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# PHASE IIA INVESTIGATION SUMMARY TECHNICAL MEMORANDUM FOR ADDITIONAL SAMPLING SITE 41 NAS PENSACOLA FL

7/15/1996

ENSAFE/ALLEN AND HOSHALL

# Phase IIA Investigation Summary
# Technical Memorandum
# Site 41
# NAS Pensacola, Florida

**Prepared for:**

**NAS Pensacola Tier I Partnering Team**

**Prepared by:**

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**July 15, 1996**

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Attachment A Tier I Partnering Team Presentation

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July 15, 1996

Mr. Bill Hill, Code 185
SOUTHNAVFACENGCOM
2155 Eagle Drive
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Re: Site 41 Technical Memorandum

Dear Bill:

On behalf of the Navy, EnSafe/Allen and Hoshall is pleased to submit two copies of the Technical Memorandum for the Site 41 investigation. This memorandum is pursuant to the presentation given to the Tier I Partnering Team on April 16, 1996.

If you have any questions or request any additional information, please feel free to contact me.

Sincerely,

ENSAFE/ALLLEN AND HOSHALL

C. Mason

Chuck Mason
Environmental Scientist

Enclosure

## 1.0 INTRODUCTION

Pursuant to the April 16, 1996, Tier I partnering team meeting, this technical memorandum will describe the remainder of Phase IIA to be completed for the Remedial Investigation (RI) at Site 41, NAS Pensacola wetlands. Phase I was performed to determine site history, wetland characteristics, and to select Phase IIA sample locations. The initial portion of Phase IIA was the collection of sediment and surface water samples from those locations for chemical analysis.

The rest of Phase IIA will use models and toxicity reference values to assess risk to assessment endpoint species based on the contaminant concentrations detected in the sediment and surface water. Phase IIB may be required, depending on the results of Phase IIA, to quantify actual ecosystem effects through the use of toxicity tests, benthic diversity studies, and bioaccumulation studies.

The aquatic assessment endpoint species selected during Phase I were white shrimp (*Penaeus setiferus*) for marine and estuarine wetlands and the crayfish (*Procambarus clarki*) for freshwater wetlands. The great blue heron (*Ardea herodias*) and raccoon (*Procyon lotor*) were chosen as terrestrial assessment endpoint species for all wetlands. All species were chosen based on their differing roles related to food chains and their dependence on wetlands as sources of food and habitat.

This memorandum details the models selected and justifies and supports their use in quantifying risk. Section 7 summarizes questions and technical issues posed to the partnering team during the April 16 meeting. Input from state and federal technical reviewers on these issues is necessary before this investigation proceeds.

## 2.0 SITE 41 INVESTIGATION SUMMARY

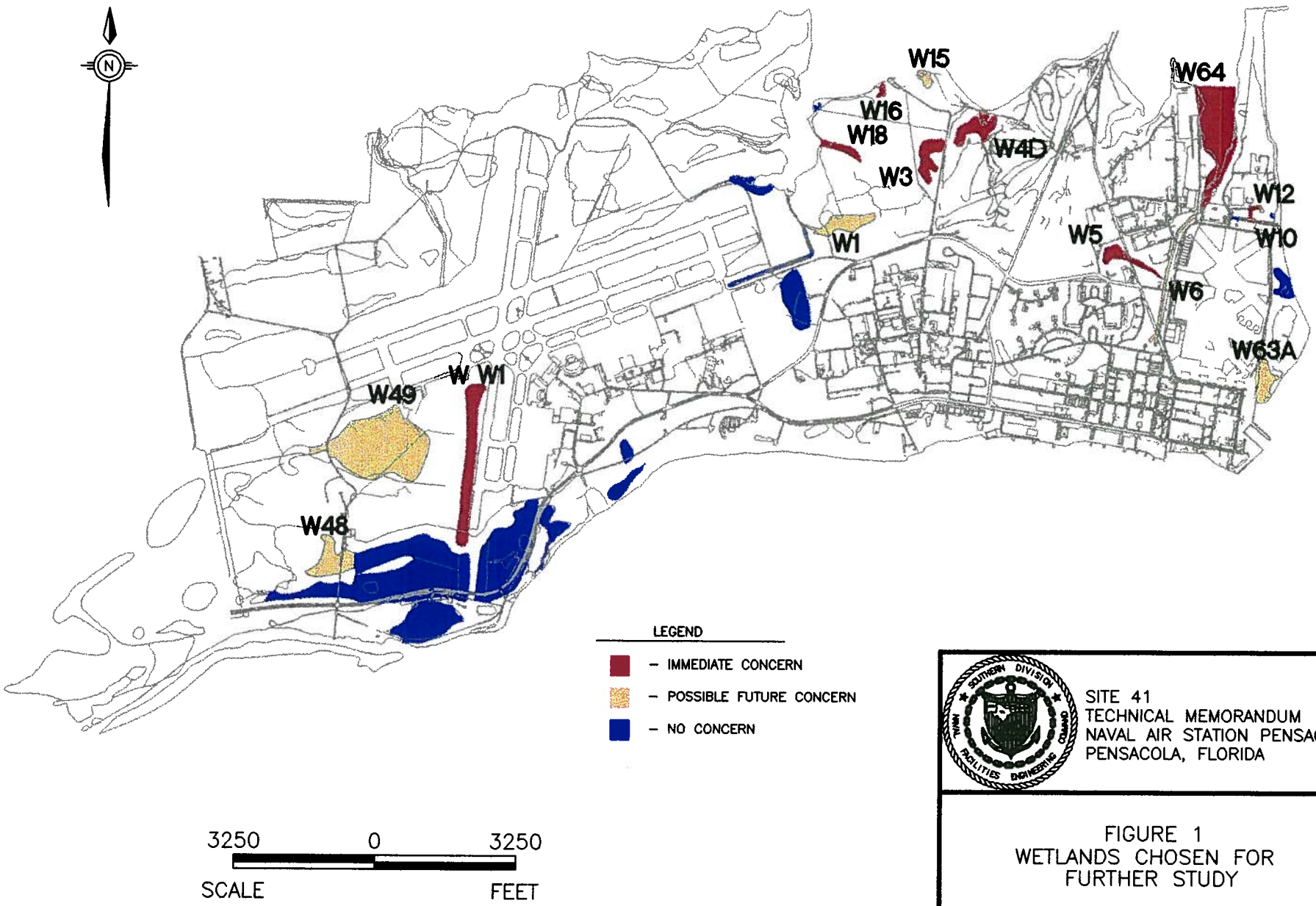
The analytical data from the Site 41 investigation were summarized during the Tier I Partnering Team meeting (Attachment A). Data in Attachment A has changed slightly after being validated. Specific information on the investigative approach is available in the Site 41 Work Plan and Sampling and Analysis Plan. Wetland rankings described in Attachment A are explained in greater detail below.

## 3.0 WETLAND RANKINGS

Only those wetlands identified during Phase I as possibly being impacted by an IR site were sampled during the Phase IIA portion of the investigation. Wetlands sampled during Phase IIA were assigned to one of three color-coded groups based on the types and concentrations of contaminants present (Attachment A). A map of these wetlands and their color code is included as Figure 1. Wetlands showing either sediment or surface water contamination that could be directly related to an IR site, and showing consistent exceedences of contaminant reference values and benchmarks, were coded red. Nine wetlands were designated red.

Wetlands showing limited contamination above reference values or benchmarks, or with contaminants that did not appear to be site-related, were coded orange. An example of an orange-coded wetland was Wetland 48, where DDT concentrations were elevated. DDT applications were not associated with the site suspected of impacting this wetland, but contaminant concentrations were elevated enough to be of ecological concern. Six wetlands were designated orange.

Wetlands with no detected contamination related to an IR site, or which had low level contamination in isolated areas, were coded blue. Contaminant concentrations at these wetlands were mostly below reference values or benchmarks. Twelve wetlands, primarily in the western portion of the base, were designated blue.




SITE 41
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PENSACOLA, FLORIDA

FIGURE 1
WETLANDS CHOSEN FOR
FURTHER STUDY

DWG DATE: 07/11/96 | DWG NAME: 036WCFS1

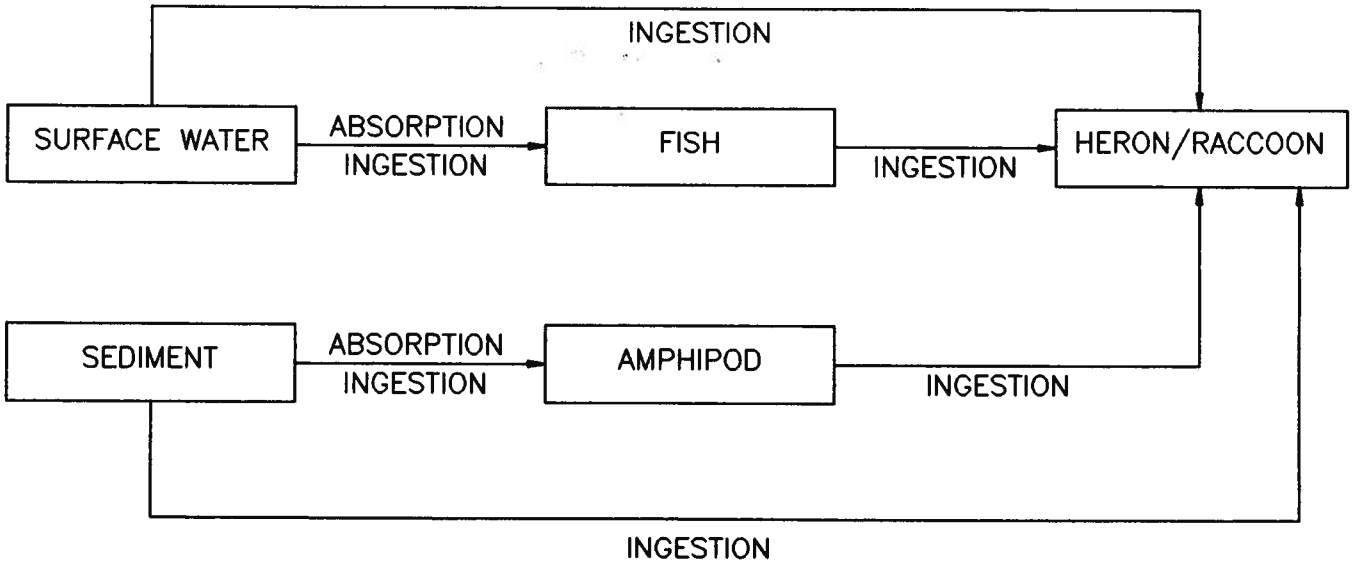
## 4.0 PROPOSED MODELING APPROACH

As presented in the Site 41 Sampling Analysis Plan and Work Plan, and as agreed upon by the partnering team, a modeling approach will first be used to predict contaminant impact in wetlands coded red. Since it will not require much more effort to perform the model for the orange-coded wetlands, the model will be used for them as well.

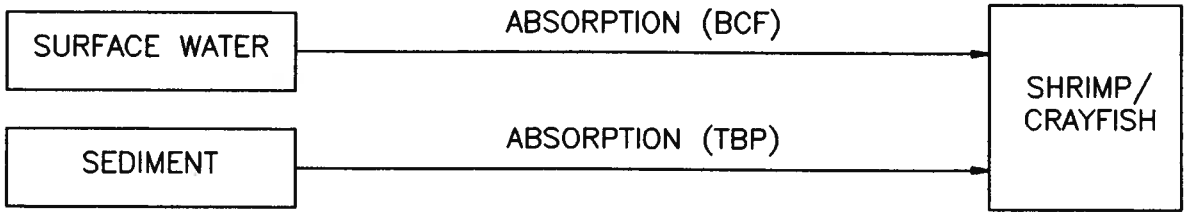
For the heron and raccoon, the modeling approach will quantify risk to these assessment endpoint species through impacts to measurement endpoint prey species. This model considers exposure concentrations of ecological chemicals of potential concern (ECPC) in terms of prey ingested, prey ingestion rates, sediment and surface water intake rates, and body weight. Prey assumed to be ingested are lower food chain fish species and benthic macroinvertebrates. The concentration of ECPCs in fish species consumed by the heron and raccoon is estimated based on literature reported bioconcentration factors (BCF), which are the reported ratio of the ECPC in fish to the concentration in surface water. The concentration of ECPCs in prey amphipod species is based on the theoretical bioaccumulation potential (TBP) model (Clarke and McFarland, 1991). The TBP model will also be used to predict concentrations of ECPCs in the assessment endpoint shrimp and crayfish, as they are lower food chain species.

Simplified food chain models were chosen to represent potential dietary exposures to the selected assessment endpoint species. Direct exposures are based on the sediment and surface water ingestion rates. For the heron and raccoon, dietary exposures via surface water will assume ingestion and absorption of contaminants into lower food chain fish via surface water, which are then assumed to be eaten by either a heron or a raccoon. Exposures via sediment include uptake by a marine or freshwater amphipod, and then consumption of those amphipods by the heron and raccoon. Prey percent diet, water and sediment ingestion rates, and mean body weights for these species will be obtained from the EPA *Wildlife Exposure Factors Handbook* (EPA/600/R-93/187a). This food chain model is depicted in Figure 2.

## EXPOSURE TO TERRESTRIAL ENDPOINT SPECIES




## EXPOSURE TO AQUATIC ENDPOINT SPECIES




SITE 41
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FIGURE 2
EXPOSURE ROUTES TO ASSESSMENT
ENDPOINT SPECIES

DWG DATE: 07/11/96 | DWG NAME: 036ERTA2

Exposure to white shrimp and crayfish will include direct uptake, reflected by the TBP model approach, since these species are closely associated with, and feed primarily on, detritus and other material in the sediment. Ingestion via surface water will also be predicted based on the equations shown below. These simplified food chain models are also shown on Figure 2.

Two macroinvertebrate species have been chosen as measurement endpoint species for the food chain model: *Ampelisca abdita*, a marine amphipod, was selected for use in marine and estuarine wetlands, and *Hyalella azteca*, a freshwater amphipod, was selected for use in the freshwater wetlands. The silverside minnow (*Menidia beryllina*) has been selected as a fish species measurement endpoint for marine surface water food chain model, and the fathead minnow (*Pimephales promelas*) will be used as the fish species measurement endpoint for freshwater food chain model. Once contaminant concentrations are predicted in measurement endpoint species, effects to assessment endpoint species can be predicted.

Although amphipods make up a portion of the diet of a heron and raccoon, they are not their major food source. The most logical dietary exposure route to the heron and raccoon would be to predict accumulation in the amphipod or lower food chain fish, then predict accumulation in a higher food chain fish species, and finally predict accumulation in the heron or raccoon which would feed on the higher food chain fish. However, there is little data available in predicting contaminant transfer from one organism to another organism using bioaccumulation factors, which govern this transfer.

The TBP model will be used to predict tissue bioaccumulation for benthic macroinvertebrates. Contaminants to be modeled using this approach are the non polar organic contaminants such as pesticides, PCBs, and possibly PAHs. Vertebrate species may metabolize PAHs upon ingestion and the reliability of the model for these organisms may vary.

The TBP model predicts contaminant bioaccumulation through desorption of the chemical through sediment and uptake of the chemical from pore water; however, surface water is another important exposure route that must be considered for fish species having limited sediment contact. Two conservative assumptions will be made in using the TBP model: 1) It will be assumed that 100% of the contaminant concentration predicted by the model in measurement endpoint species, will be used in the sediment prey exposure calculation, and 2) the sediment concentration used in the model will be the highest value observed for that wetland. These conservative assumptions will yield a better understanding of which contaminants pose the greatest ecological concern.

Sediment contaminant exposure to the white shrimp and crayfish, which have been selected as aquatic assessment endpoint species, will be predicted using the TBP model, since their exposure routes will be similar to the measurement endpoint species.

**Bioaccumulation Model Formulas**

Equation 1 is used to estimate the total exposure of the heron and raccoon to possible contamination via fish ingestion, amphipod ingestion, surface water ingestion, and sediment ingestion. Supporting equations are explained in sequence.

***EQUATION 1***

$$\text{Total Exposure (Heron/Raccoon)} = \frac{\text{(From Eq 2) Fish Ingestion Exposure (mg/kg)} + \text{(From Eq 3) Amphipod Ingestion Exposure (mg/kg)} + \text{(From Eq 4) Surface Water Ingestion Exposure (mg/kg)} + \text{(From Eq 5) Sediment Ingestion Exposure (mg/kg)} \times \text{SFF}}{\text{BW (kg)}}$$

**Where:**

| | | |
|---|---|---|
| Eq | = | Equation |
| BW | = | Bodyweight (kg) of receptor |
| SFF | = | Site foraging factor (the maximum value of 1 is assumed for all species) |
| $IR_{diet}$ | = | Food ingestion rate of receptor (kg of food item or dietary item per day). |
| BCF | = | Bioconcentration Factor (from literature). |
| mg/L | = | milligrams per liter |
| L/day | = | Liters per day |
| mg/kg | = | milligrams per kilogram |

Equation 2 is used to predict heron and raccoon dietary exposure from ingesting contaminated fish species.

***EQUATION 2***

***Fish Ingestion:***

| | | | | | | |
|---|---|---|---|---|---|---|
| *Fish Exposure (mg/kg)* | = | *% Diet as Fish* | X | $IR_{diet}$ | X | *(From Eq 6) Fish Contaminant Conc. (mg/kg)* |

Equation 3 is used to predict heron and raccoon dietary exposure from ingesting contaminated amphipod species.

***EQUATION 3***

***Amphipod Ingestion:***

| | | | | | | |
|---|---|---|---|---|---|---|
| *Amphipod Exposure: (mg/kg)* | = | *% Diet as Prey* | X | $IR_{diet}$ | X | *(From Eq 7) Amphipod Contaminant Concentration (mg/kg)* |

Equation 4 is used to predict heron and raccoon dietary exposure from ingesting contaminated sediment.

***EQUATION 4***

***Sediment Exposure:***

| | | | | | | |
|---|---|---|---|---|---|---|
| *Sediment Ingestion Exposure (mg/kg)* | = | *Sediment as % of Diet* | X | $IR_{diet}$ | X | *Sediment Contaminant Concentration (mg/kg)* |

Equation 5 is used to predict heron and raccoon dietary exposure from ingesting contaminated surface water.

***EQUATION 5***

***Surface Water Exposure:***

| | | | | |
|---|---|---|---|---|
| *Surface Water Contaminant Exposure (mg/kg)* | = | *Surface Water Contaminant Concentration (mg/L)* | X | *Water Intake Rate (L/day)* |

Equation 6 is used to predict contaminant bioaccumulation of organic contaminants in fish prey species for the heron and raccoon. It is also used to predict bioaccumulation in the shrimp and crayfish. This value is used in equation 2 for the heron and raccoon only.

***EQUATION 6***

| | | | | |
|---|---|---|---|---|
| *Fish, Shrimp, Crayfish Concentration (mg/kg)* | = | *BCF* | X | *Surface Water Contaminant Concentration (mg/L)* |

Equation 7 is the TBP model. It is used to predict contaminant bioaccumulation of organic contaminants in amphipod prey species for the heron and raccoon. This value is used in equation 3. Equation 7 is also used to predict contaminant bioaccumulation in the assessment endpoint shrimp and crayfish.

***EQUATION 7***

| | | | | |
|---|---|---|---|---|
| *Amphipod Contaminant Concentration (organics) (mg/kg)* | *TBP* | = | *pf X(Cs/TOC) x fL* | - |

*TBP is expressed as whole body (wet) weight in the same units as Cs*

| | | |
|---|---|---|
| *pf* | = | *preference factor for organism lipid over sediment organic carbon* |
| *Cs* | = | *concentration of chemical in sediment (usually dry weight)* |
| *TOC* | = | *parts per million total organic carbon in sediment* |
| *fL* | = | *organism lipid expressed in the same units as TOC* |

**Modeling Approach for Inorganics**

As an ECPC, inorganics pose unique problems from a risk perspective. A different approach will be used in quantifying risk from inorganic constituents, which were found in all of the red-coded wetlands. Some of the inorganics detected may naturally occur in fine-grained sediments. However, many of the inorganics appear associated with site-related impacts. In general, the existing data concludes that inorganics do not biomagnify in food chains (Eisler series). Also, it is commonly known that persistence measured by natural degradation does not apply directly to most inorganics. Bioaccumulation of most inorganics cannot be predicted based on equilibrium partitioning, octonal-water coefficients, or bioaccumulation factors, which are commonly used in predicting effects of organic contaminants (Clarke and McFarland, 1991). Although cadmium and mercury have been shown to appreciably bioaccumulate, no information was found using models to predict food chain bioaccumulation or biotransfer.

Risks to assessment endpoints from inorganics will be assessed using hazard quotients (EPA, 1989). Hazard quotients are derived by dividing the contaminant concentration in sediment or surface water by the sediment screening value or water quality criteria for a particular contaminant. Hazard quotients greater than 1 suggest that an ecological impact may be present. Typically, further investigation is required to quantify those effects. Because of uncertainties in food chain transfer mechanisms, risk to the heron and raccoon cannot be quantified for inorganic contaminants. These can only be applied to the shrimp, crayfish, and measurement endpoint species.

## 5.0 ECOLOGICAL EFFECTS

Potential adverse effects to assessment endpoint species associated with the identified ECPCs are based on food, water, and sediment uptake potential. Available toxicity reference values (TRVs) will be determined for assessment endpoint species. The TRV relates the dose of a respective ECPC in an exposure with an adverse effect. The lethal TRV has been determined to be one-fifth of the lowest reported LD50 value for the most closely related test species

(USEPA, 1986). One fifth of an oral 50% lethal dose ($LD_{50}$) value is considered to be protective of lethal effects for 99.9% of individuals in a test population (USEPA, 1986). It is assumed that this level of risk to individuals within assessment endpoints is acceptable.

A sublethal TRV will also be identified which represents a threshold for sublethal effects. Sublethal effects are defined as those levels derived from laboratory testing that impair or prevent reproduction, growth, or survival. These values will be obtained from the scientific literature. The sublethal TRV reflects the effects level chosen as the basis for establishing risk.

For the aquatic assessment endpoint shrimp and crayfish, the lowest body burden effects data obtained from literature will be used to determine if adverse effects may be predicted from overall surface water and sediment exposures.

## 6.0 SUMMARY

A simplified food chain model will be used to predict exposure to assessment endpoint species associated with wetlands. The TBP model will be used to predict bioaccumulation of organics to benthic macroinvertebrate and ultimately assessment endpoint species. TRVs will be used to determine if calculated bioaccumulation concentrations pose a lethal or sublethal risk to receptors from selected ECPCs. Exposure to aquatic assessment endpoint species for inorganic constituents will be assessed using water quality criteria or screening values for a hazard quotient assessment.

Based on the effects predicted, toxicity tests, diversity studies, and bioaccumulation studies may be required in Phase IIB or Phase III to help quantify impact. Also, future investigations may measure sediment acid volatile sulfides (AVS) in comparison to simultaneously extracted metals (AVS/SEM). The AVS method can, in some cases, be used to indicate bioavailable metals. If AVS/SEM analysis can yield useful information on quantifying ecological impact, its use will be considered.

## 7.0 PARTNERING ISSUES

E/A&H also believes that three issues should be addressed before this investigation proceeds:

- Several orange-coded wetlands contain elevated contaminants, such as DDT, which were detected at concentrations greater than sediment screening values, but do not appear to be site-related. E/A&H believes that many of these non-IR constituents are likely ubiquitous throughout NAS Pensacola and the general Pensacola Bay area. Therefore, there is little to gain from assessing non-IR contamination at an orange-coded wetland. Should further risk be considered in these wetlands?

- In characterizing human health exposures in wetlands, the following assumptions will be made: If water is at least 2 inches deep in a particular wetland for at least 90% of the year, then a wading exposure with incidental ingestion will be assumed. Standard wading ingestion rates are commensurate with a swimming scenario (0.05 liters/hour and 2.6 hours/day, or 0.13 liters per day). If less than 2 inches of water are present or if water is present less than 90% of the year, a recreational exposure of 45 days per year of wading will be assumed. Does the partnering team agree with these assumptions?

- Quantifying risk for the purpose of remedial decisions is the ultimate goal of this investigation. If contamination in a wetland does not warrant remedial action, further study in that wetland should cease, unless the study focus will be changed for other goals. Is the partnering team prepared to accept remediation as a feasible option within wetlands, including possibly the Yacht Basin?

## 8.0 REFERENCES

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**Attachment A**

**Tier I Partnering Team Presentation**

# NAS Pensacola
# Site 41 Remedial Investigation
# Phase IIA Sample Results

Presented to:

NAS Pensacola Tier I Partnering Team

Presented by:

Chuck Mason, EnSafe/Allen & Hoshall

**April 16, 1996**

# Three Phases - Site 41 Remedial Investigation

**Phase I** Habitat and Biota Survey/Contaminant Source Survey

**Phase IIA** **Chemical Analysis Sampling**

**Phase IIB** Toxicity/Diversity/Bioaccumulation Studies

**Phase III** Refined Studies (if necessary)

**Risk Assessment**

# Phase I

## Habitat and Biota Survey/Contaminant Source Survey

***Goal:*** *Gain familiarity, choose Phase IIA sample locations, and develop SAP.*

- ✔ Qualitative description of wetlands and receptors.
- ✔ Identify reference wetlands, endpoint determinations, and conceptual model.
- ✔ Choose "hot spot" sample locations based on site history and areas of likely contamination.

# Phase IIA

## Chemical Analysis Sampling

***Goal:*** *Characterize the nature and extent of contamination in those wetlands sampled and quantify impact.*

- ✔ Collect sediment and surface water samples at Phase I "hot spots."
- ✔ Compare contaminant levels to two times mean reference concentrations, sediment screening values, and water quality criteria.
- ✔ Determine which wetlands should be studied further based on the above review.
- ✔ Quantify potential effects through modeling or other methods in wetlands chosen.

# Phase IIB

## Toxicity/Diversity/Bioaccumulation Studies

**Goal:** *Quantify impact with respect to measurement and assessment endpoints.*

- ✔ Perform toxicity testing where contaminants are suspected of having an acute or chronic toxic effect.
- ✔ Perform bioaccumulation studies where contaminants are suspected to bioaccumulate in the food chain.
- ✔ Relate results to measurement and assessment endpoints.
- ✔ Possible more refined analyses in Phase III, if required.

# Risk Assessment

**Goal:** *Measurement or estimation of both current and future effects*

# Phase IIA Summary

- 122 Sediment Samples Collected from 29 Wetlands or Wetland Complexes
- 51 Surface Water Samples Collected from 27 Wetlands or Wetland Complexes

# General Trends

There appears to be a relationship between metal contamination and TOC; i.e., highest metal contamination is located in areas with highest TOC.

OOOOOOOOOOOOO

This relationship did not appear present in reference wetland sediments.

OOOOOOOOOOOOO

Site groundwater contamination did not appear correlated with associated wetland sediment or surface water results.

OOOOOOOOOOOOO

Surface water results, particularly from saline wetlands, did not correlate with corresponding sediment data.

# Wetlands Ranking According to Color

**RED**

Contamination appears to be related to an IR site and consistent exceedance of reference values and benchmarks. Wetlands: 64, 5, 3, 4, 16, 18, 10, 12, and W1.

**ORANGE**

Contamination may be related to an IR site. Limited contaminants are above reference values or benchmarks, or contaminants are above benchmarks but do not appear to be site related.

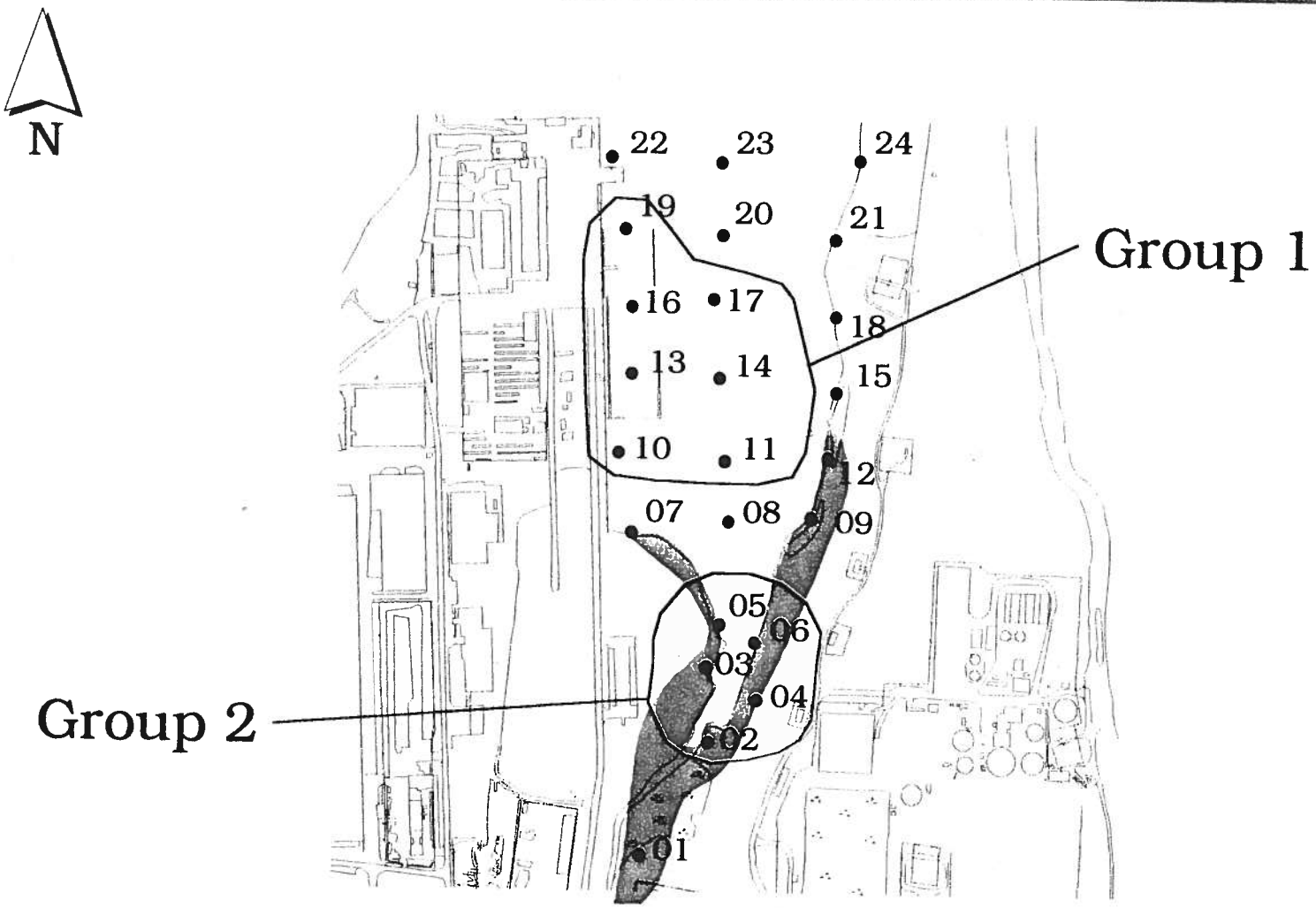
**BLUE**

None or isolated contaminants detected that in most cases were below background and/or benchmarks and do not appear IR site related. Wetlands: 10 (eastern portion) 13, 17, 19, 52, 56, 57, 58, 63B, 72, 79, and W2.

# Wetlands Ranking According to Color

## RED - Coded Wetlands

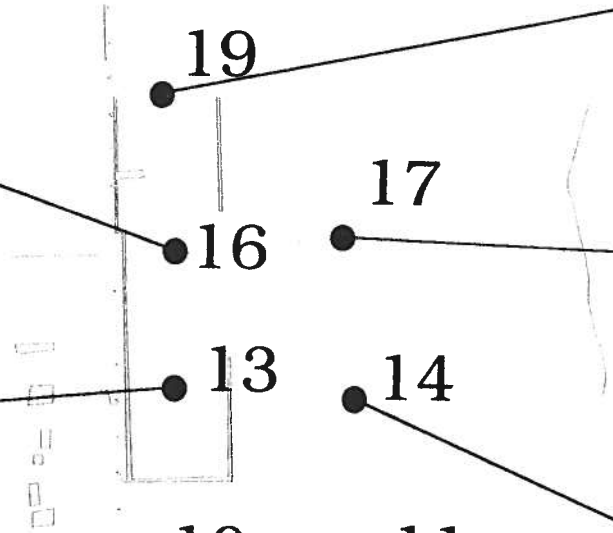
# Wetland 64




## Notes:

Wetland 64 is ranked Red.
Highest levels of metals contamination in sediment throughout base.
The highest concentrations of contaminants appears limited to two areas.
Sediment contamination does not appear to correlate with groundwater contamination from adjacent sites.

# Wetland 64 (Group 1)




| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | 19 | 1 | 1.67 * |
| Chromium | 756 | 52.3 | 16.23 * |
| Copper | 119 | 18.7 | 12.31 * |
| Lead | 249 | 30.2 | 45.8 * |
| Mercury | 0.49 | 0.13 | 0.48 * |
| Zinc | 300 | 124.0 | 17.85 * |
| total DDD,DDE,DDT | ND | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | 16 | 33 | --- + |
| total PAHs | 1,370 | 1684 | --- + |
| TOC | 67,500 | --- | --- # |

* mg/Kg + ug/Kg # ppm

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | 16.9 | 1 | 1.67 * |
| Chromium | 699 | 52.3 | 16.23 * |
| Copper | 102 | 18.7 | 12.31 * |
| Lead | 231 | 30.2 | 45.8 * |
| Mercury | 0.46 | 0.13 | 0.48 * |
| Zinc | 268 | 124.0 | 17.85 * |
| total DDD,DDE,DDT | 1.4 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | 27 | 33 | --- + |
| total PAHs | 2,300 | 1684 | --- + |
| TOC | 76,100 | --- | --- # |

* mg/Kg + ug/Kg # ppm

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | 23.2 | 1 | 1.67 * |
| Chromium | 806 | 52.3 | 16.23 * |
| Copper | 140 | 18.7 | 12.31 * |
| Lead | 324 | 30.2 | 45.8 * |
| Mercury | 0.5 | 0.13 | 0.48 * |
| Zinc | 377 | 124.0 | 17.85 * |
| total DDD,DDE,DDT | 4.7 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | 24 | 33 | --- + |
| total PAHs | ND | 1684 | --- + |
| TOC | 89,700 | --- | --- # |

* mg/Kg + ug/Kg # ppm

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | 14.8 | 1 | 1.67 * |
| Chromium | 638 | 52.3 | 16.23 * |
| Copper | 121 | 18.7 | 12.31 * |
| Lead | 224 | 30.2 | 45.8 * |
| Mercury | 0.66 | 0.13 | 0.48 * |
| Zinc | 308 | 124.0 | 17.85 * |
| total DDD,DDE,DDT | 3.5 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | 50 | 33 | --- + |
| total PAHs | 3,740 | 1684 | --- + |
| TOC | 64,000 | --- | --- # |

* mg/Kg + ug/Kg # ppm

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | 2.4 | 1 | 1.67 * |
| Chromium | 78.2 | 52.3 | 16.23 * |
| Copper | 16.3 | 18.7 | 12.31 * |
| Lead | 31.9 | 30.2 | 45.8 * |
| Mercury | ND | 0.13 | 0.48 * |
| Zinc | 52.4 | 124.0 | 17.85 * |
| total DDD,DDE,DDT | ND | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | 4.8 | 33 | --- + |
| total PAHs | 270 | 1684 | --- + |
| TOC | 14,600 | --- | --- # |

* mg/Kg + ug/Kg # ppm

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | 17.2 | 1 | 1.67 * |
| Chromium | 631 | 52.3 | 16.23 * |
| Copper | 83.9 | 18.7 | 12.31 * |
| Lead | 205 | 30.2 | 45.8 * |
| Mercury | 0.41 | 0.13 | 0.48 * |
| Zinc | 260 | 124.0 | 17.85 * |
| total DDD,DDE,DDT | ND | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | 16 | 33 | --- + |
| total PAHs | 870 | 1684 | --- + |
| TOC | 68,700 | --- | --- # |

* mg/Kg + ug/Kg # ppm

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | 20.1 | 1 | 1.67 * |
| Chromium | 659 | 52.3 | 16.23 * |
| Copper | 66.4 | 18.7 | 12.31 * |
| Lead | 221 | 30.2 | 45.8 * |
| Mercury | 0.3 | 0.13 | 0.48 * |
| Zinc | 192 | 124.0 | 17.85 * |
| total DDD,DDE,DDT | 2.68 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | 29 | 33 | --- + |
| total PAHs | 1,360 | 1684 | --- + |
| TOC | 40,100 | --- | --- # |

* mg/Kg + ug/Kg # ppm

## Notes:

Wetland 64 is ranked Red.
Dramatic decrease in contamination at adjacent sample locations.
Metals are the primary concern.

# Wetland 64 (Group 2)

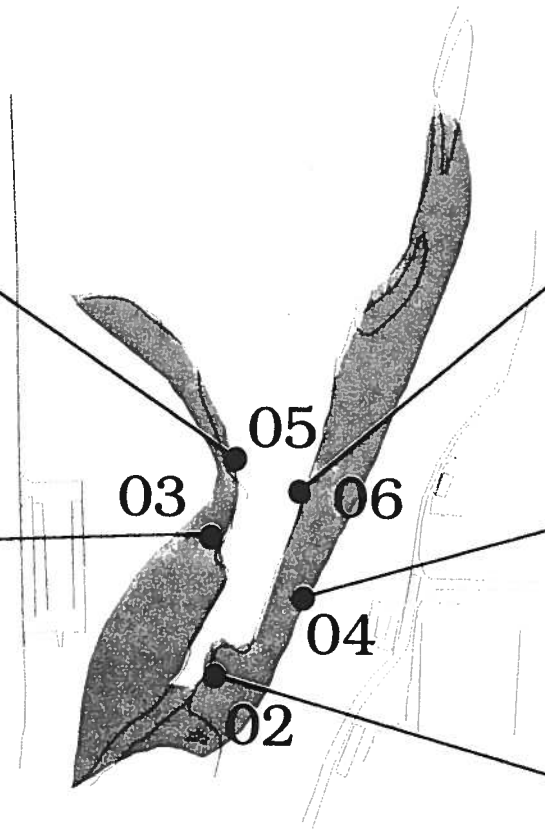
N

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | 18.5 | 1 | 1.67 * |
| Chromium | 466 | 52.3 | 16.23 * |
| Copper | 88.6 | 18.7 | 12.31 * |
| Lead | 262 | 30.2 | 45.8 * |
| Mercury | 0.27 | 0.13 | 0.48 * |
| Zinc | 290 | 124.0 | 17.85 * |
| total DDD,DDE,DDT | 56.74 | 9.9 | --- + |
| Aroclor 1254 | 58 | 33 | --- + |
| Aroclor 1260 | ND | 33 | --- + |
| total PAHs | 12,891 | 1684 | --- + |
| TOC | 83,500 | --- | --- # |

* mg/Kg + ug/Kg # ppm

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | 38.6 | 1 | 1.67 * |
| Chromium | 1,800 | 52.3 | 16.23 * |
| Copper | 255 | 18.7 | 12.31 * |
| Lead | 634 | 30.2 | 45.8 * |
| Mercury | 0.88 | 0.13 | 0.48 * |
| Zinc | 481 | 124.0 | 17.85 * |
| total DDD,DDE,DDT | 136 | 9.9 | --- + |
| Aroclor 1254 | 150 | 33 | --- + |
| Aroclor 1260 | ND | 33 | --- + |
| total PAHs | 5,370 | 1684 | --- + |
| TOC | 194,000 | --- | --- # |

* mg/Kg + ug/Kg # ppm




| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | 8.8 | 1 | 1.67 * |
| Chromium | 324 | 52.3 | 16.23 * |
| Copper | 29.4 | 18.7 | 12.31 * |
| Lead | 156 | 30.2 | 45.8 * |
| Mercury | 0.12 | 0.13 | 0.48 * |
| Zinc | 105 | 124.0 | 17.85 * |
| total DDD,DDE,DDT | 47.4 | 9.9 | --- + |
| Aroclor 1254 | 56 | 33 | --- + |
| Aroclor 1260 | ND | 33 | --- + |
| total PAHs | 3,200 | 1684 | --- + |
| TOC | 28,100 | --- | --- # |

* mg/Kg + ug/Kg # ppm

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | 2.8 | 1 | 1.67 * |
| Chromium | 1,610 | 52.3 | 16.23 * |
| Copper | 23.8 | 18.7 | 12.31 * |
| Lead | 146 | 30.2 | 45.8 * |
| Mercury | 0.43 | 0.13 | 0.48 * |
| Zinc | 31.8 | 124.0 | 17.85 * |
| total DDD,DDE,DDT | 34 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | 23 | 33 | --- + |
| total PAHs | 430 | 1684 | --- + |
| TOC | 187,000 | --- | --- # |

* mg/Kg + ug/Kg # ppm

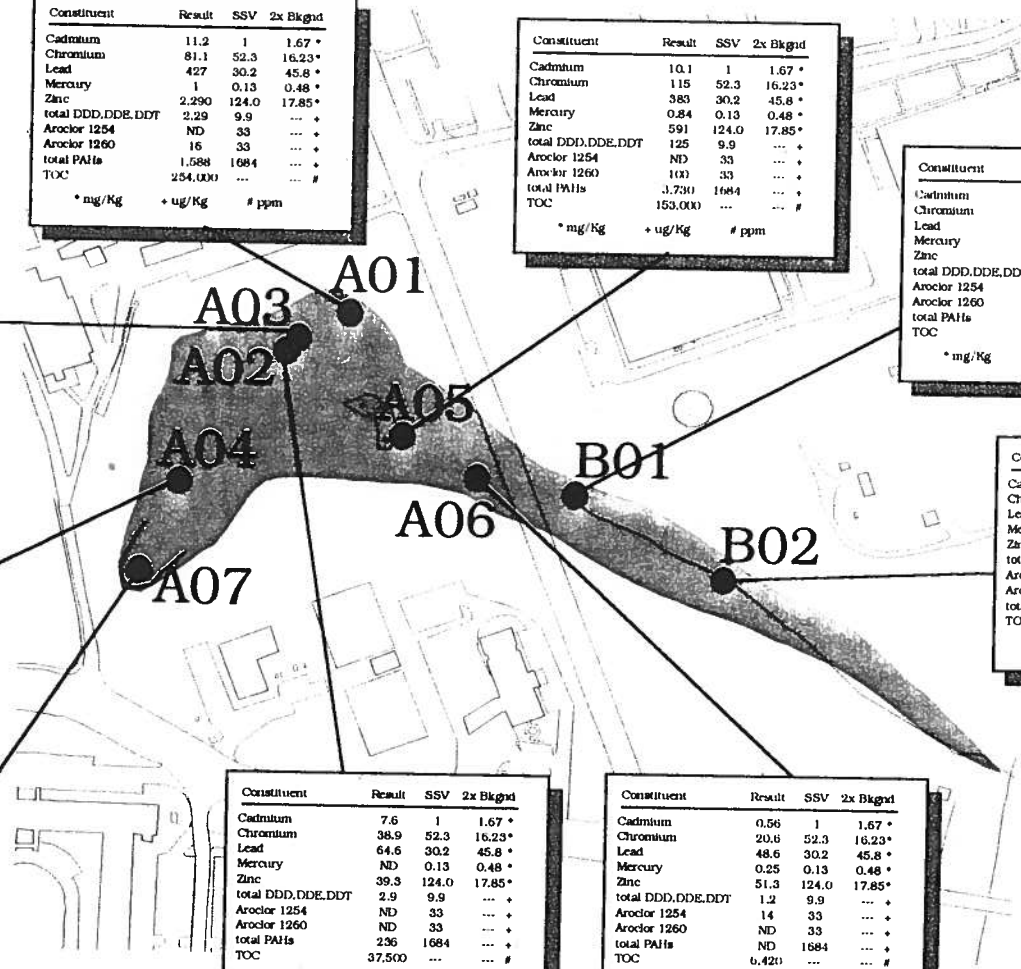
| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | 18.9 | 1 | 1.67 * |
| Chromium | 1,600 | 52.3 | 16.23 * |
| Copper | 39.8 | 18.7 | 12.31 * |
| Lead | 346 | 30.2 | 45.8 * |
| Mercury | 0.17 | 0.13 | 0.48 * |
| Zinc | 145 | 124.0 | 17.85 * |
| total DDD,DDE,DDT | 212 | 9.9 | --- + |
| Aroclor 1254 | 370 | 33 | --- + |
| Aroclor 1260 | ND | 33 | --- + |
| total PAHs | 18,600 | 1684 | --- + |
| TOC | 44,200 | --- | --- # |

* mg/Kg + ug/Kg # ppm

## Notes:

**Wetland 64 is ranked Red.**
**Metals and SVOAs are the primary concern.**

# Wetland 5 (A&B)




| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | 11.2 | 1 | 1.67 * |
| Chromium | 81.1 | 52.3 | 16.23 * |
| Lead | 427 | 30.2 | 45.8 * |
| Mercury | 1 | 0.13 | 0.48 * |
| Zinc | 2,290 | 124.0 | 17.85 * |
| total DDD,DDE,DDT | 2.29 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | 16 | 33 | --- + |
| total PAHs | 1,588 | 1684 | --- + |
| TOC | 254,000 | --- | --- # |

* mg/Kg + ug/Kg # ppm

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | 10.1 | 1 | 1.67 * |
| Chromium | 115 | 52.3 | 16.23 * |
| Lead | 383 | 30.2 | 45.8 * |
| Mercury | 0.84 | 0.13 | 0.48 * |
| Zinc | 591 | 124.0 | 17.85 * |
| total DDD,DDE,DDT | 125 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | 100 | 33 | --- + |
| total PAHs | 3,730 | 1684 | --- + |
| TOC | 153,000 | --- | --- # |

* mg/Kg + ug/Kg # ppm

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | 7.7 | 1 | 1.67 * |
| Chromium | 69.3 | 52.3 | 16.23 * |
| Lead | 111 | 30.2 | 45.8 * |
| Mercury | 0.37 | 0.13 | 0.48 * |
| Zinc | 96.9 | 124.0 | 17.85 * |
| total DDD,DDE,DDT | 0.84 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | ND | 33 | --- + |
| total PAHs | ND | 1684 | --- + |
| TOC | 99,700 | --- | --- # |

* mg/Kg + ug/Kg # ppm

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | 0.3 | 1 | 1.67 * |
| Chromium | 7.9 | 52.3 | 16.23 * |
| Lead | 17.9 | 30.2 | 45.8 * |
| Mercury | ND | 0.13 | 0.48 * |
| Zinc | 9.8 | 124.0 | 17.85 * |
| total DDD,DDE,DDT | 0.32 | 9.9 | --- + |
| Aroclor 1254 | 8.7 | 33 | --- + |
| Aroclor 1260 | ND | 33 | --- + |
| total PAHs | ND | 1684 | --- + |
| TOC | 1,790 | --- | --- # |

* mg/Kg + ug/Kg # ppm

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | 4.2 | 1 | 1.67 * |
| Chromium | 33.7 | 52.3 | 16.23 * |
| Lead | 169 | 30.2 | 45.8 * |
| Mercury | 0.54 | 0.13 | 0.48 * |
| Zinc | 91.7 | 124.0 | 17.85 * |
| total DDD,DDE,DDT | 5.3 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | ND | 33 | --- + |
| total PAHs | 244 | 1684 | --- + |
| TOC | 409,000 | --- | --- # |

* mg/Kg + ug/Kg # ppm

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | 220 | 1 | 1.67 * |
| Chromium | 416 | 52.3 | 16.23 * |
| Lead | 481 | 30.2 | 45.8 * |
| Mercury | 0.68 | 0.13 | 0.48 * |
| Zinc | 1,160 | 124.0 | 17.85 * |
| total DDD,DDE,DDT | 6.1 | 9.9 | --- + |
| Aroclor 1254 | 53 | 33 | --- + |
| Aroclor 1260 | ND | 33 | --- + |
| total PAHs | 281 | 1684 | --- + |
| TOC | 74,500 | --- | --- # |

* mg/Kg + ug/Kg # ppm

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | 0.27 | 1 | 1.67 * |
| Chromium | 2.8 | 52.3 | 16.23 * |
| Lead | 11.5 | 30.2 | 45.8 * |
| Mercury | ND | 0.13 | 0.48 * |
| Zinc | 54.7 | 124.0 | 17.85 * |
| total DDD,DDE,DDT | 0.23 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | 2.6 | 33 | --- + |
| total PAHs | 3,424 | 1684 | --- + |
| TOC | 2,100 | --- | --- # |

* mg/Kg + ug/Kg # ppm

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | 7.6 | 1 | 1.67 * |
| Chromium | 38.9 | 52.3 | 16.23 * |
| Lead | 64.6 | 30.2 | 45.8 * |
| Mercury | ND | 0.13 | 0.48 * |
| Zinc | 39.3 | 124.0 | 17.85 * |
| total DDD,DDE,DDT | 2.9 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | ND | 33 | --- + |
| total PAHs | 236 | 1684 | --- + |
| TOC | 37,500 | --- | --- # |

* mg/Kg + ug/Kg # ppm

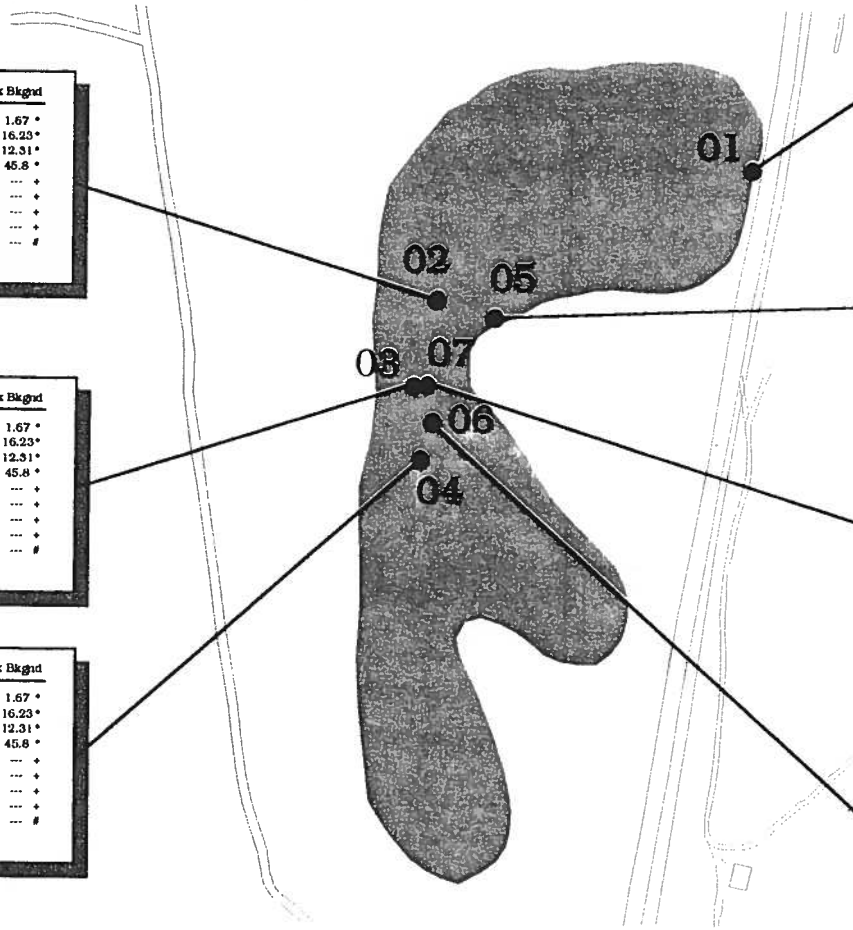
| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | 0.56 | 1 | 1.67 * |
| Chromium | 20.6 | 52.3 | 16.23 * |
| Lead | 48.6 | 30.2 | 45.8 * |
| Mercury | 0.25 | 0.13 | 0.48 * |
| Zinc | 51.3 | 124.0 | 17.85 * |
| total DDD,DDE,DDT | 1.2 | 9.9 | --- + |
| Aroclor 1254 | 14 | 33 | --- + |
| Aroclor 1260 | ND | 33 | --- + |
| total PAHs | ND | 1684 | --- + |
| TOC | 6,420 | --- | --- # |

* mg/Kg + ug/Kg # ppm

## Notes:

Wetland 5 is ranked Red.
Sediment is highly organic with several beaver dams to retain contamination.
Contamination appears well distributed throughout the wetland.
Lead exceeded chronic SW criteria at **all eight** sample locations. Copper, Chromium, Cadmium, Mercury, and Zinc also exceeded criteria at certain locations.
Does not appear to correlate with Site 30 groundwater data, although lead in groundwater is prevalent.

# Wetland 3




| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | 5.8 | 1 | 1.67 * |
| Chromium | 20.8 | 52.3 | 16.23 * |
| Copper | 17.8 | 18.7 | 12.31 * |
| Lead | 101.0 | 30.2 | 45.8 * |
| total DDD,DDE,DDT | 32.4 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | 350 | 33 | --- + |
| total PAHs | ND | 1684 | --- + |
| TOC | 241,000 | --- | --- # |

* mg/Kg + ug/Kg # ppm

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | 2.9 | 1 | 1.67 * |
| Chromium | 7.3 | 52.3 | 16.23 * |
| Copper | 4.6 | 18.7 | 12.31 * |
| Lead | 11.5 | 30.2 | 45.8 * |
| total DDD,DDE,DDT | 2.62 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | ND | 33 | --- + |
| total PAHs | 255 | 1684 | --- + |
| TOC | 51,800 | --- | --- # |

* mg/Kg + ug/Kg # ppm

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | ND | 1 | 1.67 * |
| Chromium | 1.5 | 52.3 | 16.23 * |
| Copper | 0.86 | 18.7 | 12.31 * |
| Lead | 2.9 | 30.2 | 45.8 * |
| total DDD,DDE,DDT | 2.82 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | ND | 33 | --- + |
| total PAHs | ND | 1684 | --- + |
| TOC | 4,780 | --- | --- # |

* mg/Kg + ug/Kg # ppm

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | 0.52 | 1 | 1.67 * |
| Chromium | 4.50 | 52.3 | 16.23 * |
| Copper | 2.20 | 18.7 | 12.31 * |
| Lead | 12.60 | 30.2 | 45.8 * |
| total DDD,DDE,DDT | 42.5 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | ND | 33 | --- + |
| total PAHs | 405 | 1684 | --- + |
| TOC | 8,150 | --- | --- # |

* mg/Kg + ug/Kg # ppm

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | 2.00 | 1 | 1.67 * |
| Chromium | 5.30 | 52.3 | 16.23 * |
| Copper | 1.90 | 18.7 | 12.31 * |
| Lead | 2.40 | 30.2 | 45.8 * |
| total DDD,DDE,DDT | 3.50 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | ND | 33 | --- + |
| total PAHs | ND | 1684 | --- + |
| TOC | 10,800 | --- | --- # |

* mg/Kg + ug/Kg # ppm

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | 72.7 | 1 | 1.67 * |
| Chromium | 196.0 | 52.3 | 16.23 * |
| Copper | 68.8 | 18.7 | 12.31 * |
| Lead | 18.7 | 30.2 | 45.8 * |
| total DDD,DDE,DDT | 7.74 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | ND | 33 | --- + |
| total PAHs | 180 | 1684 | --- + |
| TOC | 73,900 | --- | --- # |

* mg/Kg + ug/Kg # ppm

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | 1.8 | 1 | 1.67 * |
| Chromium | 4.9 | 52.3 | 16.23 * |
| Copper | 1.7 | 18.7 | 12.31 * |
| Lead | 8.0 | 30.2 | 45.8 * |
| total DDD,DDE,DDT | 12.1 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | ND | 33 | --- + |
| total PAHs | ND | 1684 | --- + |
| TOC | 6,720 | --- | --- # |

* mg/Kg + ug/Kg # ppm

## Notes:

Wetland 3 is ranked Red.

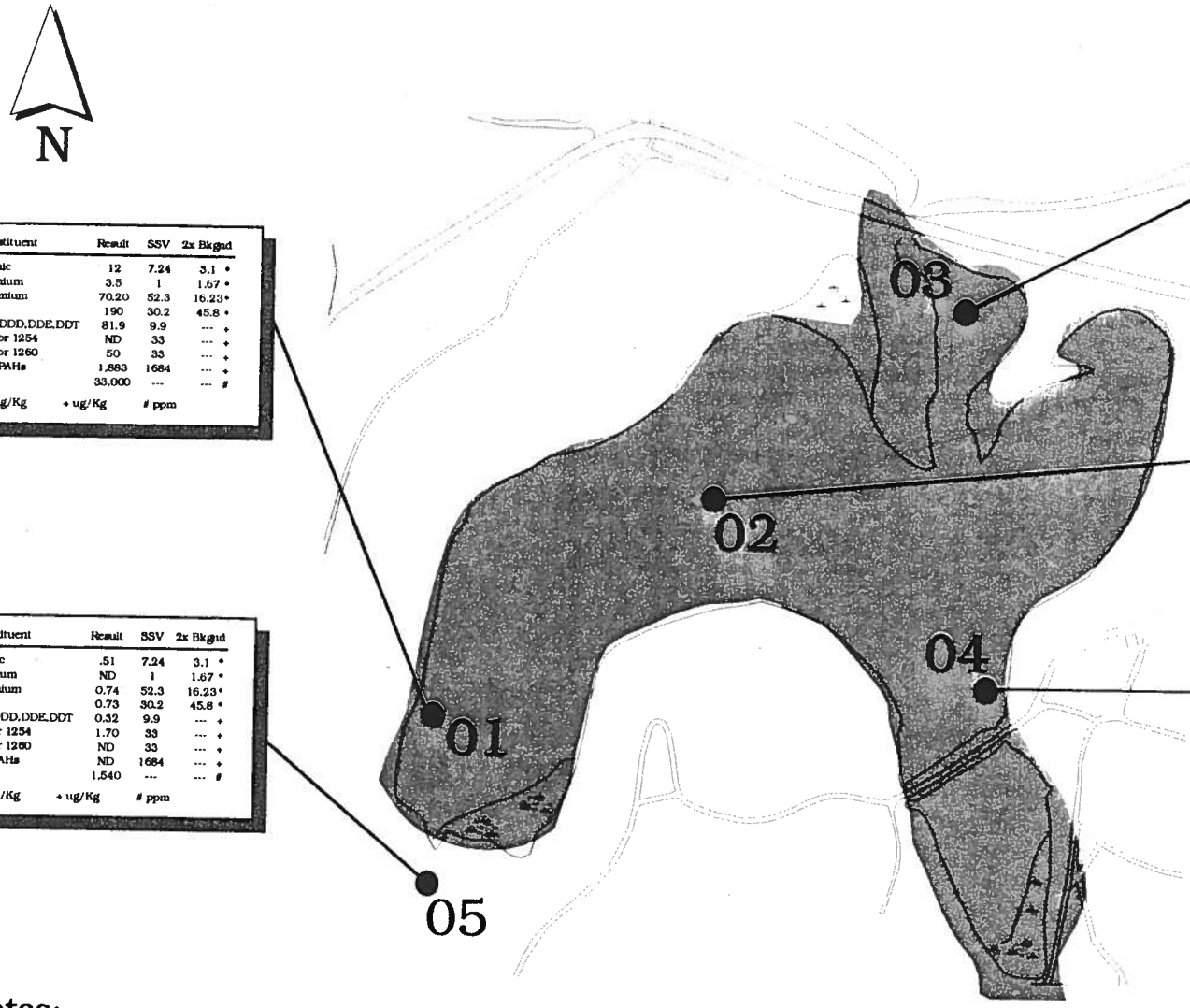
Sediment is highly organic with high iron content throughout. Surface water exceeds Florida Class III standards for iron in all four SW locations and in historical SW sample locations.

Eastern portion and most upgradient seep appears most contaminated; location 07 was collected from within a concrete structure.

Lead, Cadmium, and Copper exceed chronic surface water criteria in locations 02 and 03.

Does not appear to correlate with groundwater data from Site 1.

# Wetland 4D




| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Arsenic | 12 | 7.24 | 3.1 * |
| Cadmium | 3.5 | 1 | 1.67 * |
| Chromium | 70.20 | 52.3 | 16.23 * |
| Lead | 190 | 30.2 | 45.8 * |
| total DDD,DDE,DDT | 81.9 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | 50 | 33 | --- + |
| total PAHs | 1,883 | 1684 | --- + |
| TOC | 33,000 | --- | --- # |

* mg/Kg + ug/Kg # ppm

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Arsenic | .51 | 7.24 | 3.1 * |
| Cadmium | ND | 1 | 1.67 * |
| Chromium | 0.74 | 52.3 | 16.23 * |
| Lead | 0.73 | 30.2 | 45.8 * |
| total DDD,DDE,DDT | 0.32 | 9.9 | --- + |
| Aroclor 1254 | 1.70 | 33 | --- + |
| Aroclor 1260 | ND | 33 | --- + |
| total PAHs | ND | 1684 | --- + |
| TOC | 1,540 | --- | --- # |

* mg/Kg + ug/Kg # ppm

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Arsenic | 0.49 | 7.24 | 3.1 * |
| Cadmium | 0.26 | 1 | 1.67 * |
| Chromium | 1.30 | 52.3 | 16.23 * |
| Lead | 10.90 | 30.2 | 45.8 * |
| total DDD,DDE,DDT | 2.43 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | ND | 33 | --- + |
| total PAHs | 1,073 | 1684 | --- + |
| TOC | 2,040 | --- | --- # |

* mg/Kg + ug/Kg # ppm

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Arsenic | 20 | 7.24 | 3.1 * |
| Cadmium | 3.7 | 1 | 1.67 * |
| Chromium | 65.5 | 52.3 | 16.23 * |
| Lead | 348 | 30.2 | 45.8 * |
| total DDD,DDE,DDT | 46.2 | 9.9 | --- + |
| Aroclor 1254 | 42 | 33 | --- + |
| Aroclor 1260 | ND | 33 | --- + |
| total PAHs | 2,840 | 1684 | --- + |
| TOC | 45,100 | --- | --- # |

* mg/Kg + ug/Kg # ppm

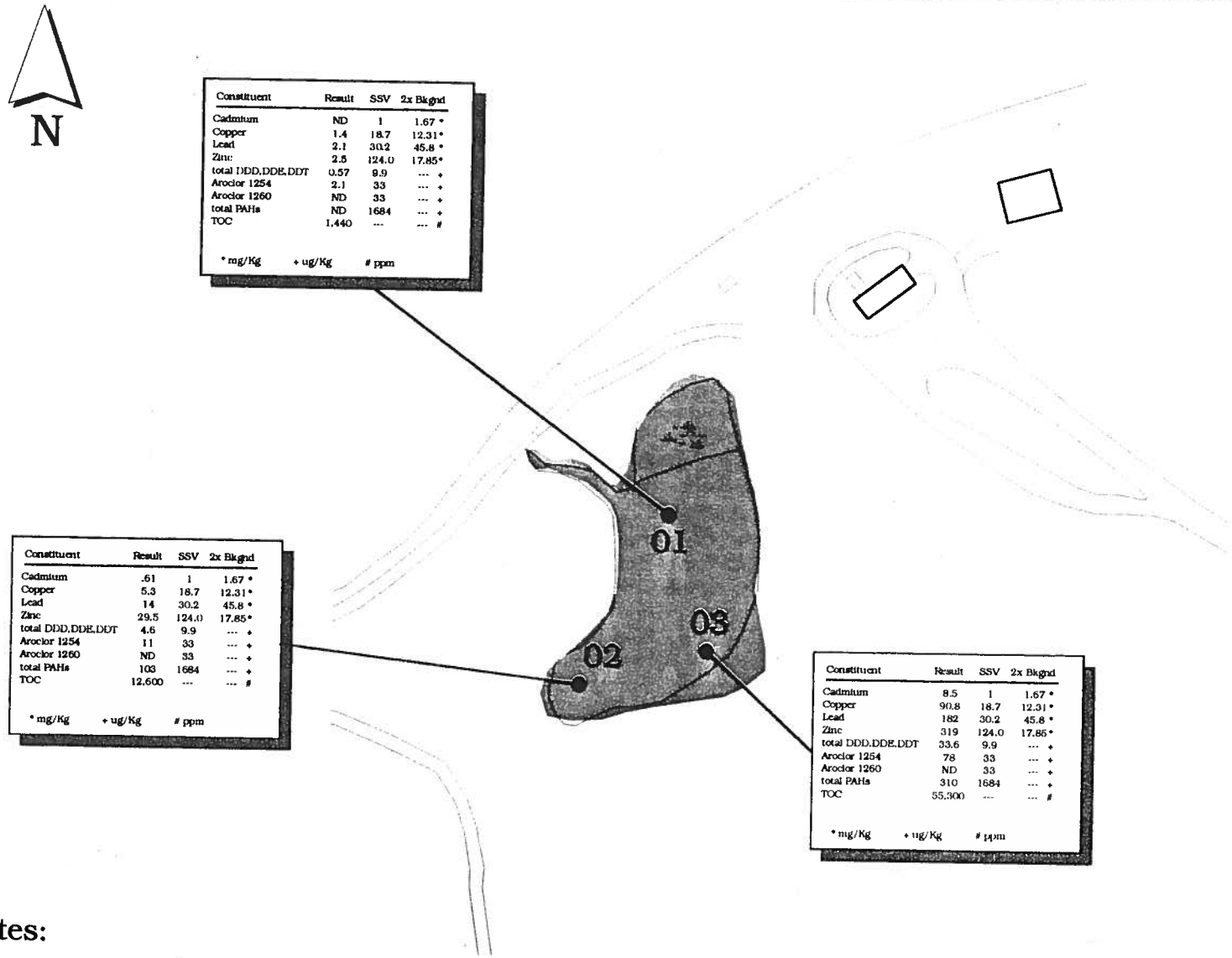
| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Arsenic | 11 | 7.24 | 3.1 * |
| Cadmium | 2.8 | 1 | 1.67 * |
| Chromium | 43.5 | 52.3 | 16.23 * |
| Lead | 162 | 30.2 | 45.8 * |
| total DDD,DDE,DDT | 178.9 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | ND | 33 | --- + |
| total PAHs | ND | 1684 | --- + |
| TOC | 70,000 | --- | --- # |

* mg/Kg + ug/Kg # ppm

## Notes:

Wetland 4D is ranked Red.
Sediment has highest iron content at loctions 1 and 2.
Surface water exceeds FL Class III iron standards at location 1 only.

# Wetland 16




| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | ND | 1 | 1.67 * |
| Copper | 1.4 | 18.7 | 12.31 * |
| Lead | 2.1 | 30.2 | 45.8 * |
| Zinc | 2.5 | 124.0 | 17.85 * |
| total DDD,DDE,DDT | 0.57 | 9.9 | --- + |
| Aroclor 1254 | 2.1 | 33 | --- + |
| Aroclor 1260 | ND | 33 | --- + |
| total PAHs | ND | 1684 | --- + |
| TOC | 1,440 | --- | --- # |

* mg/Kg + ug/Kg # ppm

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | .61 | 1 | 1.67 * |
| Copper | 5.3 | 18.7 | 12.31 * |
| Lead | 14 | 30.2 | 45.8 * |
| Zinc | 29.5 | 124.0 | 17.85 * |
| total DDD,DDE,DDT | 4.6 | 9.9 | --- + |
| Aroclor 1254 | 11 | 33 | --- + |
| Aroclor 1260 | ND | 33 | --- + |
| total PAHs | 103 | 1684 | --- + |
| TOC | 12,600 | --- | --- # |

* mg/Kg + ug/Kg # ppm

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | 8.5 | 1 | 1.67 * |
| Copper | 90.8 | 18.7 | 12.31 * |
| Lead | 182 | 30.2 | 45.8 * |
| Zinc | 319 | 124.0 | 17.85 * |
| total DDD,DDE,DDT | 33.6 | 9.9 | --- + |
| Aroclor 1254 | 78 | 33 | --- + |
| Aroclor 1260 | ND | 33 | --- + |
| total PAHs | 310 | 1684 | --- + |
| TOC | 55,300 | --- | --- # |

* mg/Kg + ug/Kg # ppm

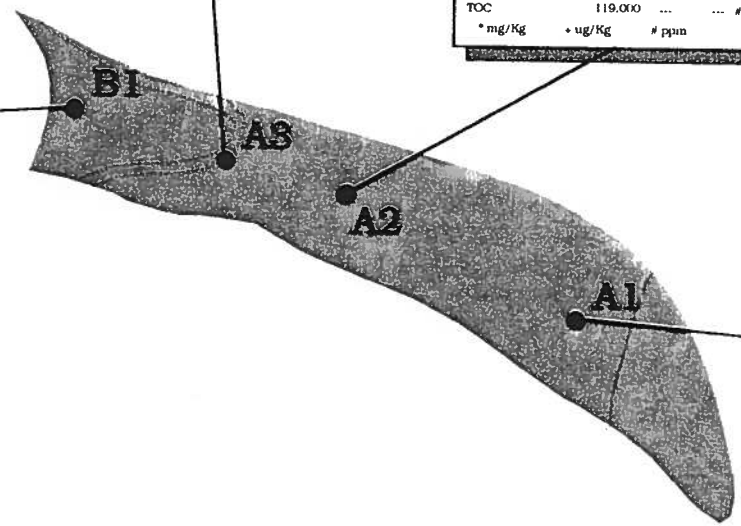
## Notes:

Wetland 16 is ranked Red.

EPA results showed high levels of Chromium, Lead, Zinc, DDT, and some PAHs in some sediment sample locations, especially those locations closest to Site 1.

Surface water results for iron at both sample locations exceeded marine water quality criteria.

# Wetland 18




| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Arsenic | 2.9 | 7.24 | 3.1 * |
| Chromium | 6.3 | 52.3 | 16.23 * |
| Copper | 11.5 | 18.7 | 12.31 * |
| Lead | 66 | 30.2 | 45.8 * |
| total DDD,DDE,DDT | 31.9 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | ND | 33 | --- + |
| total PAHs | ND | 1684 | --- + |
| TOC | 343,000 | --- | --- # |

* mg/Kg + ug/Kg # ppm

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Arsenic | 31.4 | 7.24 | 3.1 * |
| Chromium | 8.9 | 52.3 | 16.23 * |
| Copper | 5.2 | 18.7 | 12.31 * |
| Lead | 45.4 | 30.2 | 45.8 * |
| total DDD,DDE,DDT | 416 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | ND | 33 | --- + |
| total PAHs | 300 | 1684 | --- + |
| TOC | 119,000 | --- | --- # |

* mg/Kg + ug/Kg # ppm

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Arsenic | 83.8 | 7.24 | 3.1 * |
| Chromium | 66.2 | 52.3 | 16.23 * |
| Copper | 17.9 | 18.7 | 12.31 * |
| Lead | 111 | 30.2 | 45.8 * |
| total DDD,DDE,DDT | 2,080 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | ND | 33 | --- + |
| total PAHs | ND | 1684 | --- + |
| TOC | 118,000 | --- | --- # |

* mg/Kg + ug/Kg # ppm

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Arsenic | 2.9 | 7.24 | 3.1 * |
| Chromium | 5.8 | 52.3 | 16.23 * |
| Copper | 22.6 | 18.7 | 12.31 * |
| Lead | 70.1 | 30.2 | 45.8 * |
| total DDD,DDE,DDT | 2,400 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | ND | 33 | --- + |
| total PAHs | ND | 1684 | --- + |
| TOC | 208,000 | --- | --- # |

* mg/Kg + ug/Kg # ppm

## Notes:

Wetland 18 is ranked Red.
Iron in sediment was elevated in the downgradient sample locations.
Iron exceeded marine and freshwater quality criteria fir both sample locations. Chromium, lead, and aluminum also exceeded criteria for the most upgradient SW location.

# Wetland 10

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | 1.70 | 1 | 1.67 * |
| Chromium | 11.60 | 52.3 | 16.23* |
| Zinc | 39.60 | 124.0 | 17.85* |
| total DDD,DDE,DDT | 2.55 | 9.9 | --- + |
| total PAHs | 258 | 1684 | --- + |
| TOC | 5,640 | --- | --- # |

* mg/Kg + ug/Kg #ppm

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | 2.8 | 1 | 1.67 * |
| Chromium | 79.0 | 52.3 | 16.23* |
| Zinc | 22.3 | 124.0 | 17.85* |
| total DDD,DDE,DDT | 98.8 | 9.9 | --- + |

* mg/Kg + ug/Kg

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | ND | 1 | 1.67 * |
| Chromium | 9.3 | 52.3 | 16.23* |
| Zinc | 8.0 | 124.0 | 17.85* |
| total DDD,DDE,DDT | 317 | 9.9 | --- + |

* mg/Kg + ug/Kg

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | ND | 1 | 1.67 * |
| Chromium | 4.9 | 52.3 | 16.23* |
| Zinc | 6.7 | 124.0 | 17.85* |
| total DDD,DDE,DDT | ND | 9.9 | --- + |
| total PAHs | 1028 | 1684 | --- + |
| TOC | 3,690 | --- | --- # |

* mg/Kg + ug/Kg #ppm

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | 34.6 | 1 | 1.67 * |
| Chromium | 1,180 | 52.3 | 16.23* |
| Zinc | 115 | 124.0 | 17.85* |
| total DDD,DDE,DDT | 50.8 | 9.9 | --- + |

* mg/Kg + ug/Kg

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | 0.27 | 1 | 1.67 * |
| Chromium | 10.10 | 52.3 | 16.23* |
| Zinc | 8.00 | 124.0 | 17.85* |
| total DDD,DDE,DDT | .78 | 9.9 | --- + |
| total PAHs | 855 | 1694 | --- + |
| TOC | 2030 | --- | --- # |

* mg/Kg + ug/Kg #ppm

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | ND | 1 | 1.67 * |
| Chromium | 18.5 | 52.3 | 16.23* |
| Zinc | 38.2 | 124.0 | 17.85* |
| total DDD,DDE,DDT | 64.2 | 9.9 | --- + |

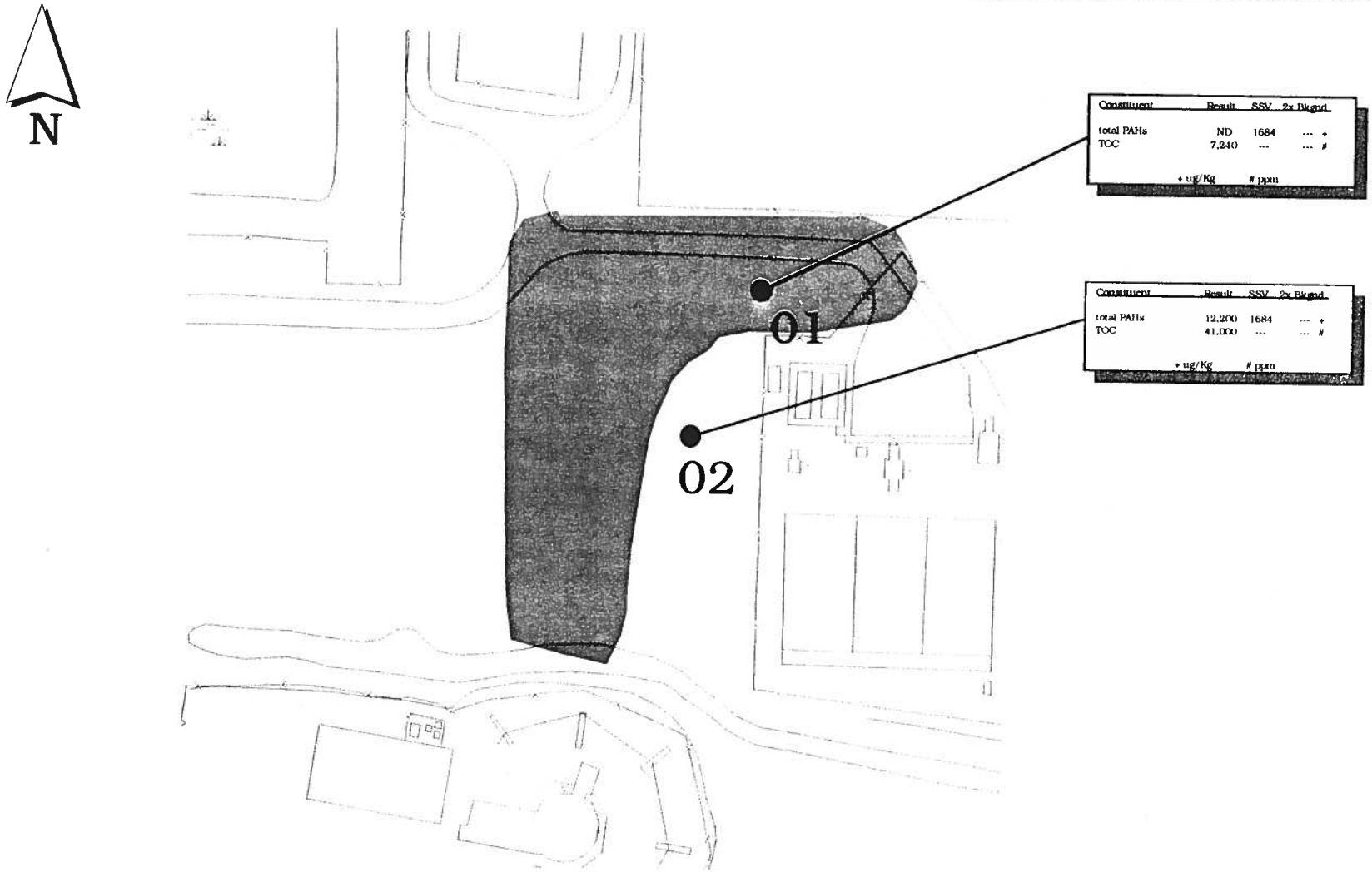
* mg/Kg + ug/Kg

A1
A2
A3
01
02
03
04

## Notes:

**Wetland 10 is ranked Red.**
**Chromium, iron,and DDT exceeded freshwater criteria from previous E/A&H investigations.**

# Wetland 12




| Constituent | Result | SSV | 2x Bkgnd | |
|---|---|---|---|---|
| total PAHs | ND | 1684 | --- | + |
| TOC | 7,240 | --- | --- | # |

+ ug/Kg # ppm

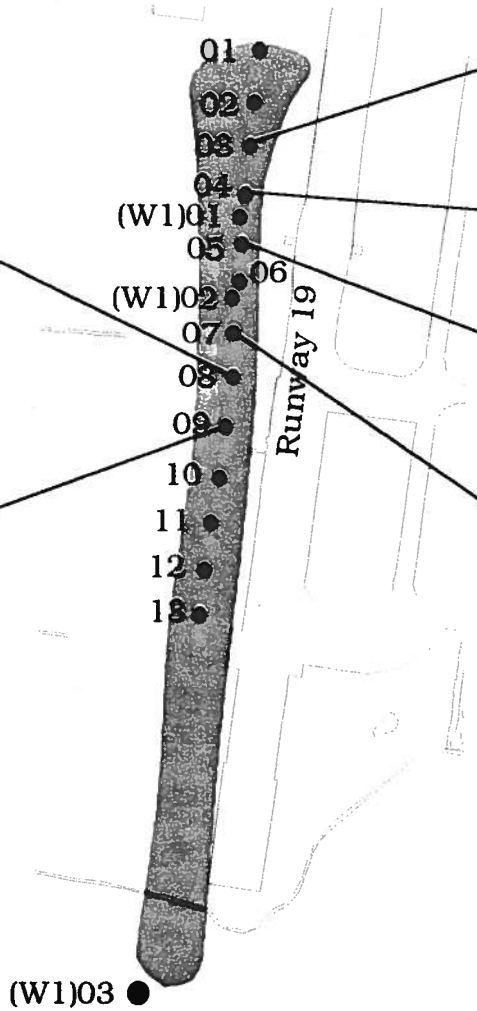
| Constituent | Result | SSV | 2x Bkgnd | |
|---|---|---|---|---|
| total PAHs | 12,200 | 1684 | --- | + |
| TOC | 41,000 | --- | --- | # |

+ ug/Kg # ppm

## Notes:

Wetland 12 is ranked Red.
Possible impacts from bilgewater spill may have contributed to high PAHs in 02, although they are not present in 01.
No PAHs detected in surface water.

# Wetland W1




| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Chromium | 68.7 | 52.3 | 16.23 * |
| Copper | 40.2 | 18.7 | 12.31 * |
| Lead | 950 | 30.2 | 45.8 * |
| Zinc | 126 | 124.0 | 17.85 * |

* mg/Kg

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Copper | 27.9 | 18.7 | 12.31 * |
| Lead | 245 | 30.2 | 45.8 * |

* mg/Kg

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Copper | 86.3 | 18.7 | 12.31 * |
| Lead | 833 | 30.2 | 45.8 * |

* mg/Kg

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Lead | 42.3 | 30.2 | 45.8 * |
| total DDD,DDE,DDT | 17 | 9.9 | --- + |

* mg/Kg + ug/Kg

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| total DDD,DDE,DDT | 253 | 9.9 | --- + |

+ ug/Kg

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| total DDD,DDE,DDT | 9.1 | 9.9 | --- + |

+ ug/Kg

## Notes:

Wetland W1 is ranked Red.

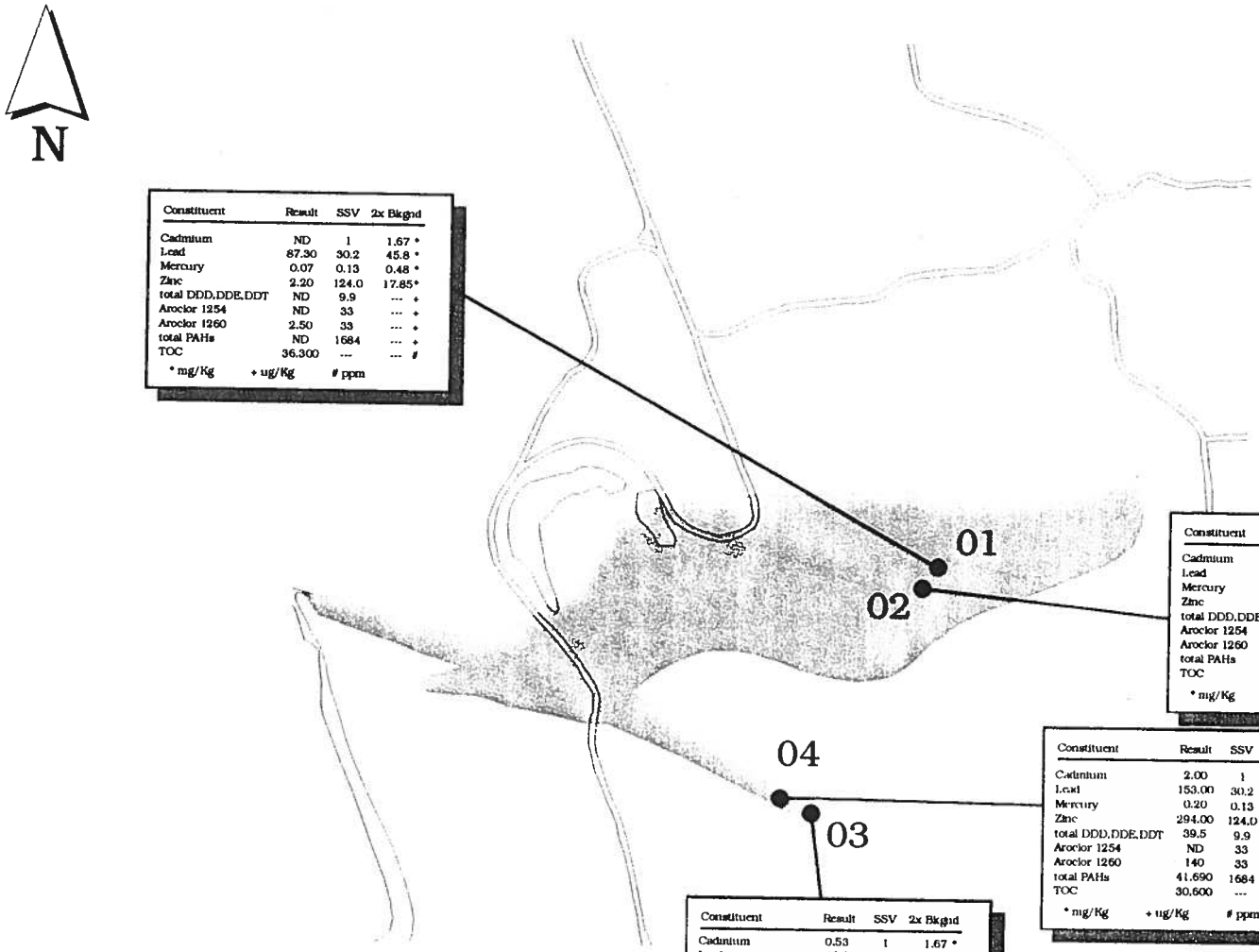
Chromium, Copper, Lead, and Zinc were prevalent in the northern-most sediment samples, which corresponds to the Site 3 location.

Lead exceeded freshwater criteria at all three sample locations. Copper and Zinc also exceeded the criteria other locations.

# Wetlands Ranking According to Color

Orange - Doubtful Wetlands

# Wetland 1




| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | ND | 1 | 1.67 * |
| Lead | 87.30 | 30.2 | 45.8 * |
| Mercury | 0.07 | 0.13 | 0.48 * |
| Zinc | 2.20 | 124.0 | 17.85* |
| total DDD,DDE,DDT | ND | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | 2.50 | 33 | --- + |
| total PAHs | ND | 1684 | --- + |
| TOC | 36.300 | --- | --- # |

* mg/Kg + ug/Kg # ppm

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | 1.20 | 1 | 1.67 * |
| Lead | 1.80 | 30.2 | 45.8 * |
| Mercury | 0.25 | 0.13 | 0.48 * |
| Zinc | 91.0 | 124.0 | 17.85* |
| total DDD,DDE,DDT | 17.6 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | 7.70 | 33 | --- + |
| total PAHs | ND | 1684 | --- + |
| TOC | 145.000 | --- | --- # |

* mg/Kg + ug/Kg # ppm

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | 2.00 | 1 | 1.67 * |
| Lead | 153.00 | 30.2 | 45.8 * |
| Mercury | 0.20 | 0.13 | 0.48 * |
| Zinc | 294.00 | 124.0 | 17.85* |
| total DDD,DDE,DDT | 39.5 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | 140 | 33 | --- + |
| total PAHs | 41.690 | 1684 | --- + |
| TOC | 30.600 | --- | --- # |

* mg/Kg + ug/Kg # ppm

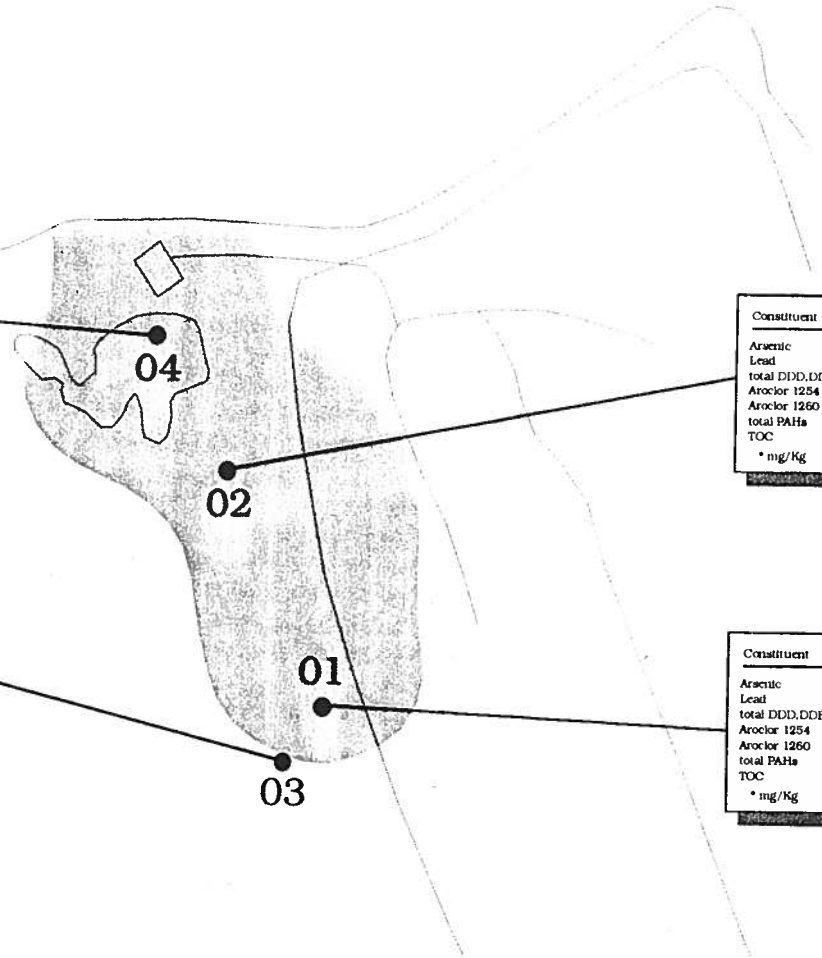
| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | 0.53 | 1 | 1.67 * |
| Lead | 48.8 | 30.2 | 45.8 * |
| Mercury | 0.17 | 0.13 | 0.48 * |
| Zinc | 69.1 | 124.0 | 17.85* |
| total DDD,DDE,DDT | 6.88 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | 110.0 | 33 | --- + |
| total PAHs | 255.0 | 1684 | --- + |
| TOC | 5.320 | --- | --- # |

* mg/Kg + ug/Kg # ppm

## Notes:

Wetland 1 is ranked Orange.
Wetland 1 has standing water for small portion of the year.
Contamination may have resulted from outfall upgradient of Wetland 1.
No exceedances for surface water.

# Wetland 15




| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Arsenic | 2.5 | 7.24 | 3.1 * |
| Lead | 20.7 | 30.2 | 45.8 * |
| total DDD,DDE,DDT | 11.3 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | ND | 33 | --- + |
| total PAHs | 352 | 1684 | --- + |
| TOC | 395,000 | --- | --- # |

* mg/Kg + ug/Kg # ppm

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Arsenic | 15.2 | 7.24 | 3.1 * |
| Lead | 211.0 | 30.2 | 45.8 * |
| total DDD,DDE,DDT | 176.3 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | 24 | 33 | --- + |
| total PAHs | 650 | 1684 | --- + |
| TOC | 149,000 | --- | --- # |

* mg/Kg + ug/Kg # ppm

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Arsenic | 141.0 | 7.24 | 3.1 * |
| Lead | 174.0 | 30.2 | 45.8 * |
| total DDD,DDE,DDT | 285.0 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | 32 | 33 | --- + |
| total PAHs | 620 | 1684 | --- + |
| TOC | 112,000 | --- | --- # |

* mg/Kg + ug/Kg # ppm

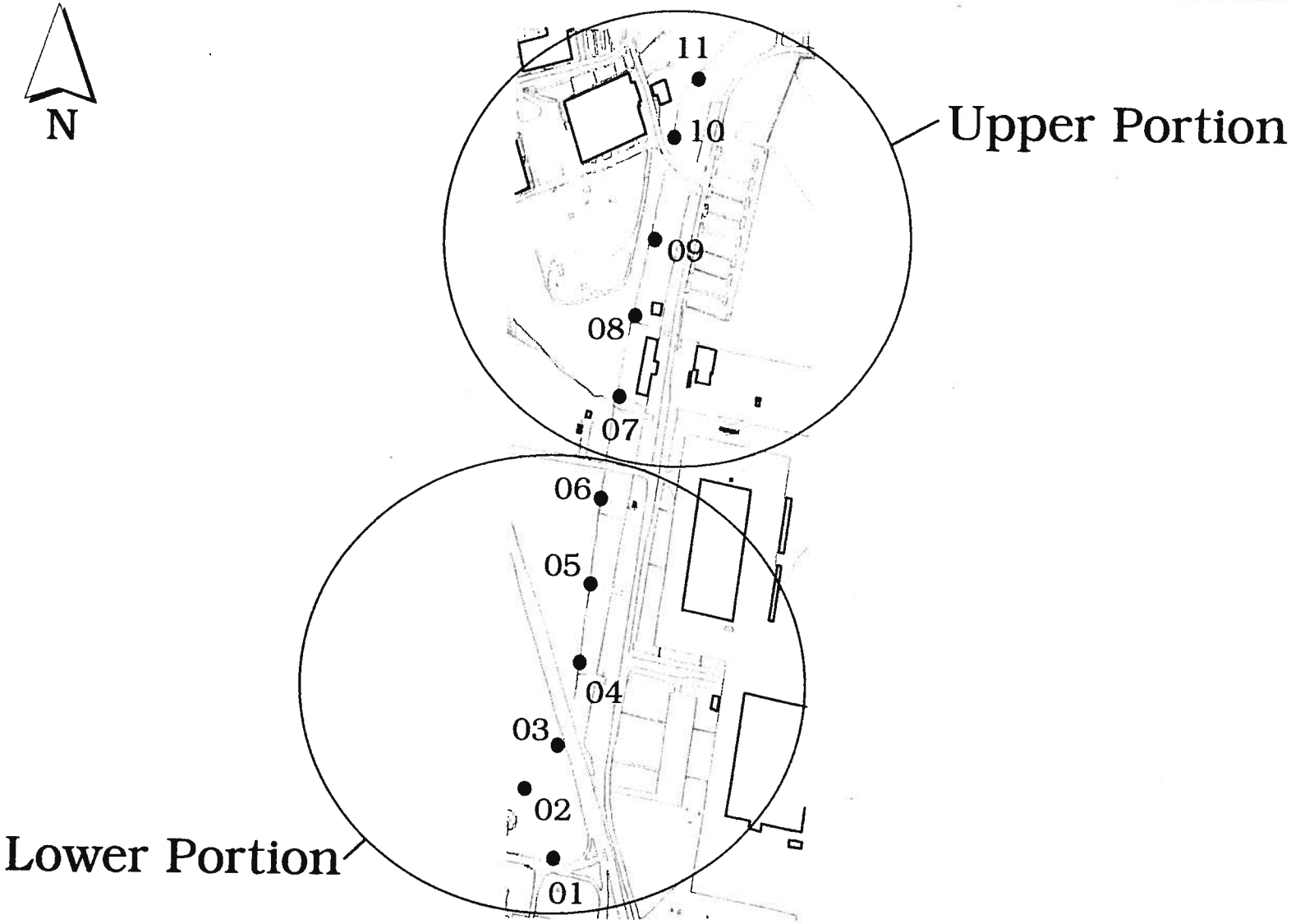
| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Arsenic | 4.8 | 7.24 | 3.1 * |
| Lead | 39.7 | 30.2 | 45.8 * |
| total DDD,DDE,DDT | 434.9 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | 14 | 33 | --- + |
| total PAHs | 200 | 1684 | --- + |
| TOC | 121,000 | --- | --- # |

* mg/Kg + ug/Kg # ppm

## Notes:

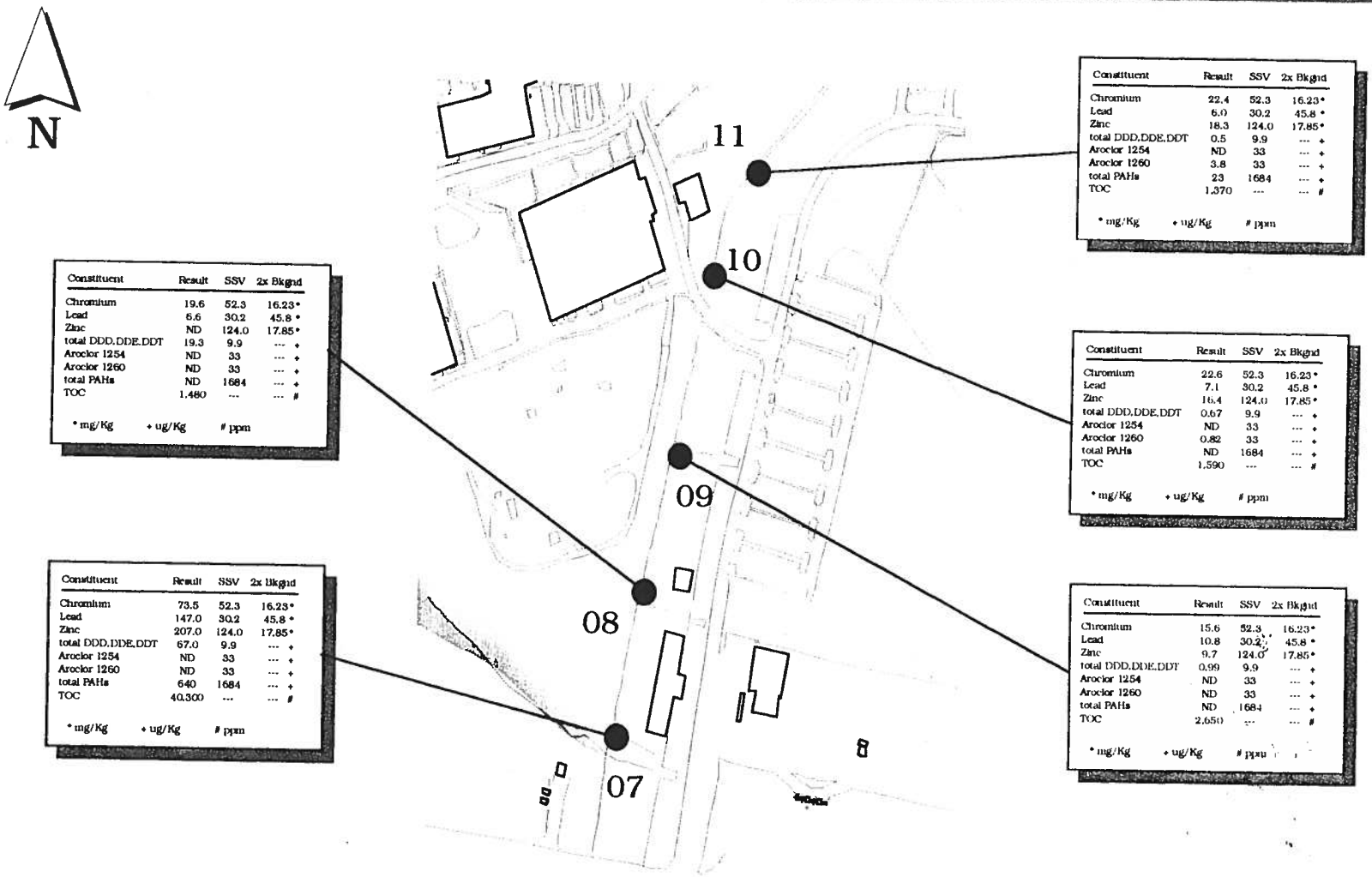
Wetland 15 is ranked Orange.
Wetland 15 is not expected to be impacted by Site 1.
Mercury, lead, iron, zinc, nickel, and copper exceeded marine surface water criteria in E/A&H data.
Mercury, lead, and iron exceeded marine surface water criteria in EPA data.

# Wetland 6




Site 41 RI - Phase IIA Sample Results

# Wetland 6 (Upper Portion)




| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Chromium | 19.6 | 52.3 | 16.23 * |
| Lead | 6.6 | 30.2 | 45.8 * |
| Zinc | ND | 124.0 | 17.85 * |
| total DDD,DDE,DDT | 19.3 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | ND | 33 | --- + |
| total PAHs | ND | 1684 | --- + |
| TOC | 1,480 | --- | --- # |

* mg/Kg + ug/Kg # ppm

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Chromium | 22.4 | 52.3 | 16.23 * |
| Lead | 6.0 | 30.2 | 45.8 * |
| Zinc | 18.3 | 124.0 | 17.85 * |
| total DDD,DDE,DDT | 0.5 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | 3.8 | 33 | --- + |
| total PAHs | 23 | 1684 | --- + |
| TOC | 1,370 | --- | --- # |

* mg/Kg + ug/Kg # ppm

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Chromium | 22.6 | 52.3 | 16.23 * |
| Lead | 7.1 | 30.2 | 45.8 * |
| Zinc | 16.4 | 124.0 | 17.85 * |
| total DDD,DDE,DDT | 0.67 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | 0.82 | 33 | --- + |
| total PAHs | ND | 1684 | --- + |
| TOC | 1,590 | --- | --- # |

* mg/Kg + ug/Kg # ppm

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Chromium | 73.5 | 52.3 | 16.23 * |
| Lead | 147.0 | 30.2 | 45.8 * |
| Zinc | 207.0 | 124.0 | 17.85 * |
| total DDD,DDE,DDT | 67.0 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | ND | 33 | --- + |
| total PAHs | 640 | 1684 | --- + |
| TOC | 40,300 | --- | --- # |

* mg/Kg + ug/Kg # ppm

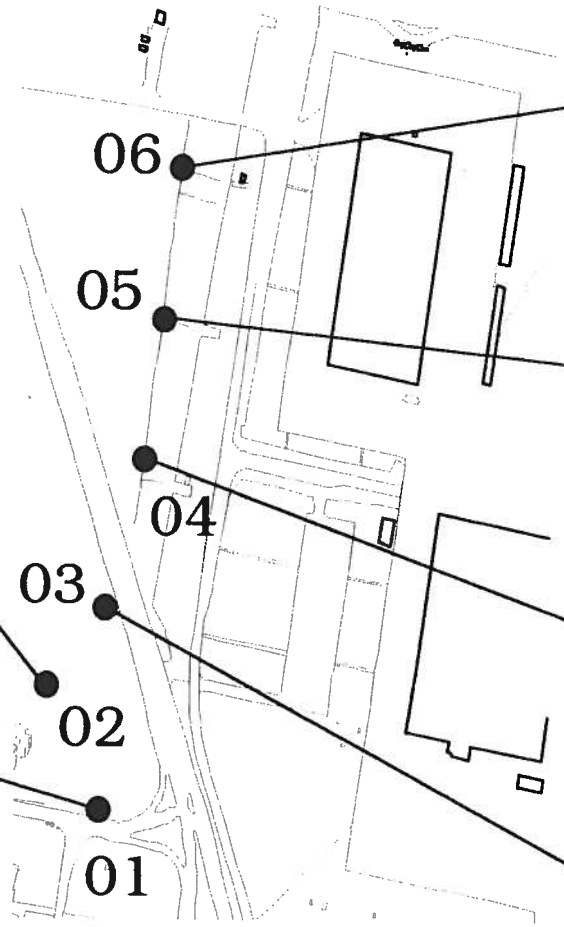
| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Chromium | 15.6 | 52.3 | 16.23 * |
| Lead | 10.8 | 30.2 | 45.8 * |
| Zinc | 9.7 | 124.0 | 17.85 * |
| total DDD,DDE,DDT | 0.99 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | ND | 33 | --- + |
| total PAHs | ND | 1684 | --- + |
| TOC | 2,650 | --- | --- # |

* mg/Kg + ug/Kg # ppm

## Notes:

Wetland 6 is ranked Orange.
Sedimentation from construction operations may have impacted downgradient portions.
Wetland 5 may have impacted location 07 and 10, as metals are detected there in surface water. TCE and its breakdown products were also detected in surface water at location 10 at levels below criteria. Lead and mercury exceed criteria at location 10.

# Wetland 6 (Lower Portion)




| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Chromium | 7.5 | 52.3 | 16.23* |
| Lead | 49.1 | 30.2 | 45.8 * |
| Zinc | 75.7 | 124.0 | 17.85* |
| total DDD,DDE,DDT | 21.1 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | 4.1 | 33 | --- + |
| total PAHs | 260 | 1684 | --- + |
| TOC | 13,000 | --- | --- # |

* mg/Kg + ug/Kg # ppm

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Chromium | 0.56 | 52.3 | 16.23* |
| Lead | 9.4 | 30.2 | 45.8 * |
| Zinc | 18.8 | 124.0 | 17.85* |
| total DDD,DDE,DDT | 7.2 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | ND | 33 | --- + |
| total PAHs | ND | 1684 | --- + |
| TOC | 2,040 | --- | --- # |

* mg/Kg + ug/Kg # ppm

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Chromium | 0.85 | 52.3 | 16.23* |
| Lead | 16.2 | 30.2 | 45.8 * |
| Zinc | 28.1 | 124.0 | 17.85* |
| total DDD,DDE,DDT | 8.6 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | ND | 33 | --- + |
| total PAHs | 176 | 1684 | --- + |
| TOC | 1,210 | --- | --- # |

* mg/Kg + ug/Kg # ppm

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Chromium | 4.4 | 52.3 | 16.23* |
| Lead | 36.1 | 30.2 | 45.8 * |
| Zinc | 74.1 | 124.0 | 17.85* |
| total DDD,DDE,DDT | 125 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | ND | 33 | --- + |
| total PAHs | 2,993 | 1684 | --- + |
| TOC | 11,000 | --- | --- # |

* mg/Kg + ug/Kg # ppm

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Chromium | 2.0 | 52.3 | 16.23* |
| Lead | 10.9 | 30.2 | 45.8 * |
| Zinc | 29.5 | 124.0 | 17.85* |
| total DDD,DDE,DDT | 6.25 | 9.9 | --- + |
| Aroclor 1254 | 9.5 | 33 | --- + |
| Aroclor 1260 | ND | 33 | --- + |
| total PAHs | 533 | 1684 | --- + |
| TOC | 3,780 | --- | --- # |

* mg/Kg + ug/Kg # ppm

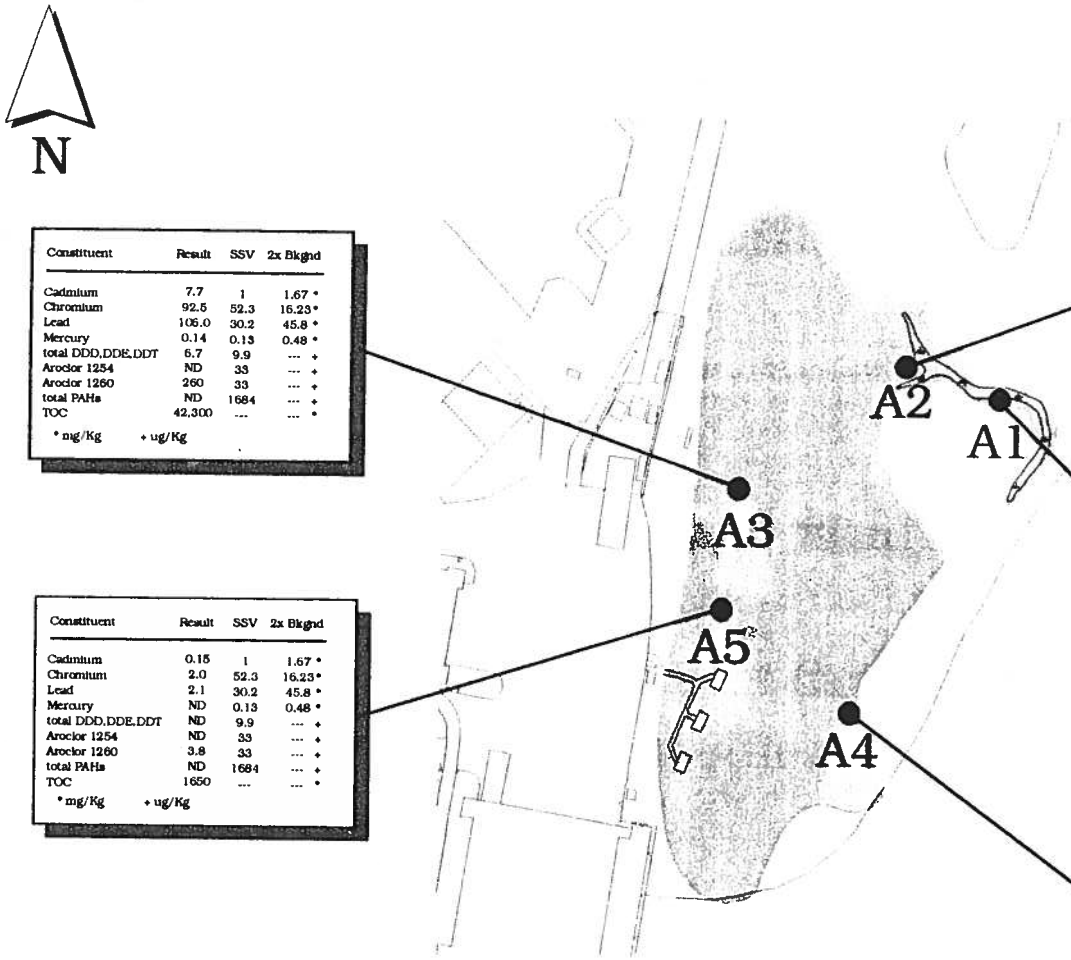
| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Chromium | 2.5 | 52.3 | 16.23* |
| Lead | 47.4 | 30.2 | 45.8 * |
| Zinc | 64.2 | 124.0 | 17.85* |
| total DDD,DDE,DDT | 393 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | ND | 33 | --- + |
| total PAHs | 469 | 1684 | --- + |
| TOC | 3,620 | --- | --- # |

* mg/Kg + ug/Kg # ppm

## Notes:

Wetland 6 is ranked Orange.
Sedimentation from construction operations may have impacted downgradient portions.
Wetland 5 may have impacted location 07 and 10, as metals are detected there in surface water. TCE and its breakdown products were also detected in surface water at location 10 at levels below criteria. Lead and mercury exceed criteria at location 10.

# Wetland 63A




| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | 7.7 | 1 | 1.67 * |
| Chromium | 92.5 | 52.3 | 16.23 * |
| Lead | 106.0 | 30.2 | 45.8 * |
| Mercury | 0.14 | 0.13 | 0.48 * |
| total DDD,DDE,DDT | 6.7 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | 260 | 33 | --- + |
| total PAHs | ND | 1684 | --- + |
| TOC | 42,300 | --- | --- * |

* mg/Kg + ug/Kg

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | 0.37 | 1 | 1.67 * |
| Chromium | 2.2 | 52.3 | 16.23 * |
| Lead | 3.1 | 30.2 | 45.8 * |
| Mercury | ND | 0.13 | 0.48 * |
| total DDD,DDE,DDT | 2.54 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | 14.0 | 33 | --- + |
| total PAHs | 24.0 | 1684 | --- + |
| TOC | 1690 | --- | --- * |

* mg/Kg + ug/Kg

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | 0.17 | 1 | 1.67 * |
| Chromium | 0.51 | 52.3 | 16.23 * |
| Lead | 0.93 | 30.2 | 45.8 * |
| Mercury | ND | 0.13 | 0.48 * |
| total DDD,DDE,DDT | ND | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | ND | 33 | --- + |
| total PAHs | ND | 1684 | --- + |
| TOC | 873 | --- | --- * |

* mg/Kg + ug/Kg

| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | 0.15 | 1 | 1.67 * |
| Chromium | 2.0 | 52.3 | 16.23 * |
| Lead | 2.1 | 30.2 | 45.8 * |
| Mercury | ND | 0.13 | 0.48 * |
| total DDD,DDE,DDT | ND | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | 3.8 | 33 | --- + |
| total PAHs | ND | 1684 | --- + |
| TOC | 1650 | --- | --- * |

* mg/Kg + ug/Kg

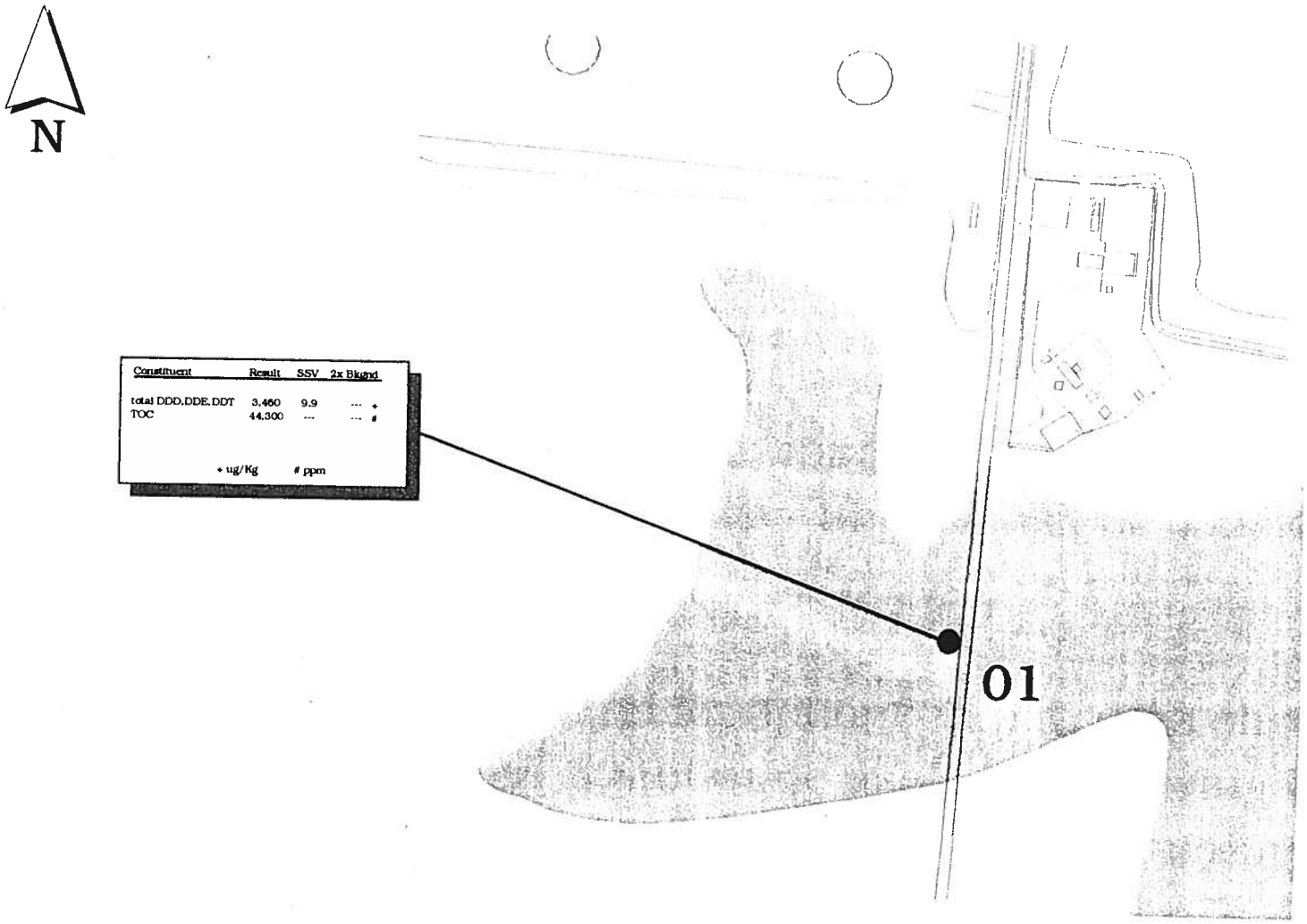
| Constituent | Result | SSV | 2x Bkgnd |
|---|---|---|---|
| Cadmium | 0.7 | 1 | 1.67 * |
| Chromium | 6.2 | 52.3 | 16.23 * |
| Lead | 32.1 | 30.2 | 45.8 * |
| Mercury | ND | 0.13 | 0.48 * |
| total DDD,DDE,DDT | 1.1 | 9.9 | --- + |
| Aroclor 1254 | ND | 33 | --- + |
| Aroclor 1260 | 1.1 | 33 | --- + |
| total PAHs | 758 | 1684 | --- + |
| TOC | 9630 | --- | --- * |

* mg/Kg + ug/Kg

## Notes:

Wetland 63A is ranked Orange.
Wetlands has been altered by construction activities.
Lead exceeded marine surface water criteria.
Could not correlate well with limited groundwater data.

# Wetland 48



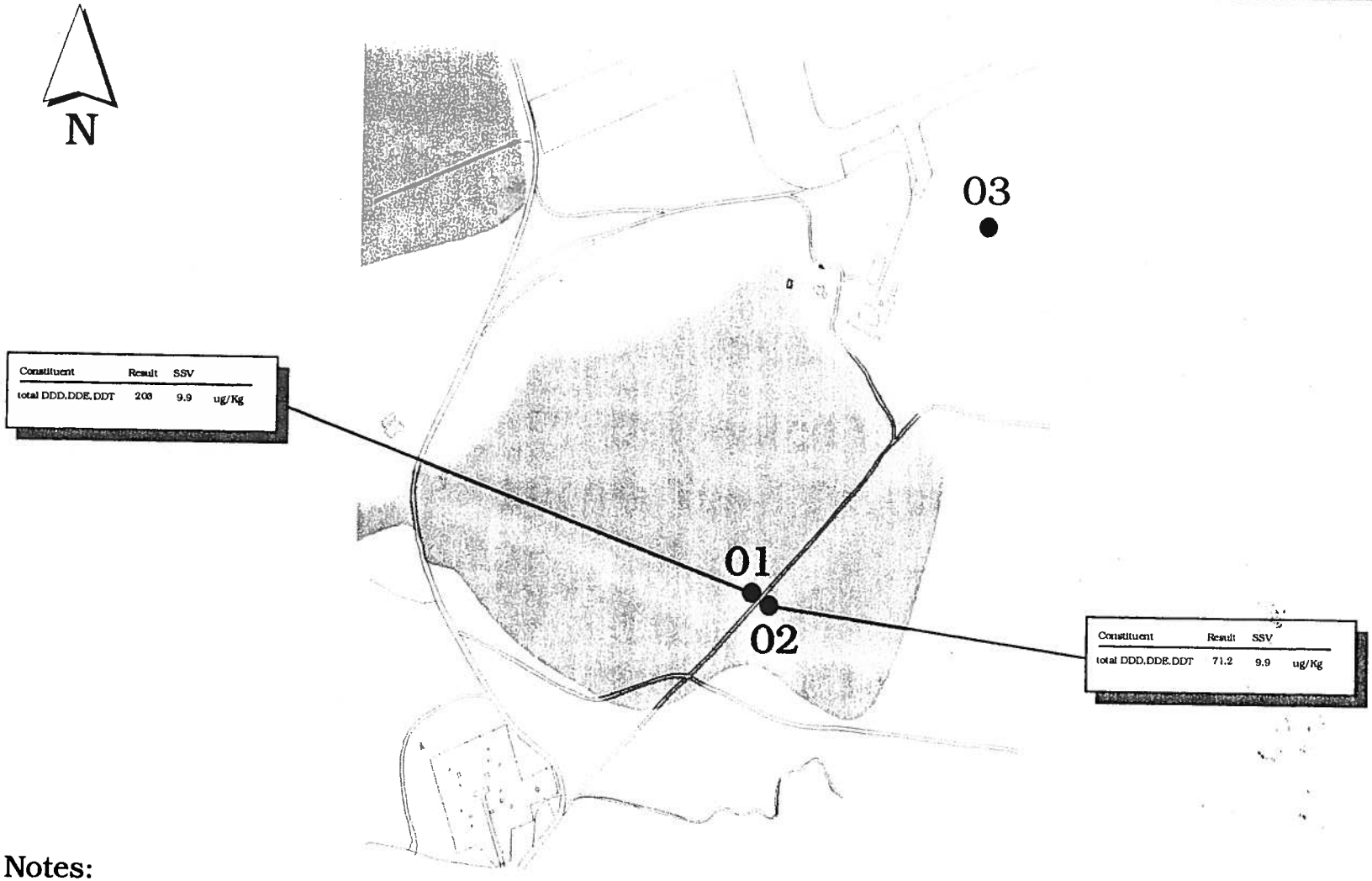

| Constituent | Result | SSV | 2x Bkgnd | |
|---|---|---|---|---|
| total DDD,DDE,DDT | 3,460 | 9.9 | --- | + |
| TOC | 44,300 | --- | --- | # |

+ ug/Kg # ppm

## Notes:

Wetland 48 is ranked Orange.
No fuel-related constituents appeared prevalent.
DDT and its breakdown products appear to be the greatest concern.

# Wetland 49




## Notes:

Wetland 49 is ranked Orange.
No fuel-related constituents appeared prevelant.
DDT and its breakdown products appear to be the greatest concern.

# The Next Proposed Step for Phase IIA...

***Goal:***

*Develop contaminant model in red-coded wetlands to determine risk to measurement and assessment endpoints.*

Will be accomplished through:

- ✔ Modeling programs.
- ✔ Literature searches for toxicity reference values.

# After Completed...

***...discuss results with Tier I Partnering Team.***

Possibilities for further study may involve:

- ✔ Verification of impacts through toxicity/diversity or bioaccumulation studies, depending on the nature of the contaminant.
- ✔ Quantify risk and make collective decisions for remedial action, if any.

# Issues Which MUST Be Addressed...

***... before continuing in this investigation:***

- ✔ How to address non-IR site contamination that appears prevalent in many wetlands. Should risk be considered in these wetlands?
- ✔ Is wetland remediation an option? If not, data should be focused toward its ultimate use (i.e., assessing fate and transport from an associated site or estimating distribution only).
- ✔ Definition of possible human exposure routes.