.83 \; \frac{f \;\; P(u^{+}) \;\; (1-V)}{\left(\frac{PE}{50}\right)^2}$$

Where: E_{10} = Respirable particulate (<10μm) emission rate (mg/m^2-hr)
f = Frequency of disturbance (events/month)
$P(u^{+})$ = Observed fastest mile windspeed (m/sec)
V = Fraction of vegetated cover (unitless)
PE = Thornthwaite's Evaporative Index (obtained from Figure 4-2)

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SUBJECT CALCULATION OF FUGITIVE DUST EMISSION RATES			
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- Erosion threshold windspeed (u_t)

$$u(z) = \left(\frac{u_*}{0.4}\right) \ln \left(\frac{z}{z_0}\right)$$

Where: u(z) = Windspeed at height z (m/sec)
u. = Threshold friction velocity (m/sec)
z = Height above surface (cm)
z_0 = Roughness height (cm)

The value for u. is determined from a site survey as the windspeed at the ground surface which results in erosion of the surface. The height above the surface (z) is the height from which windspeed data is obtained (typically from a 7 m high weather station). The roughness height (z_0) is obtained from Figure 3-6.

SAMPLE CALCULATION:

For Norfolk, Virginia, a mean annual windspeed of 4.7 m/sec and a fastest mile windspeed of 21.3 m/sec is reported. From an assumed mode particle size of 1 mm, a value of u. = 0.65 m/sec is obtained from Figure 3-4. Also, from Figure 3-6 a roughness height (z_0) of 1 cm is obtained for a bare field.

- Erosion threshold windspeed (u_t)

$$u(z) = \left(\frac{u_*}{0.4}\right) \ln \left(\frac{z}{z_0}\right)$$

Substituting;

$$u(z) = \left(\frac{0.65\ m/sec}{0.4}\right) \ln \left(\frac{700\ cm}{1\ cm}\right)$$

$$u_t = 10.6\ m/sec$$

- Emission rate from surface with limited erosion potential (E_{10})

$$E_{10} = 0.83\ \frac{f\ P(u^+)\ (1-V)}{\left(\frac{PE}{50}\right)^2}$$

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SUBJECT CALCULATION OF FUGITIVE DUST EMISSION RATES			
BASED ON COWHERD, et al., September 1984.		DRAWING NUMBER	
BY JHS	CHECKED BY KMS	APPROVED BY	DATE 04/01/94

and

$$P(u^+) = 6.7\ (u^+ - u(z))$$

Where: u^+ = Fastest wind speed (m/sec)

$$E_{10} = 0.83\ \frac{(\frac{50}{12})\ [(6.7)\ (21.3\ m/sec - 10.6\ m/sec)]\ (1-0)}{(\frac{111}{50})^2}$$

$$E_{10} = 50.3\ mg/m^2\text{-}hr$$

- Emission rate for Site 5:

Based on an area that is 1100 feet (335 m) long and 100 feet (31 m) wide an area of 10,385 m^2 is obtained. Under worst case conditions, limited reservior, the following emission rate can be expected from the site:

$$R_{10} = (50.3\ mg/m^2\text{-}hr)\ (10{,}385\ m^2)\ (10^{-6}\ Kg/mg) = 0.522\ Kg_{soil}\ /\ hour$$

- Dispersional modeling

Indian Head, MD is located in Climatic Zone 7 (from Figure 4-5). Therefore, the value P_R which corresponds is P_R = 0.296. This allows the calculation of the annual scaling factor and respirable concentration of dust.

Annual Scaling Factor Q_i

$$Q_i = \frac{R_{10}}{P_R} = \frac{0.522\ Kg_{soil}/hr}{0.296}\ x\ \frac{1\ hr}{3600\ sec}\ x\ \frac{1000\ gm}{1\ kg}$$

$$Q_i = 0.490\ gm/sec$$

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CLIENT NSWC INDIAN HEAD - CTO 157 - SITE 5		JOB NUMBER 1464	
SUBJECT CALCULATION OF FUGITIVE DUST EMISSION RATES			
BASED ON COWHERD, et al., September 1984.		DRAWING NUMBER	
BY	CHECKED BY KMS	APPROVED BY	DATE 04/01/94

Respirable concentration (X)

$$X = Q_l\, f_l = (0.490\ gm/sec)\ (5.454 \frac{\mu g\ sec}{gm\ m^3}) = 2.67\ \mu g/m^3$$

NSWC INDIAN HEAD - CTO 157 - SITE 5 1454

CALCULATION OF FUGITIVE DUST EMISSION RATES

COWHERD, et al., September 1984.

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