1. Project Overview

On January 30, 1991, the U. S. Department of State designated Presque Isle Bay as the 43rd Area of Concern (AOC) under the terms of the Great Lakes Water Quality Agreement. That designation required the preparation of a Remedial Action Plan (RAP) for the Bay, to provide a framework for ecosystem restoration and management activities needed to restore impaired uses. A Stage 1 RAP was prepared by the Pennsylvania Department of Environmental Resources (PADER) with the assistance of the Presque Isle Bay Public Advisory Committee (PAC) to identify use impairments in the Bay, sources of pollution, and information gaps. The RAP also identified current remedial actions and possible future actions. The RAP was submitted to the USEPA for review on January 15, 1993 and to the International Joint Commission (IJC) on July 14, 1993, in accordance with the requirements of the Great Lakes Critical Programs Act of 1990. Both USEPA and the IJC have responded with comments, which are included in this report as Appendix A. Responses to those comments are included in appropriate sections of this report.

This report is not intended to replace the original RAP document, but rather to revise and update various portions and make corrections where needed. It is our intent to produce a revision at least biennially to ensure that the RAP is as current as possible. We believe this is a more practical approach than waiting until a Stage 2 RAP is ready before updating the document. It is our understanding that this is the approach being taken by most, if not all, of the AOC's in the US. In addition, the IJC in their Seventh Biennial report recommend that "Governments encourage the publication of periodic updates of activities and goals associated with each Remedial Action Plan to allow improved monitoring of implementation progress..." It is expected that in several areas this report will supersede portions of the original RAP and in those instances this report has precedence.

1.1 Background and Environmental Setting

Obviously, the geographic, geologic and other physical aspects of the Bay have not significantly changed since the RAP was written, and this information is readily available in Chapters 2 and 3 of that document. However, there are several issues which were raised in the review comments that need to be addressed and a few areas where updates are needed.

In the RAP it was determined that the Area of Concern should be defined as Presque Isle Bay (PIB) and its tributary watershed areas. Sources of pollution outside of that area are to be identified and dealt with and a commitment was made to continue investigations in the Outer Harbor area to determine if it should be included in the AOC. Considerable discussion was had concerning this issue over several months of PAC meetings, and this decision reflects the consensus reached. The IJC in its comments again raises this issue in the context of the ecosystem approach. They "urge the RAP team and Public Advisory Committee to continue to investigate if there are use impairments in the waters of Lake Erie in the vicinity of Erie, Pennsylvania, including the Outer Harbor of Presque Isle Bay." They further state that "From an ecosystem perspective, pollutants cannot be transported outside a defined geographic boundary of Presque Isle Bay without being considered." In essence, the IJC is encouraging a continuation of the approach already articulated in the RAP, i.e. deal with the problems in PIB while investigating other areas for possible impairments. While inclusion of nearshore areas adjacent to the Presque Isle Peninsula may become necessary at some future date, it is important to recognize the distinction between these areas and the "Outer Harbor". The Outer Harbor is an artifact of the mapmaker's art and, from an ecological and scientific point of view, is mostly indistinguishable from the open lake. For example, including certain areas near the harbor channel mouth, should sediment contamination be found, may be feasible and appropriate. But simply incorporating the Outer Harbor into the AOC is impractical and counterproductive. It would be impossible to assess all 14 use impairments in any meaningful way, without addressing

lakewide conditions. This is clearly not the intent of the RAP process and it is the reason such an approach was rejected in the original document. Rather than lose time arguing about where the Bay ends and the Lake begins, we have decided to let the original delineation stand and concentrate our efforts on problem identification and remediation.

The IJC also requested that socio-economic data be included in the RAP so that we can ensure that all sectors of the community are included in the process.

(Include section on 1990 Census data)

1.2 RAP process status

The RAP process is divided into three stages involving: 1. Problem identification; 2. Remedial alternative selection and implementation; and, 3. Monitoring and follow up. The expectation is that the program will move from one stage to the next, as each is completed. Unfortunately, the real world refuses to be so neatly compartmentalized, and actual RAP activities span all three stages at once. In some areas, we are still working on problem identification and delineation, while in others, remediation is underway or monitoring is being conducted. For this reason, we believe it is unproductive to try and put each activity into a particular "stage" for reporting purposes. Instead, this report will address activities that have occurred since the RAP was written, regardless of where in the "process" that activity falls.

PADER is currently drafting a separate formal response to the USEPA comments, which will encompass the information contained in this report. There is no separate response planned for the IJC comments, but these will be addressed in pertinent sections of this report where appropriate.

2. Use Impairment Update

The bulk of the RAP document contained a discussion of the 14 use impairments identified by the IJC. Correspondingly, the majority of comments received from the USEPA and IJC were in regard to that section of the RAP. The following sections address specific questions and comments, as well as providing information on activities conducted since the RAP was written.

2.1 Restrictions on Fish and Wildlife Consumption

Both the IJC and the USEPA question the RAP's finding that this use is not impaired, based primarily on the fact that there exist lakewide advisories on carp and channel catfish for PCBs and chlordane. In addition, they note the need for more extensive fish flesh analysis to confirm this finding.

Our approach to this impairment stems primarily from a direct reading of the IJC criteria which states "Contaminant levels in fish and wildlife *must* be due to contaminant input from the watershed." (emphasis added). We relied on existing fish flesh analysis data, water analysis results and sediment chemistry data in reaching our conclusion in the RAP. We also committed to do additional work to confirm this conclusion.

USEPA suggested that we examine a bottom dwelling species to see if fish flesh contamination existed. As part of the Brown Bullhead study (which is discussed more fully in section 2.4), fish flesh analysis was conducted by Cornell College of Veterinary Medicine (Cornell). Five composite samples of skin-on fillets were analyzed for PCBs, pesticides and heavy metals. The results showed PCBs and pesticides to be below detection, and all metals were below FDA standards. Fish tissue was not analyzed for PAH compounds or metabolites. PAH compounds do not usually bioaccumulate at significant amounts in fish tissue because of the fishes' ability to metabolize them. Bile sampling is presently recognized as the standard test

to assess PAH metabolite levels and their effects on fish. See Section 2.4 for a discussion on bile sampling conducted in conjunction with the Brown Bullhead tumor study.

Since the criteria require that the contaminants, in this case PCBs and chlordane, must come from the AOC watershed, we have continued to analyze sediments for these compounds. As part of the Gannett Fleming sediment study completed in March 1993 (discussed more fully in section 2.7), twenty-one locations throughout the Bay and Outer Harbor areas were sampled. In all instances, there was no detection of PCBs or pesticides, including chlordane, above the sample quantification limit. Gannett Fleming has recommended continued sampling for these compounds using even more sensitive tests, and so additional sampling will be done during Spring 1994 as part of our continuing sediment evaluation.

Pennsylvania strongly believes that the existing fish advisories need to be addressed, and has participated with the other Great Lakes states in developing a more meaningful advisory strategy that can be adopted basinwide. The Lakewide Management Plan (LAMP) currently being developed will certainly be examining these lakewide advisories, and we are confident that this issue will not be ignored, even if it is not addressed specifically by the RAP. We are committed to continuing our sampling and analysis of fish, water and sediments. Should sources of the toxics identified by fish advisories be discovered within the AOC, this impairment can be reevaluated. Until such time, we believe we have properly applied the critieria as specified in the guidelines.

2.2 Tainting of Fish and Wildlife Flavor

The RAP indicates that no impairment exists for this use and the IJC and USEPA have concurred with that finding. While continued monitoring is expected, no specific actions are planned in this area.

2.3 Degradation of Fish and Wildlife Populations

As with fish consumption discussed above, the criteria for evaluating this use impairment are fairly specific. Either fish and wildlife management programs must have identified degraded populations due to a cause within the watershed or, relevant, field-validated, fish or wildlife bioassays with appropriate QA/QC confirm significant toxicity from the water column or sediments. Neither of these conditions is met in PIB. In fact, the Pennsylvania Fish and Boat Commission (PFBC), which is charged with managing the Bay's resources, has described PIB as an exceptional, high quality fishery in its evaluations. In addition, there is no evidence confirming toxicity from water or sediments.

USEPA, as well as some IJC commentors, indicates that since sediment conditions in the Bay no longer reflect the original conditions existing before anthropogenic sources of pollution were introduced, there *must* be impacts on macroinvertebrates and fish and wildlife populations. Therefore, this use and the benthos use should be listed by default as impaired.

While such an approach is intellectually satisfying, in attempting to view the Bay holistically, it ignores the specific criteria outlined for making these determinations by the IJC itself. No one can argue that conditions in the Bay 400 years ago were different, and probably better, than they are today. The founding of the City of Erie, the Industrial Revolution, and continuing urbanization have significantly affected habitat, fish and wildlife populations, and benthic conditions. Most of these changes are impossible to reverse, and realizing this, we believe it is more important to move forward on the things which can be addressed. Continued work on sediments and an evaluation of the benthic community are covered in later sections, and may ultimately impact overall fish and wildlife population health. But at this point, we do not meet the tests specified in the criteria, and therefore maintain that no impairment exists for this use.

It is appropriate to note that some members of the PAC agree with the idea that uses should be considered impaired until it is proven they are not. There is concern that if a use impairment is not identified at the outset, then the opportunity is lost to address possible

problems. The majority of the PAC supports the idea that problems can be addressed as they are identified, and decisions regarding impairments can change. What is important is that the investigation continues and that remediation is initiated wherever problems are identified.

2.4 Fish Tumors or Other Deformities

In 1984 the U.S. Fish and Wildlife Service (FWS) at State College, Pa. began receiving reports of tumored Brown Bullheads being caught by fishermen from Presque Isle Bay in Lake Erie, Erie, Pa. In response to these reports, FWS collected 5 Bluegill, 4 Largemouth Bass, and 48 Brown Bullheads, which were necropsied and the tumorous tissues and organs preserved in buffered formalin. Only the Brown Bullheads showed the presence of skin and lip tumors. Gross observation of the livers did not reveal the presence of tumors in any of the samples taken during this period.

Since the preceding study identified an external tumor problem in the PIB Brown Bullhead population, it was decided that a more intensive survey was needed to determine if liver tumors, not observed by gross examination, might be identified through microbiological studies. Liver tumors are considered rare in natural fish populations unaffected by anthropogenic sources. The presence of liver tumors in fish populations is an indication of environmental contamination of a water body. The IJC uses a liver tumor rate of 2% or greater to determine if a fish tumor impairment exists.

In 1985 the FWS collected an additional 93 Brown Bullheads for necropsy. Histological examination of 81 of 93 Brown Bullheads collected exhibited an incidence rate of 11% oral neoplasms, 2.5% skin neoplasm, and 11% epidermal hyperplasia. No liver neoplasms were observed in the samples collected.

In 1990, during the process of preparing the Background Report on Presque Isle Bay, Potomac Hudson contacted PADER for information on the present status of the Brown Bullhead tumors in PIB. In an attempt to answer their request, 65 Brown Bullheads were examined from Pennsylvania Fish and Boat Commission (PFBC) trapnets. External tumor rates for these fish were extremely high, with approximately 86% of the bullheads observed being tumored.

In January of 1991, while in the process of obtaining information on bullhead tumor studies, a contact was made with Dr. Eric May, a veterinarian for the Maryland Department of Natural Resources. Dr. May, himself extremely interested in studying tumor promotion in fish, offered to examine some PIB bullheads. Ten livers and gallbladders from the most tumored (worst case) bullheads were sent to Dr. May for histological analyses. Consequently, four of the ten livers from these fish were determined to have tumors. Consultation by Dr. May with Dr. Harshbarger of the Smithsonian Institute, Washington D.C. confirmed his findings of liver tumors in these fish. This was the first documentation of liver tumors in PIB Brown Bullheads. The results of this sampling prompted the initiation of a histological study to determine the liver tumor rate in the PIB Brown Bullhead population.

A joint study of tumors on Brown Bullheads in PIB was initiated in March 1992. Spearheaded by PADER, it involved the cooperation of the Erie County Department of Health, PFBC, FWS, and the Cornell College of Veterinary Medicine. The purpose of the study was to determine the incidence rate and the causative agents promoting tumors in the fish.

The plan incorporated two distinct aspects of study to evaluate the tumor problem. The first was to conduct a mark-recapture study to determine the life history and distribution of the PIB bullhead population, and the second was a histological study to determine the percentage of bullheads affected by liver and external tumors.

Mark-Recapture Study:

One of the reasons for conducting a mark-recapture study on Brown Bullheads in the Bay was to characterize territorial preferences and seasonal distributions. There are virtually no comprehensive scientific studies regarding these aspects of bullhead biology in the literature. The bullhead is not a glamorous gamefish species that demands serious study by fisheries management personnel. Neither is it highly sought by fishermen in comparison to many other species. This lack of information in the literature left many gaps in trying to assess the mode in which bullheads might encounter contaminants. One of the first questions to be asked was whether the PIB bullheads were residents of the Bay or of Lake Erie. At the start of this study it was not known whether bullheads occupied a small territory for most of their life (e.g. 1 acre), or whether they migrated around the Bay or Lake Erie at random.

During the period of March 29, 1992 to May 6, 1992, a total of 2000 bullheads were tagged and released back to their point of capture from 29 locations in Presque Isle Bay (Map). Prior to tagging all fish captured were measured, weighed, and diagrammed. Locations of external tumors and lesions affecting individual fish were recorded on silhouette diagrams. The diagram form included the corresponding fish tag number and capture location along with length and weight of the fish. A photographic log was made of the first 1,000 bullheads tagged. A total of 112 bullheads were recaptured during 1992. A population estimate (Schnabel method) showed the PIB bullhead population to be 31,715 with a 95% confidence level of 24,827 to 40,476.

The results of this study as they apply to the PIB bullhead fishery, tend to show that the majority of bullheads captured were residents of the Bay. A very limited migration of individuals between the Bay and Outer Harbor was observed (Map 1). Migration patterns within the bay developed from recapture data showed a high rate of migration from the Misery Bay and Lagoon area to the Mill Creek area. Several individuals captured at one end of the bay were recaptured at the other end. PIB bullheads tended to be found in small schools rather than as solitary individuals. They also exhibited seasonal distributions as shown by monthly distribution mapping (Maps 2-7). Seasonal distributions of Presque Isle Bay bullheads were compiled by plotting electrofishing runs for each month that had more than 25 individuals per run. These maps showed the bullheads to be concentrated in the embayments and lagoon system in early and late spring and then concentrated around the shipping channel, near the confluence of Mill Creek, during mid to late summer. The reasons for these seasonal distributions are unclear. Possible explanations might be related to light intensity preference, temperature preference (cooler water), or attraction to nutrient inputs from Mill Creek.

Brown bullheads examined for external tumors during the tagging study exhibited a body tumor rate of 64%. Yellow Bullheads examined exhibited a body tumor rate of 13%. Tumor percentage rates for areas with catch rates greater than 100 individuals are shown on Map __. It is interesting to note that the Mill Creek area (Station 29) had the highest rate of external tumors (82%), and also exhibited the highest levels of Polycyclic Aromatic Hydrocarbon (PAH) levels in the sediment study performed by Gannett Fleming, Inc. (See Section 2.7). These results lend strong support to the identification of the Mill Creek area as a hot spot of environmental contamination that may be promoting tumors in the bullheads.

Histological Study:

A histological study was performed on a random sample of 100 Brown Bullheads from PIB by Dr. Jan Spitsbergen at the Cornell College of Veterinary Medicine, Ithaca, NY. The study was conducted to determine the percentage of external tumors and internal liver tumors on Brown Bullheads within PIB. The results of the study showed an external tumor rate of 64% and a liver tumor rate of 22%.

Part of the histology study included an age analysis of the fish. Fifty of the 100 bullheads necropsied were aged by Dr. Edward Brothers of EFS Consultants, Ithaca NY. The bullheads ranged in age from 8 to 15 years with 36% of the fish being 14 years of age. The length of these bullheads was between 290 mm and 355mm. The results of this study developed into a point of controversy.

Dr. Brothers is noted for his aging of fish by the use of otoliths (a small bone in the head). However, practically all historical work on bullhead ages found in the literature was performed on sections of pectoral or dorsal spines. Scott & Crossman Freshwater Fishes of Canada lists the maximum age of Brown Bullheads at 6 to 8 years. This discrepancy between the ages of the PIB bullheads and published literature accounts presented a problem of determining whether Dr. Brothers or past studies performed by other researchers were correct. Fisheries research personnel opinions varied on this subject. Several researchers felt that otolith aging was a better technique than aging from spines. Others felt just the opposite is true. The crux of the problem is that if Dr. Brother's otolith technique is correct then probably all other aging studies recorded in the literature are wrong.

In order to shed more light on this controversy, a sample of 10 Brown Bullheads ranging in size from (144 mm to 376mm) were sent to Bruce Tezlaff of Southern Illinois University, Cooperative Research Lab. Southern Illinois is known for their research on Channel Catfish, and has used both spine and otolith techniques in aging determinations. Tezlaff agreed to use both techniques on the ten bullheads from PIB. The results of these comparisons showed that the otolith technique appeared to be more accurate than the spine method. Tezlaff felt that some of the annual rings used to age the fish from spines appeared indistinct. However, when the otolith of that same fish was examined, the indistinct rings noted on the spines showed up as distinct annuli. These results appear to support otoliths as a more accurate measure of bullhead aging.

Comparison of otolith to spine aging is significant not only as it pertains to the most accurate aging method. It is significant with regard to bioaccumulation impacts on the PIB bullhead population. These fish can now be viewed as long lived with a greater chance of exposure to environmental contaminants over a longer period of time.

Related Studies:

In addition to the histologic study conducted, 100 tumored Brown Bullheads (live fish) were collected and transported to Cornell agronomy ponds for observation over the summer. This aspect of the study was conducted to examine the possibility of a disease or virus being the cause of tumor promotion. A regression of the tumors could be expected if the tumors were caused by disease or viral transmission. Electron microscopy and transmission studies conducted at Cornell did not detect viral particles, nor were they able to produce tumors on clean fish by injecting them with homogenates made from tumor cultures. Recaptured bullheads from PIB and Cornell agronomy ponds showed that the tumor conditions of the majority of bullheads remained unchanged. These results support the theory that the tumors in PIB bullheads are not produced by viruses or disease, but rather by some type of contaminant.

Bile samples were collected from the gallbladders of 17 Brown Bullheads from three locations within the bay for analyses of Polycyclic Aromatic Hydrocarbons (PAH) metabolites. The bullheads sampled included 3 fish judged to be clean or free of external tumors, and the remaining 14 bullheads tumored. The bile samples were analyzed for three PAH metabolites, napthalene, phenanthrene, and benzo(a)pyrene (Table 1), by the Geochemical and Environmental Research Group at Texas A.& M. University.

The tumor free fish had significantly lower levels of PAH metabolites in their bile. The PAH metabolites levels in some of the tumored fish were at or above levels capable of promoting carcinogenic or mutagenic effects. The bile results strongly support the theory that PAH's are a cause of tumor promotion in the PIB bullhead population. These results have

prompted a need to do additional PAH bile sampling from selected sites and also other fish species in 1994.

In addition to the histological study performed by Cornell, 10 Yellow Bullhead livers and gallbladders were examined by Joyce Evans, a pathobiologist for the Maryland Department of Natural Resources at the Cooperative Oxford Laboratory. The livers and gallbladders were collected from fish captured in PIB trapnet and electrofishing operations conducted by PADER in April 1993. Yellow Bullheads collected during the 1992 sampling had exhibited a external tumor rate of only 17% as compared to the Brown Bullhead external tumor rate of 64%. The differences in tumor rates between the two species is significant since both were captured from similar habitats within the bay and have similar life styles. These differences in external tumor rates led to speculation that there might also be differences in liver tumor rates. The ten Yellow Bullheads livers examined by Joyce Evans were diagnosed as being free of tumors. Although the sample size of Yellow Bullheads is small compared to the number of Brown Bullheads examined, it does raise questions as to why the tumor rates are so different between the two species. These findings support the idea that genetic differences in species may play an important role in determining a species' susceptibility to environmental contaminants.

Sediment Study:

Another source of carcinogenic tumor promotion may be naturally formed nitrosamines. Dr. Spitsbergen has speculated that these compounds may be promoting tumors in PIB bullheads. N-nitroso compounds are potent carcinogens and can form spontaneously in natural waters and sediments in the presence of nitrite from decomposing plant material and organic precursors such as amines, ureas, and amides. Laboratory studies have shown acute toxicity to freshwater aquatic life occurs at concentrations as low as 5,850 ug/l.

In 1992, nitrosamine sediment samples were collected from ten sites within the bay to determine their presence or absence. N-nitrosodimethylamine (NDMA) and N-nitrosodi-N-propylamine (NDPA) were found to be present at all ten sites, but below levels of published carcinogenicity. In 1993, sediments were sampled at 9 locations within the bay and lagoon system. Sediment samples were collected biweekly from April 29, 1993 to October 7, 1993, and analyzed for nitrosamines and metals. Nitrosamine analyses showed several sampling sites to have NDMA and NDPA at levels greater than those shown to cause liver tumors in laboratory studies. Additional sediment sampling for nitrosamines will be included in the 1994 sediment sampling plan.

Summary:

The results of the mark-recapture study in conjunction with the histological analyses and tumor regression studies suggests that the cause of tumor promotion in Brown Bullheads from PIB is related to a carcinogenic contaminant or contaminants. The presence of liver tumors in 22% of the fish and the absence of a verifiable disease or virus supports this conclusion. Sediment and bile studies have documented the presence of two contaminants (nitrosamines and Polycyclic Aromatic Hydrocarbons) at levels capable of promoting tumors in fish. Tumor rates generated for specific sites have shown the Mill Creek area as a possible hot spot for PAH contamination, while sediment sampling results have shown several Bay sites to have extremely high nitrosamine levels. Since it appears that the tumor problem is directly linked to the sediment contamination problem, it is hoped that the sediment work planned for 1994 will give more direction to remediation of the tumor problem.

2.5 Bird or Animal Deformities or Reproductive Problems

The RAP indicates that no impairment exists for this use and the IJC and USEPA have concurred with that finding. While continued monitoring is expected, no specific actions are planned in this area.

2.6 Degradation of Benthos

Both the IJC and the USEPA have commented that there is a lack of data regarding this impairment, and suggest addition work be done. It is noted that both believe that in light of this data insufficiency, it is incorrect for the RAP to consider the use not impaired. It is somewhat ironic that based on the very same lack of data, they both conclude that it should be considered impaired. Rather than continuing to debate the logic of these opposite approaches or the impossibility of proving a negative, we have scheduled additional data collection for the Spring of 1994.

Using the "triad" method recommended by USEPA's Assessment and Remediation of Contaminated Sediments (ARCS) project, we will conduct bulk chemistry analysis, sediment biotoxicity testing, and a benthic community evaluation at a number of sites in PIB. As part of the sediment assessment discussed under section 2.7, twenty-one locations will be sampled for bulk chemistry analysis. Of those twenty-one, ten sites have been selected for concurrent sediment toxicity testing, and eight sites have been selected for benthic community evaluation. The sampling sites for each activity are identified in Figure 1.

Hopefully this direct data collection effort will move us out of the realm of speculation about what might be, to the realm of what is. This use will be re-evaluated in light of the results of these investigations.

2.7 Restrictions on Dredging Activity

In their comments, both the IJC and USEPA concur with the RAP's finding that this use is impaired. That finding was based on historic data which was then compared to the USEPA's 1977 Guidelines for the Pollutional Classification of Great Lakes Harbor Sediments. The criteria established by the IJC for this impairment, and the USEPA guidelines noted above, are designed specifically to address the suitability of dredged sediments for open lake, confined or other disposal. A strict application of either criteria does not require a consideration of the effects contaminated sediments may have on other conditions in the Bay and, perhaps more importantly, on other uses such as fish tumors. We believe a broader consideration of sediment contamination is appropriate, and have begun a more in depth look at current conditions. The reader may feel that this is a departure from the approach taken with regard to some of the other impairments, where a strict reading of the criteria was applied. The important distinction is that sediment impairments are due directly to conditions known t exist in the Bay, as opposed to the lakewide conditions affecting other uses. We are able to assess and deal with local conditions and contaminant sources directly.

As noted above, previous evaluations relied on historic data sets which did not cover the entire spectrum of contaminants of concern. The validity of the 1977 USEPA guidelines has been questioned by the scientific community, and they have essentially been abandoned in favor of more modern criteria. The discussion contained in the original RAP document, while valuable for historic background, does not reflect changes in methods and evaluative criteria and is superseded by this report.

The first order of business in tackling the sediment issue was to obtain current samples and analysis. Working with USEPA Region 3, we were able to contract with Gannett Fleming, Inc. to conduct a study of PIB sediment quality. Twenty-two locations were selected in the Bay and Outer Harbor in an effort to get a reasonable cross-section of sediments (see Figure 2). Grab samples were collected from 21 locations (Station 17 was not sampled as it fell within the

dredged portion of the Bay and consisted entirely of coarse sand) using a petite ponar dredge. Samples were analyzed for organics, including PCBs, pesticides, and PAH compounds, as well as metals and other physical/chemical parameters. Sample Quantification Limits (SQLs) were calculated for the parameters tested. The SQL differs from Method Quantification Limits (MQLs) and instrument detection limits in that it considers not only the matrix of the sample, as does the MQL, but also considers interferences. While SQLs tend to be higher than MQLs (which are in turn higher than instrument detection limits), they more accurately depict site specific conditions. Complete results of the analysis are included in Gannett Fleming's report and are not repeated here.

The results of this study showed no detection of PCBs or pesticides above the SQLs. Nine PAH compounds and two phthalate compounds were found. Figure 3 shows the distribution of organic constituents throughout the Bay. The highest concentrations of PAHs were found near the mouth of the Mill Creek Tube and in the areas nearest the City of Erie shoreline. Total organic carbon (TOC) levels were relatively high throughout the Bay, as were oil and grease levels, but there was no readily discernible pattern in distribution. Total organic halogens (TOX) were found at only one location (Station 14).

The distribution of heavy metals in the sediments was also highly variable, with the maximum concentrations found in areas adjacent to the City of Erie. Figure 4 shows the distribution of heavy metals throughout the Bay. It is important to keep in mind that these are total analysis results. The distribution of the physical/chemical parameters is depicted in Figure 5.

The Gannett Fleming report discusses the need for consistant sediment quality criteria (SQC) against which measured values can be compared to determine if more in-depth evaluations are necessary. At this time, there is no single accepted SQC which can be used. New approaches are currently being examined and tested, and it may be some time before there is universal agreement. As noted above, the RAP used only the USEPA 1977 guidelines for comparison. Unfortunately, this is the least reliable and least scientifically supportable of the possible alternatives. Gannett Fleming compares the results of their analysis with eight different criteria (Table 2). It is evident from this comparison that a chemical may or may not be flagged depending on which SQC is selected. This variability among methods makes determining the significance of these results all the more difficult.

What is needed at this point, based both on Gannett Fleming's recommendations and the work of the USEPA ARCS program, is a three-pronged or "triad" approach to evaluating the sediments. The triad approach (scheduled for spring of 1994 and discussed in section 4.1) combines a bulk chemical analysis, a sediment toxicity test, and a macroinvertebrate survey of sediments from the same location at the same time. Such an evaluation will help us to determine the need for and extent of remedial actions.

Based on these most current analysis results, there is every reason to believe that sediment contamination exists in PIB and this use is impaired. The challenge now is to determine whether that contamination is affecting the biota, and if so the extent of the problem.

2.8 Eutrophication and Undesirable Algal Blooms

The RAP indicates that no impairment exists for this use and the IJC and USEPA have concurred with that finding. The IJC mentions the possible effects of Zebra Mussels, which have yet to be fully evaluated. Activities regarding the mussels are discussed in Section 3.2. No other activities beyond continued monitoring are planned at this time.

2.9 Restrictions on Drinking Water Consumption or Taste and Odor Problems

The RAP indicates that no impairment exists for this use and the IJC and USEPA have concurred with that finding. Continued monitoring is expected, but no specific actions are planned.

2.10 Beach Closings

The IJC notes the need for additional bacterial monitoring in the Bay to support the contention that, with the exception of the mouth of Mill Creek, this use is not impaired. While recognizing that there are no public bathing beaches within the Bay, the IJC was concerned with the large amount of whole-body contact recreation, such as water skiing and sail boarding, that occurs in the Bay.

In August of 1993, with the assistance of personnel from Presque Isle State Park, samples were gathered from three locations on a weekly basis and analyzed for total and fecal coliform bacteria. Chapter 193 of the Department's regulations specifies the criteria to be used in beach closing determinations. When the geometric mean of five consecutive samples is greater or equal to 200 fecal coliforms per 100 milliliters of water; or, a single sample exceeds 1000 fecal coliforms per 100 milliliters of water, the beach is closed. There were no exceedances of the criteria for the six week period studied. In order to confirm the findings from 1993, and to monitor changing conditions in the Bay, we will continue collecting samples in 1994 beginning earlier in the season, and possibly including additional locations.

Continued monitoring, coupled with the City of Erie's ongoing program to correct problems with Combined Sewer Overflows (CSOs), will help to ensure the continued health and safety of those who use the waters of the Bay for recreation.

2.11 Degradation of Aesthetics

The RAP indicates that no impairment exists for this use and the IJC and USEPA have concurred with that finding. Continued monitoring is expected, but no specific actions are planned.

2.12 Added Costs to Agriculture or Industry

The RAP indicates that no impairment exists for this use and the IJC and USEPA have concurred with that finding. Continued monitoring is expected, but no specific actions are planned.

2.13 Degradation of Phytoplankton and Zooplankton Populations

The RAP indicated that the existing information was insufficient to make a determination as to whether or not an impairment existed. To rectify that situation, specific toxicity testing was conducted.

The USEPA contracted with A.T. Kearney, Inc. to conduct the study. The potential impacts of toxics on plankton populations was conducted using a four-day, chronic algal (*Selanastrum capricornutum*) static growth test and a three-brood, seven-day, chronic cladoceran (*Ceriodaphnia dubia*) static renewal, survival, and reproduction test using ambient water collected from PIB. The tests were conducted four times to account for seasonal variations. Samples were collected on September 2, 1992; October 27, 1992; February 24 and 25, 1993 (through the ice cover); and May 24, 1993. Four sampling locations were selected (shown in

Figure 6), three along the mid-line of the Bay and one outside the Bay, and samples collected from approximately two meters down. While the same three Bay locations were used for all sampling events, four different points were used as controls. The physical and chemical parameters of the water were measured at the time of sampling using a Hydrolab®.

The specific test protocols and detailed results are available in the original reports. In summarizing the results of the four sampling events, A.T. Kearney found:

Summer - *Ceriodaphnia* reproduction was significantly greater at Station 2 than at control Station 5, and there was no significant difference in algal growth.

Fall - Algal growth in PIB water was not inhibited, but was significantly inhibited in the Lake Erie sample. Station 3 showed significantly greater *Ceriodaphnia* reproduction than control Station 4.

Winter - There were no significant differences in *Ceriodaphnia* reproduction, but algal growth was significantly less than control Station 7. However, when compared to the inoculum control, the algal growth in the four winter samples was not significantly inhibited.

Spring - PIB samples had greater young production than the Lake control or reference control. Algal growth showed no significant differences between sites, but control Station 8 was significantly less than the inoculum control.

A. T. Kearney concluded that "Based on results from the summer, fall, winter, and spring sampling, water samples collected from Presque Isle Bay do not appear to adversely affect *Ceriodaphnia* reproduction or algal growth." Since no toxic effects are demonstrated by the sampling, we conclude that there is no impairment of the phyto- or zooplankton populations from toxics in ambient waters.

In conjunction with the sediment sampling discussed in Section 2.7, Gannett Fleming also collected phyto- and zooplankton samples from four locations in the Bay. As this was a single sampling event, no specific conclusions could be reached with regard to the overall structure of the plankton community. It was noted in Gannett Fleming's report that the types of organisms found and their numbers are consistant with results obtained by other researchers using similar methods in the Bay. This sampling event does add to the baseline information on plankton and will be correlated with future samples. Plankton will be collected in the spring of 1994 as part of the sediment sample collection effort. Some university researchers are also studying plankton in PIB. As funding becomes available, more aggressive plankton community studies may be instituted as part of the RAP.

The impact of Zebra Mussels on the plankton communities is obvious. While there have been some studies published and further evaluations are on-going, at this point we are merely documenting the changes as the system reestablishes equilibrium. It may be years or even decades before we can determine the overall effect of the mussels on the ecology of not just the Bay, but the entire Great Lakes Basin. The system will almost certainly not return to its pre-Zebra Mussel conditions, and so comparisons to the past are not relevant with regard to impaired uses. Just as other exotic species have become part of the "natural" landscape in the past (few people think of starlings, pheasant or house sparrows as "exotic"), so too will the Zebra Mussels. What this means for native species and how we evaluate these impacts on other conditions or remedial activities in PIB will be considered as we move forward. But, nothing we do as part of this RAP will change the fact that the Zebra Mussel is here to stay. We should not consider a use impaired in the AOC on the basis of a fundamental basinwide changes in the system.

On the basis of new information and analysis of the conditions in the Bay, as well as the Lake, we conclude that this use is not impaired.

2.14 Loss of Fish and Wildlife Habitat

In their comments, the IJC concurs with our finding that this use is not impaired. The USEPA, while not disagreeing with our assessment, indicates that more information on possible habitat loss from City of Erie development should be included. It is clear to everyone working in urban AOCs that there has been historic loss of natural areas as cities developed and spread. The City of Erie is no different and it is acknowledged that the construction of breakwalls, piers, marinas, housing, and dredge and fill activities have changed the face of the shoreline and nearshore conditions over time. While it is unlikely that any of the existing structures will be removed or the shoreline returned to pristine conditions, the current regulatory requirements place strict controls on proposed activities, and effects on existing habitat and conditions are carefully considered before any new actions are taken.

In addition, the IJC has recommended that habitat enhancement projects be pursued, and, in fact, this intention is stated in the RAP. Section 4.3 describes the effort to place fish habitat enhancement structures called "porcupine cribs" in PIB. This will be a joint effort with the PA Fish and Boat Commission and will hopefully occur within the next year. The PADER Bureau of Parks has recently set aside the tip of Gull Point as a bird sanctuary, off limits to all people during the nesting and migration season, in an effort to reestablish colonial and other shorebirds and provide an undisturbed rest area for migrants. While not in the AOC itself, this effort will benefit bird populations throughout the entire area.

Other enhancements are being considered and will be pursued as specific projects are identified.

2.15 Summary

For the most part, reviewers comments and ongoing studies and data collection have confirmed the RAP's evaluation of the impaired uses in PIB. Sediment contamination and tumors in Bullheads are the biggest concerns. Bacterial contamination is present in very restricted areas and will continue to be noted as a limited impairment. We have respectfully disagreed with the reviewers regarding fish flesh contamination, fish and wildlife population effects, and benthic community impacts, more on a philosophical level than a practical level. We believe that the reviewers have, in some instances, misapplied the established criteria and in so doing would place the RAP in the impossible position of proving a negative hypothesis. However, this disagreement will in no way prevent continued investigation into those areas, or the remediation of problems should they be subsequently found. Actions to improve conditions in the Bay are more important than rhetorical discussions.

2.16 Pollutants of Concern and their Sources

The RAP indicated that heavy metal contamination and possibly PAH compound were responsible for the impairments identified. Recent work on both sediments and Brown Bullheads indicates that it is the PAHs which may be the greater pollutants of concern. In addition, fish researchers at Cornell have indicated that nitrosamine compounds may also be contributing to the tumor problems.

Ambient water and sediment samples were collected during the spring, summer and fall of 1993 from nine locations around the Bay (Figure 7). The results (Tables 3-11) show that while there are scattered measurements above water quality limits, there are no patterns of water quality problems. Of over 1000 analyses performed only 58 exceeded water standards, and none consistently. Of those 58, almost half (26) are due to iron (Fe) and aluminum (Al). The remainder were copper (Cu) 14, lead (Pb) 12, and cadmium (Cd) 6. It can be noted that in a number of cases, excursions of several parameters occur in the same sample. Since these are unfiltered samples, it is possible that turbidity played a role, i.e. the more turbid a sample is, the higher the metal values are likely to be. There also does not appear to be any correlation

between the water and sediment values for samples taken at the same location. In essence, a high sediment value does not necessarily mean a high water value. As stated in the RAP, the main source of contaminants appears to be the in-place sediments. While we will continue to collect ambient water sample, our main focus will be on sediment sampling as discussed in Section 4.1.

PAH compounds are implicated by the bullhead studies as a cause of the tumors observed. Sediment analysis indicates the presence of PAHs at levels sufficient to induce tumors in the lab. The question becomes one of identifying the source of these compounds. Are they historic or are there continuing inputs to the system? Are they petrogenic (petroleum) or pyrogenic (fire) in origin? Specific analysis conducted as part of the sediment project discussed in Section 4.1 should help to answer these questions. Since these are not naturally occurring compounds, it may then be possible to eliminate or minimize their sources through remedial actions.

Nitrosamines, on the other hand, can be created through the natural breakdown of other compounds. While sewage and other organic inputs may increase nitrosamine production, there will always be some formed. If further work determines that these compounds are contributing to the bullhead tumor problem, there may be little that can be done in the way of total remediation.

Other sections of this report outline the steps that are being taken to determine the sources and transport mechanisms for the pollutants of concern discussed above. Air deposition, combined sewer overflows (CSOs), and urban runoff can all contribute these compounds to the Bay. A recent study for the Erie County Planning office looked at the contribution of metals, PAHs, and other contaminants to the Bay from pleasure boats. While there are some questions regarding the magnitude of that contribution, it is a source that should be considered in the overall evaluation.

3. Ongoing Activities

During the time between the writing of the original RAP and the preparation of this update report, activities have been initiated or continued which bear directly on improving conditions in the Bay. The following sections describe these activities, and their relation to addressing impairments or adding to the body of knowledge on which future actions may be based.

3.1 Consent Decree with the City of Erie

Considerable progress has been made on the 1989 Consent Decree between the Commonwealth of Pennsylvania and the City of Erie (City). The City continues to put forth the manpower and financial resources needed to meet the milestones within the Decree. The following lists four of the remedial actions which are required by the Decree, each of which is subsequently discussed:

V.B.1 Prevent known unpermitted dry-weather discharges into the Mill Creek Tube.

V.B.2 Formulate a study to determine the additional sources of pollution into the Mill Creek Tube and alternatives for removal.

V.B.3 Formulate a study to include other sources of pollution (excluding Mill Creek Tube) entering Presque Isle Bay (PIB), its tributaries and Lake Erie and alternatives for removal.

V.C. Perform a comprehensive evaluation of existing and future sewage disposal needs of Erie and tributary municipalities.

V.B.1 was completed by the City during the second quarter of 1991 and reported to DER as complete on July 3, 1991. The list of known dry weather Combined Sewer Overflows (CSOs)

was based on CSO inspections performed by the Bureau of Sewers and Bureau of Engineering for the City. Thirty-seven known CSOs were located within the Mill Creek Tube drainage area. Each of these CSO points were inspected weekly and found not to overflow during dry weather conditions.

V.B.2 required the City to determine the extent of pollutants in the Mill Creek Tube and to evaluate both structural and non-structural alternatives to reduce these pollutants. The pollutants to be identified included those from sources other than dry weather CSOs. Malcolm Pirnie, Inc. was retained by the City to perform this study. It was labeled the Mill Creek Tube Pollution Study (MCTPS) and commenced in March, 1991.

A two-phased monitoring and sampling program was utilized. The Phase I program was conducted during the Fall of 1991. Five long-term flow monitors and samplers were installed at key locations along the Mill Creek Tube (See Map 8). Samples were collected from three dry weather and two wet weather events and analyzed for 184 parameters at these 5 monitoring locations. The results showed the only pollutants being discharged into PIB from Mill Creek are those associated with domestic sewage, and that the pollutants were present under both dry and wet weather conditions. Certain metals (iron, copper, and zinc) also appeared to be ubiquitous in the Mill Creek watershed.

Phase II reduced the pollutant of concern parameter list from 184 to 38 parameters as a result of Phase I findings. Eight short-term flow monitors and samplers were installed in combined sewers or combined sewer overflows (See Map 8). The Phase II flow monitoring and sampling program was conducted during the Spring of 1992. Again, both dry and wet weather events were sampled. The Phase II monitoring and sampling program confirmed the results of the Phase I study.

Based upon the Phase I and II findings, a Dry Weather Mitigation Program was developed. Besides being illegal, the dry weather discharges masked the true extent of the wet weather pollution problem throughout the City of Erie. Unknown combined sewer overflows, illegal house connections, private sewers, maintenance issues and leaking sanitary sewers were listed as the possible dry weather sanitary contributors. An investigative and sampling program similar to that formulated for V.B.3 (Other Sources of Pollution Study) is currently being used for the Dry Weather Mitigation Program. At least 168 discharges in the Tube are to be investigated and sampled. To date, several large domestic sewage sources have been located and actions taken for their removal. Once this program is com[illegible]ed, the extent of wet weather domestic sewage pollutants in the Tube must be quantified. [illegible]ctural and non-structural alternatives for addressing the remaining discharges can then be e[illegible]luated. A separate Storm Water Management Model (SWMM) is envisioned to be used in this endeavor. These results are then to be incorporated into the SWMM model being run for the Act 537 Official Sewage Plan which encompasses the City of Erie and tributary municipalities.

V.B.3 required the City to focus on other pollutant sources emanating from within the City boundaries (other than Mill Creek) and reaching Presque Isle Bay, its tributaries and Lake Erie. This study was labeled the Other Sources of Pollution Study (OSPS). Twelve discharge locations were strategically chosen and flow monitoring devices and samplers installed (see Map 9). These twelve locations encompassed all the remaining CSOs inside the City. Five sets of samples (two dry and three wet weather events) were analyzed for the OSPS drainage area. The 1992 sampling program results provided the City with an identification of the pollutants entering Lake Erie and Presque Isle Bay. Rather than studying the other sources further through a Request for Proposal, the City opted to perform implementation and rehabilitation to address the identified pollutants themselves.

The results of the sampling allowed the twelve sites to be logged into three categories. Four discharge points (DP 3, 4, 5, & 9) were identified as containing industrial pollutants and pollutants of domestic origin. These four were the initial areas of study. Four discharge points

(DP 1, 8, 10, & 13) were identified as containing dry weather domestic sewage. These four sites were considered additional areas to receive study. The remaining four discharge points (DP 2, 6, 7, & 12) contained domestic sewage pollution evident only during wet weather sampling (to be expected with CSOs). Although no further study is planned for these last four sites, Garrison Run (DP-6) was further investigated and sampling activities conducted as a result of past problems.

To date, the City has made measurable progress in the clean-up of these other sources. Progress reports are supplied to the Department and meetings are held as necessary.

Finally, V.C. involves the formation of an Official Sewage Plan Update for the City under the PA Sewage Facilities Act (Act 537). This plan consists of a comprehensive evaluation of existing and future sewage disposal needs (both treatment and conveyance) of Erie and the tributary municipalities. The Plan is to be submitted in October, 1994. As previously mentioned, a SWMM model will aide in this endeavor.

Many of the surrounding municipalities are updating their Official Sewage Plans at this time as well. In order to facilitate communication and ensure the compatibility of the conclusions of each of these planning efforts, representatives from the City, each of the surrounding municipalities and DER have formed a sewage planning "Task Force." The Task Force has been meeting every two months since May, 1993.

3.2 Zebra Mussels

As discussed earlier in this report, the introduction of the Zebra Mussel (*Dreissena polymorpha*) has greatly affected the ecology of the entire Great Lakes system. The abundance of the mussels in the vicinity of PIB has already resulted in a number of noticeable effects. The City of Erie's water intake lines had become so infested with the mussels that a significant reduction in volume was created. After mechanically cleaning the lines, a system was installed to release low levels of chlorine (as hypochlorite) at the mouth of the intake pipe to kill veligers before they had a chance to attach themselves. Monitoring for trihalomethanes was required in several locations throughout the City water system to ensure that this additional introduction of chlorine did not create a new problem. No significant increases were noted.

The filtering activities of the mussels has caused a dramatic increase in water clarity. Visibility which had previously been only to a depth of 3 - 4 feet is now in the 10 - 15 foot range. This increase has allowed deeper sunlight penetration, affecting submergent and emergent plant growth, plankton populations and distributions, and as some PAH compounds are photoactive (e.g. phenanthrene), sunlight reaching the bottom sediments may cause additional toxic effects.

The abundance of the mussels affects the cycling of nutrients in the system, such as when calcium and phosphorus used to produce mussel shells become unavailable for other organisms. The food chain may shift from a pelagic (open water) to a benthic (bottom) system as nutrients are taken in by the mussels and deposited on the bottom.

It is important to re-emphasize the fact that these are not strictly PIB concerns, but rather issues that are being addressed and examined on a lakewide basis. Even so, research being done may ultimately help us in understanding conditions in the Bay. There are some university researchers examining the effects of the mussel on plankton populations in the Bay itself. Paschke and Zagorski (1993) released a study comparing phyto- and zooplankton populations before and after the Zebra Mussel invasion. Generally, the average population, especially of phytoplankton, decreased with the advent of the mussels. More specific statistical tests were hampered by a lack of data, and a genera specific evaluation has yet to be conducted. It may be that certain types of plankton are affected more than others, and therefore community structures may change as time goes on. The RAP needs to be cognizant of these findings as they become available in order to separate these biological effects from toxics or other stressors.

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We hope that this comprehensive, integrated assessment approach will more clearly define the magnitude and extent of the sediment contamination problem and guide us in our remediation decisions.

4.2 Fish Collection and Tumor Analysis

Work plans scheduled for 1994 are based on obtaining the necessary funding to accomplish these tasks. As of this writing, it appears that funding will be available from USEPA's RCRA program to support this effort. Additional histological and bile sampling will be conducted on Brown Bullheads, Yellow Bullheads, White Suckers, and Bowfin from selected sites. Species of bottom feeding fish other than just Brown Bullheads will be examined to determine external and liver tumor rates. It is possible that some species of fish may possess liver tumors without developing external tumors. Bowfin have been noted in previous studies from contaminated sites to develop liver tumors without the presence of external tumors. Bile samples will be extracted at the time of histological examination for PAH metabolite analyses. The results of the bile sampling will be used to verify previous bile sampling results showing elevated levels of PAH metabolites in tumored fish as compared to untumored fish. Fingerprinting of PAH metabolites may help in determining the source and type of PAH contamination within Presque Isle Bay. If PAH sources or sites can be determined then it may be possible to develop a remediation plan for the source or site.

4.3 Habitat Enhancement Project

Two years ago, the Pennsylvania Fish and Boat Commission (PFC) was contacted to get their thoughts on fish habitat enhancements which could be constructed within PIB. Coarse brush structures along and near the northwest shore (Presque Isle State Park) were suggested as possibly being appropriate. The coarse brush structure suggested is the PA Porcupine Brush Crib. The Porcupine Brush Crib is designed to provide cover to young-of-the-year, juvenile and adult gamefish and panfish. It has a long submerged life span and is easy to construct and place. A program known as Adopt-a-Stream was recommended as the best vehicle to get a project such as this into action. Adopt-a-Stream is a cooperative program which provides technical assistance and planning, construction supervision, and a limited amount of materials to the cooperator of an approved project on qualified waters.

Presque Isle State Park and Save Our Native Species (SONS) of Lake Erie filled out the Adopt-a-Stream application and submitted it May 28, 1993. Dave Houser, Chief of the Adopt-a-Stream Section has indicated the application for the project is currently under review. All feedback he has gotten regarding this project has thus far been positive. However, to institute, other approvals such as an Army Corps of Engineers 404 Permit will be necessary. The PFC intends to visit PIB this Spring to evaluate the site and more specifically determine the optimum number and placement areas for the cribs. The project could conceivably come to fruition later in 1994. Worst case would be construction and placement of the cribs in 1995.

4.4 Environmental Monitoring

In addition to the specific sample collection and monitoring activities outlined in this report, PADER is also attempting to initiate a more rigorous plan for routine environmental monitoring. This will involve bringing the Department's mobile laboratory unit to PIB on a regular basis, and collecting air, water, and biological samples for screening. The mobile lab is equipped with a gas chromatograph/mass spectrometer unit, as well as standard wet chemistry capabilities. By coordinating sample collection with real time analysis, a large amount of data can be collected to establish baselines and help determine if progress is being made.

PADER also plans to collect additional bacterial samples on a weekly basis to continue the evaluation begun in 1993. While it is believed that there is no health or safety problem

associated with whole-body contact recreation in the Bay, we believe it is prudent to continue monitoring the ambient conditions.

4.5 Pollution Prevention and Source Reduction

PADER has a continuing program to promote pollution prevention and source reduction (PP/SR) throughout the state. Recently instituted regulatory programs, such as the residual waste regulations and Clean Air Act amendments have included these components. Facilities are being asked to develop PP/SR plans as part of their normal operating requirements. PADER has worked with USEPA to promote the 33/50 program in the Erie area and continues to encourage industry participation. Technical and financial assistance are available through PADER initiatives as well as university cooperatives.

A program to alert homeowners and other individuals to the importance of not discharging polluting substances to storm drains which flow to PIB is being developed by local citizens. This initiative will involve painting messages on area storm drains to identify them as potential sources of pollution. The work will be conducted by volunteers with materials supplied by PADER or other sponsors.

5. Public Participation

5.1 Public Advisory Committee (PAC)

A key component of any RAP strategy is the involvement of the affected public in decisions and actions. From the outset in 1990, it was obvious that a public forum, similar to the then existing Erie Harbor Improvement Council (EHIC), was necessary to ensure that the public had access to RAP information and activities, and could advise PADER in the creation of the RAP itself. With the permission of the Mayor of Erie and the Erie County Executive, who had created the EHIC, PADER took over responsibility for the Council and converted it into the PIB Public Advisory Committee (PAC). Prior to the conversion, the EHIC discussed its existing membership in an effort to ensure that all constituencies were included in the RAP discussions. Stakeholders not represented on the EHIC were contacted and invited to nominate a PAC member. A review of the PAC membership list included in the original RAP document clearly shows that a wide spectrum of interests is represented. The EHIC met one Monday morning a month, and that schedule was continued for the PAC. After the RAP was submitted to USEPA in 1993, the PAC began meeting once every two months.

The primary responsibility for preparing the RAP and ensuring its submission to USEPA and IJC in accordance with the Great Lakes Critical Programs Act of 1990 falls on the Commonwealth. To fulfill that responsibility, PADER needs to provide an opportunity for community involvement in the process, so that a consensus can be reached among conflicting interests. The role of the PAC, as the name implies, is to create that opportunity and allow advice to be given to PADER on RAP related activities.

In addition, the PAC provides PADER with the means to quickly and efficiently disseminate information to a wide audience. As each portion of the RAP is produced, it is distributed to the PAC members for review. It is their obligation to evaluate RAP activities in the context of the groups they represent, and report comments back to PADER directly or at subsequent meetings. Minutes from all meetings are kept as part of the permanent record of RAP activities, and provide a record of discussions and dissenting opinions. From these comments and discussions, a consensus position or recommendation is developed. It is important to note that there is no direct voting process involved, and consensus does not mean that everyone agrees. It is probably fair to say that no one agrees with everything the RAP says or recommends. The ideas and opinions in the RAP documents reflect the PADER writing team's best synthesis of the technical information, advice from the PAC, IJC, USEPA and others, and resource or legal considerations.

5.2 Public Outreach

Admittedly, this is one area where the RAP can be made stronger. Even though documents are readily available and meetings are open to the public, there is limited knowledge about the RAP or related activities in the general populous. There needs to be a more focussed effort to educate the general public as to the importance of the RAP, the activities going on around them, and most importantly, the ways that they can become involved and assist the effort.

To correct this problem, PADER with the help of the PAC is organizing a public information committee. The charge to this group will be to develop public display and presentation materials, school programs, brochures and other means to generate public awareness and interest.

Through the use of Pennsylvania's Great Lakes Protection Fund money, PADER is contracting with the Northwest Tri-County Intermediate Unit to conduct training for teachers in environmental issues, with a specific emphasis on Lake Erie and PIB. Using the Lake as the laboratory, these teachers will hopefully gain a better appreciation of the ecosystem approach to environmental problems and weave that theme into classroom instruction.

An environmental curriculum for grades K - 12 is under development by the Benedictine Sisters' Glinodo Center. Again it is hoped that by creating awareness in the schools, we can generate interest elsewhere.

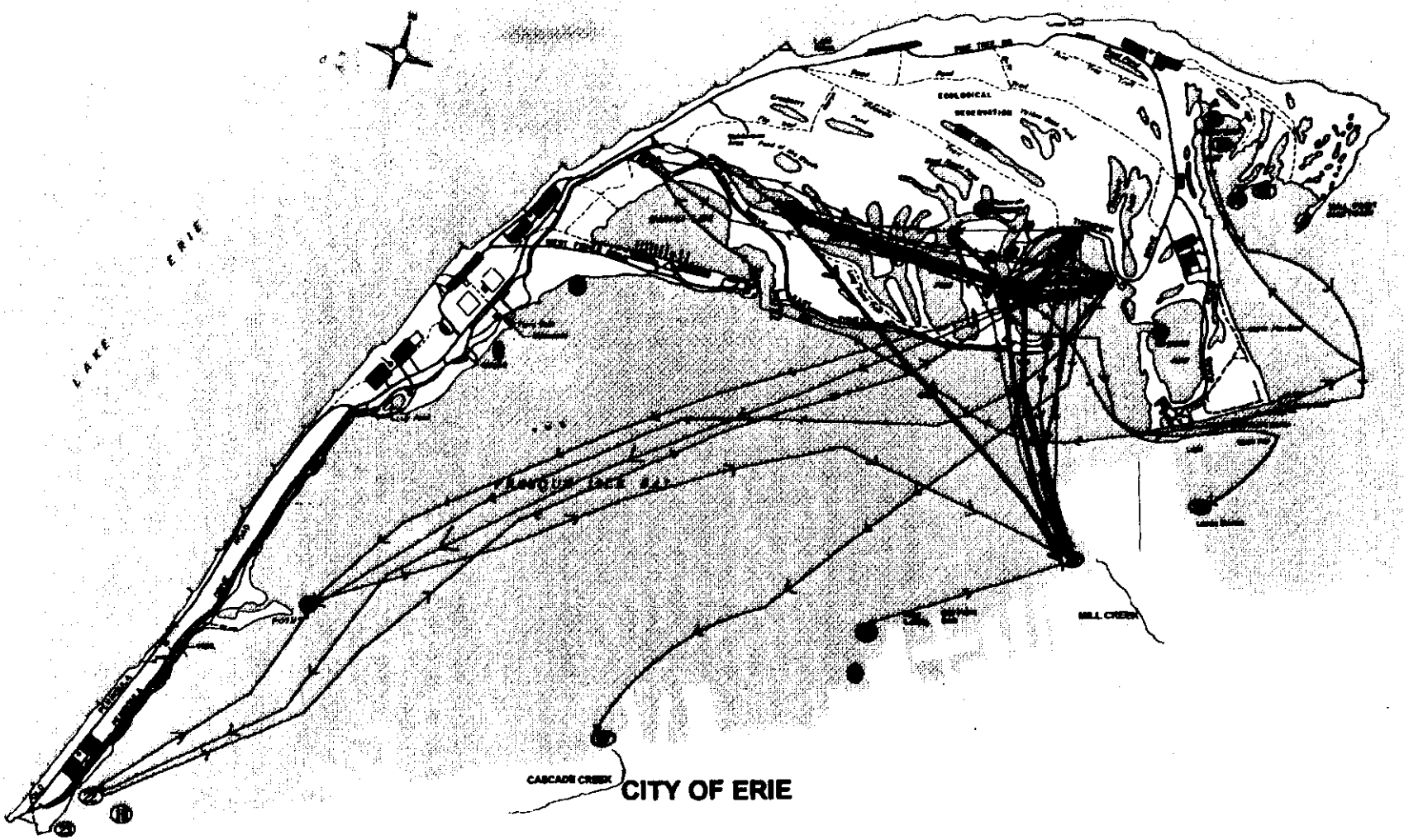
6. Conclusion

As should be clear from the foregoing report, much has been accomplished in the past two years. Areas where data gaps were identified or conclusions were unclear have received attention in the form of additional studies and evaluation. To date, the USEPA has provided over $300,000 in grants to pursue sediment, fish and plankton evaluations. In addition to funding, they have provided technical advice and will be sending the RV Mudpuppy to assist in sediment sampling this spring. PAC members, municipal and county officials, PADER and other state and federal employees, and concerned citizens have all contributed, many on a voluntary basis, to help move this process forward. The heart of the RAP process is this spirit of cooperation and community. There is still much work ahead and many decisions yet to be made, and undoubtedly there will be disagreements on the best way to proceed. Hopefully, the solid foundation we have laid can be built upon as this process proceeds to ensure that our ultimate goal, restoring Presque Isle Bay, will be achieved.

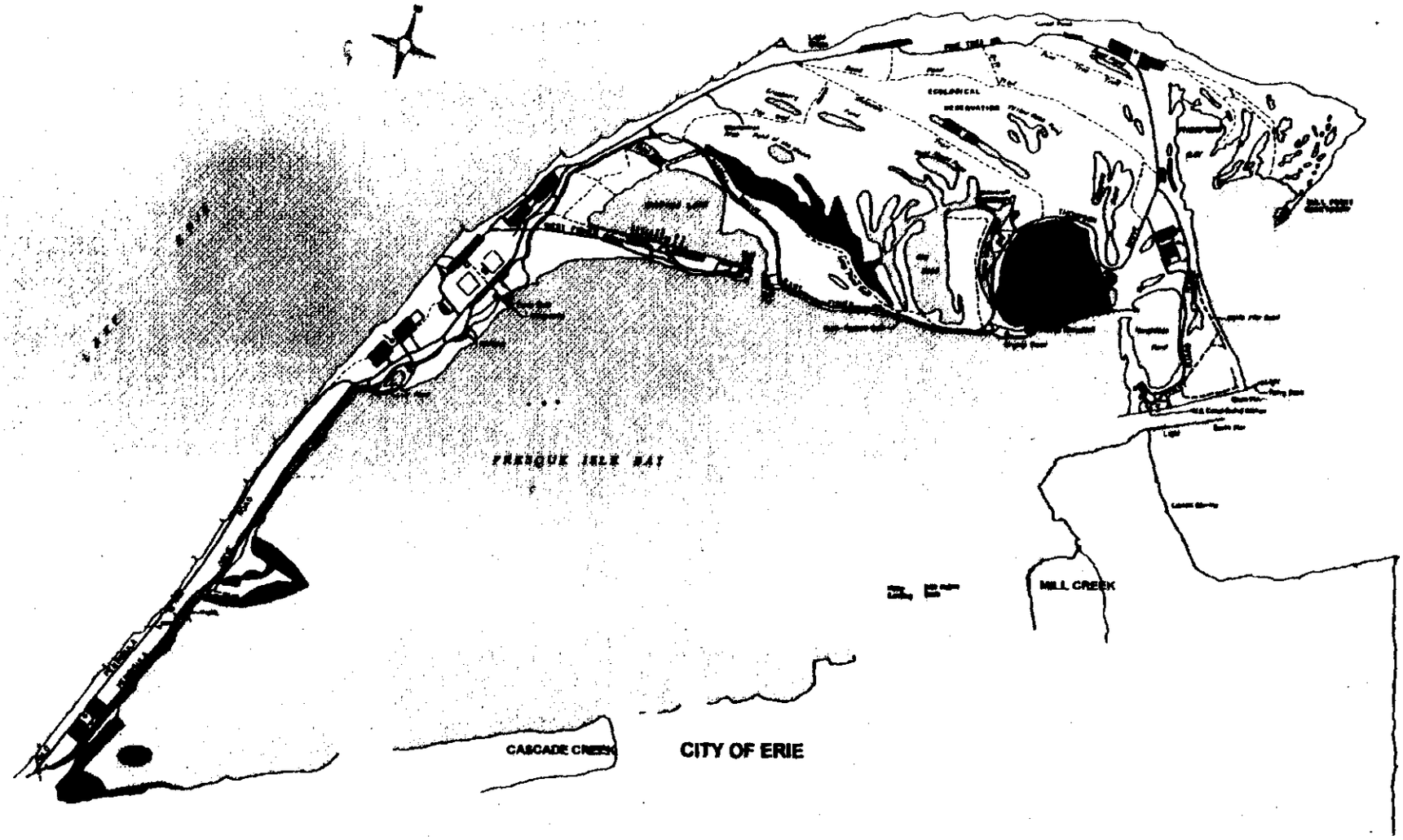
MAP 1. PRESQUE ISLE BAY BULLHEAD MIGRATION ROUTES FROM 1992 TAGGING STUDY.

No. FISH - COLOR

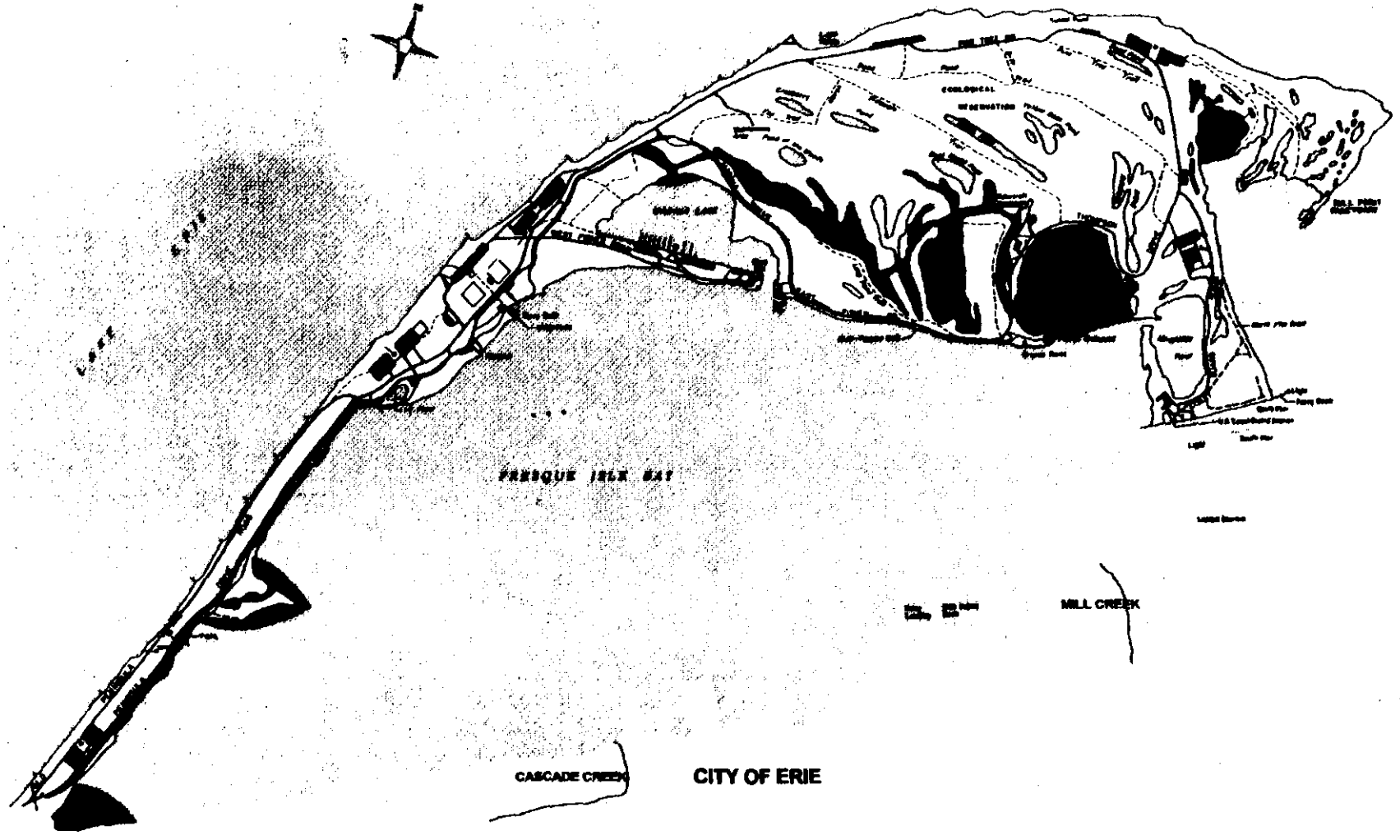
1 -
2 -
3 -
4 -
5 -
6 -



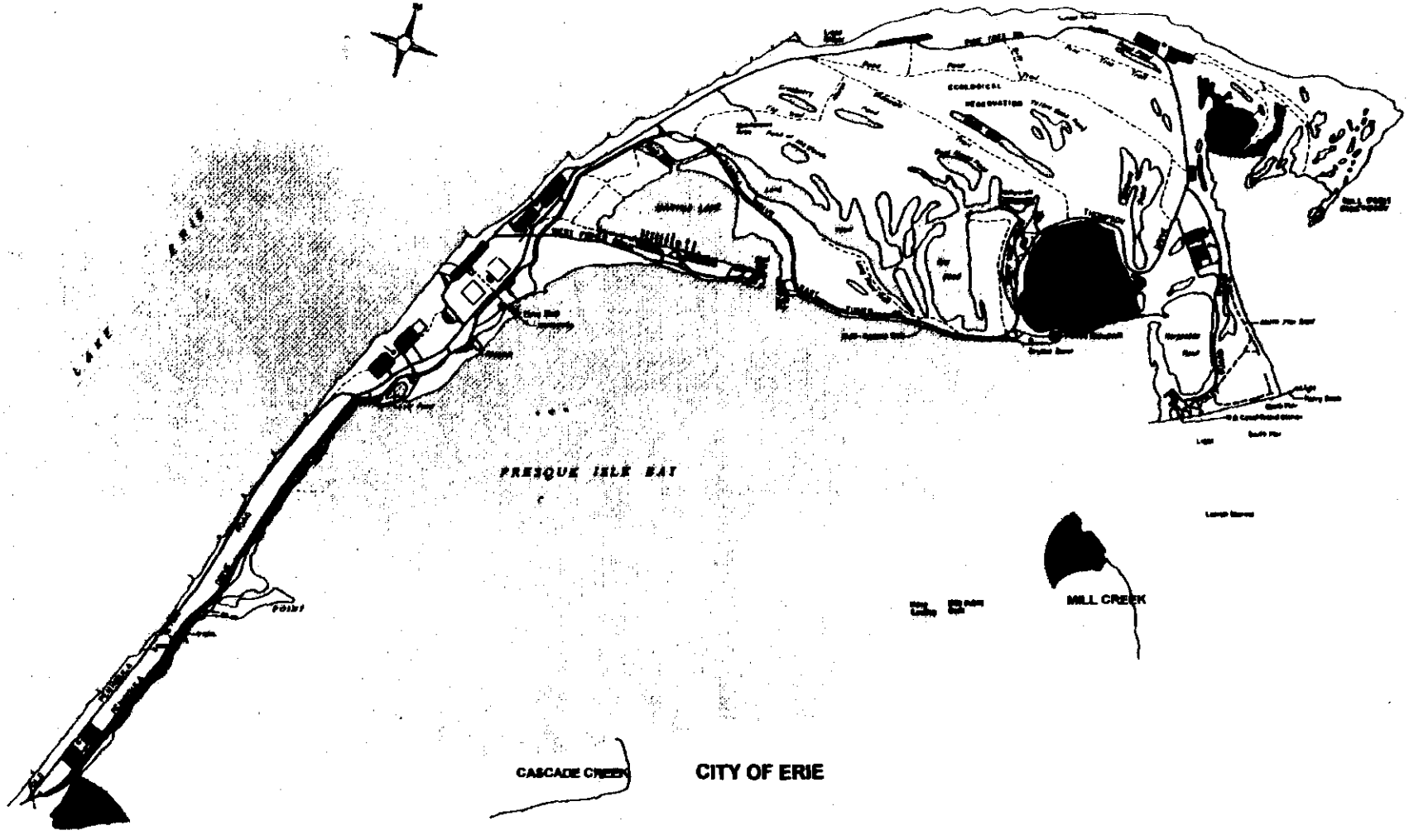
MAP 2. BULLHEAD DISTRIBUTION FOR APRIL 1992.



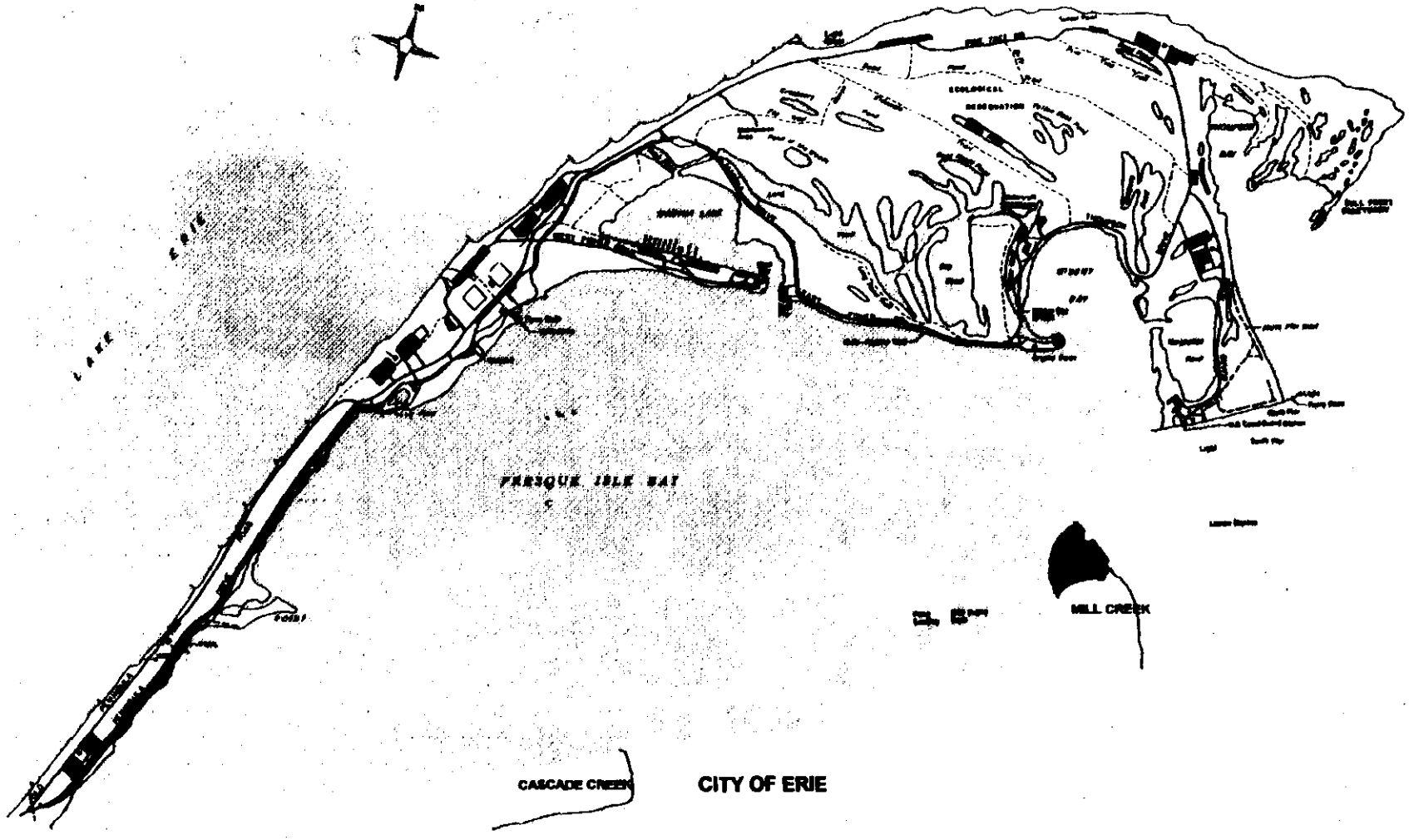
MAP 3 L LHEAD DISTRIBUTION FOR MAY 1992.



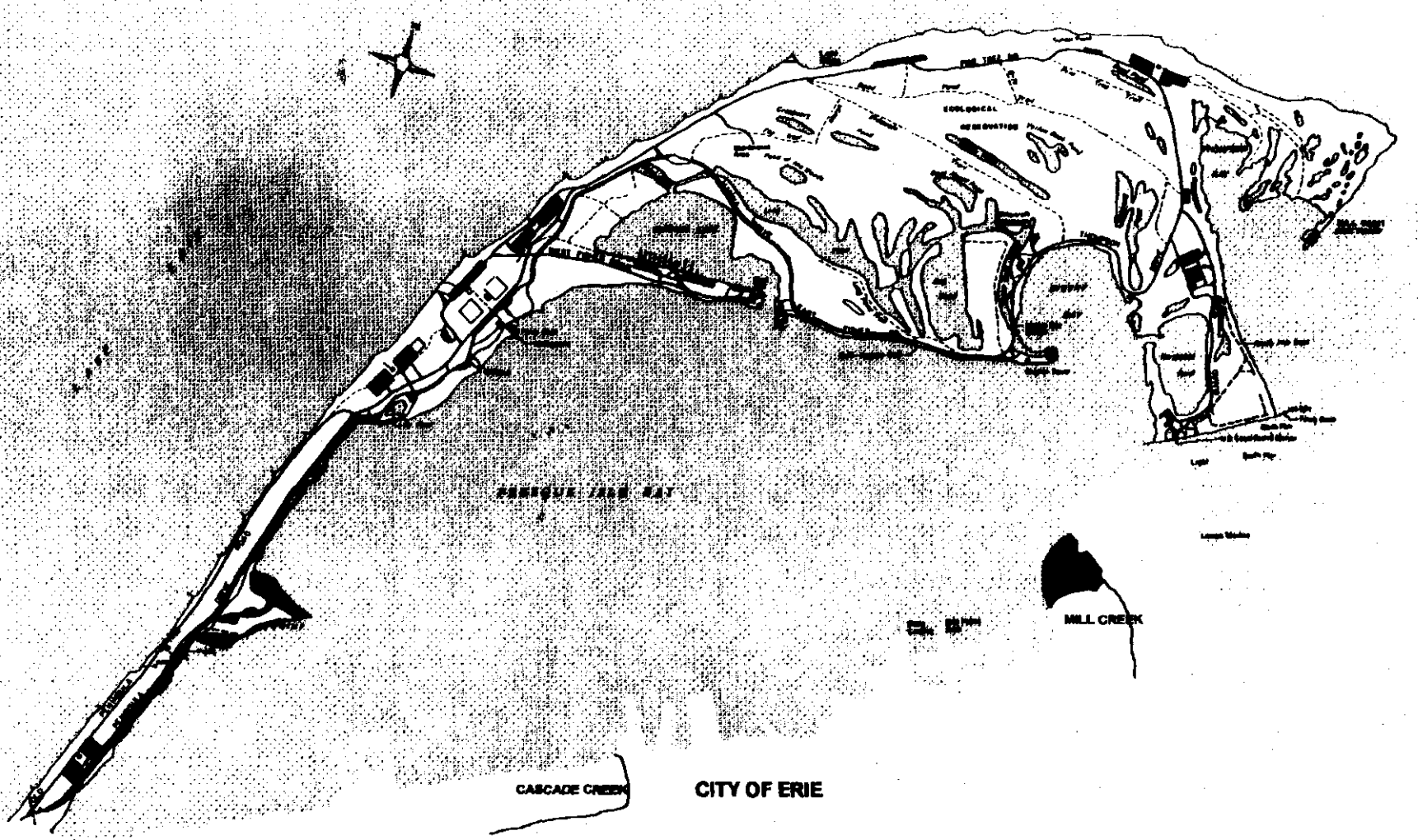
MAP 4 BULLHEAD DISTRIBUTION FOR JUNE 1992.



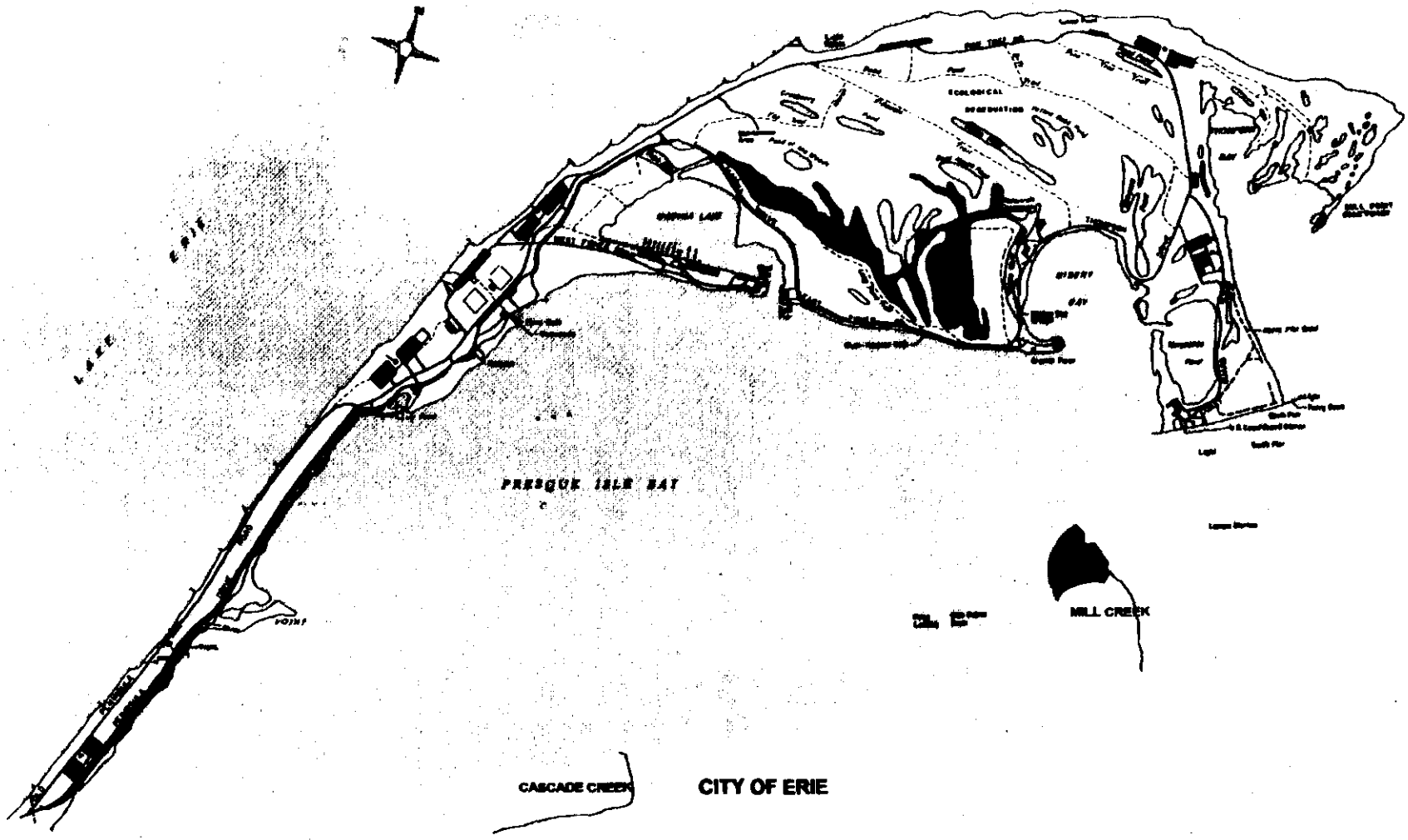
MAP 5 B. LHEAD DISTRIBUTION FOR JULY 1992.

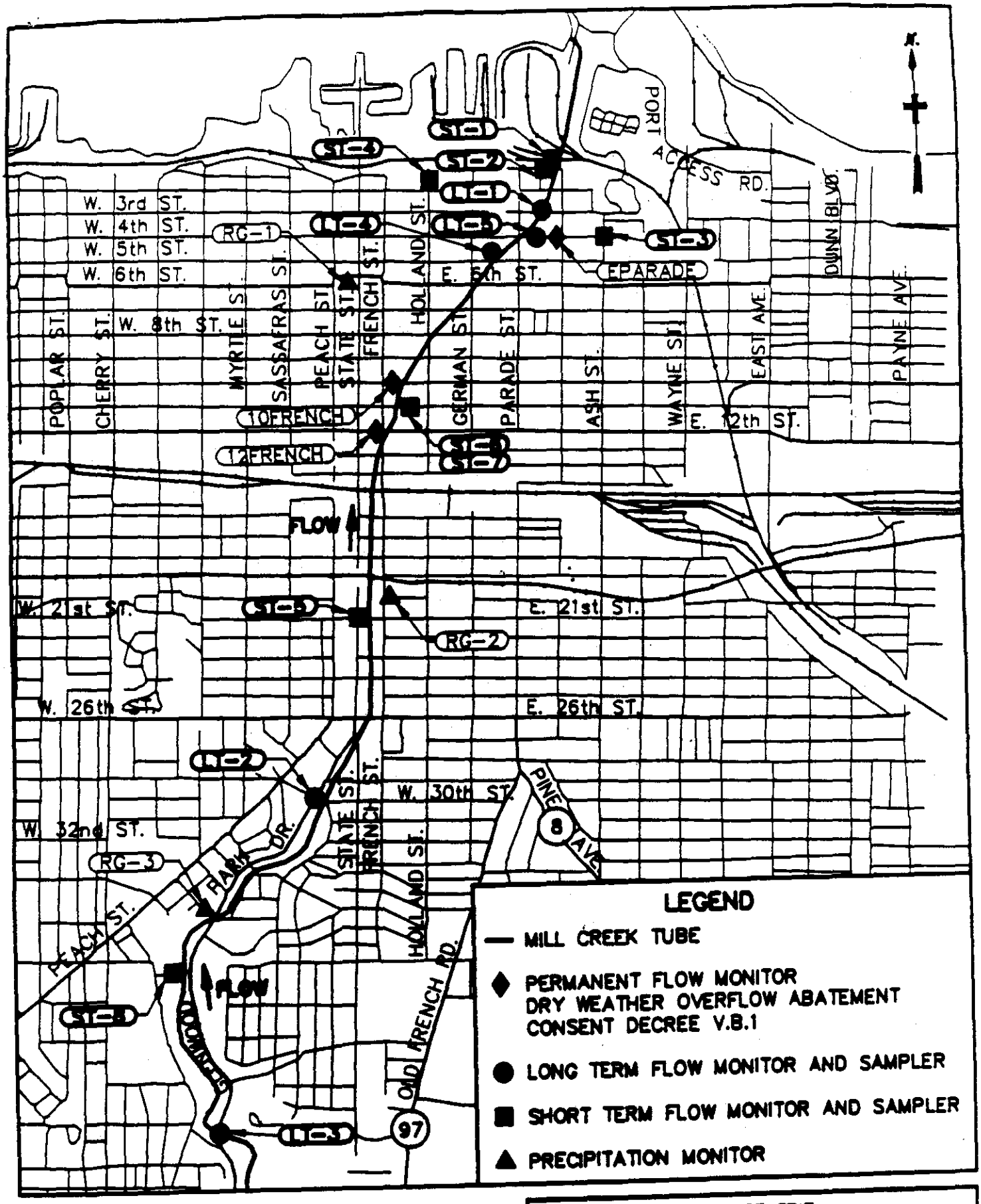


MAP 6 BULLHEAD DISTRIBUTION FOR AUGUST 1992.



MAP 7 L..LHEAD DISTRIBUTION FOR SEPTEMBER 1992.





MALCOLM PIRNIE

ERIE-85A

CITY OF ERIE
MILL CREEK TUBE POLLUTION STUDY
MONITORING SITE LOCATIONS

CITY OF ERIE, PA.

FEBRUARY 1993

Map

MALCOLM PIRNIE

CITY OF ERIE
MILL CREEK TUBE POLLUTION STUDY

LOCATION OF LONG-TERM FLOW MONITORS AND SAMPLERS

Monitor I.D.	Location	Flow Monitor	Sampler Location
LT1	Discharge of Mill Creek Tube	X	X
LT2	Inlet of Mill Creek Tube	X	X
LT3	Mill Creek upstream of City of Erie	X	X
LT4	East 5th Street 54" combined sewer and 36" overflow	X	X
LT5	East 4th Street 60" storm sewer	X	X
10FRENCH	East 10th Street 24" combined sewer and 24" overflow	X	
12FRENCH	East 12th Street 24" combined sewer and 18" overflow	X	
EPARADE	East 4th Street 36" combined sewer and 36" overflow	X	

NOTES: Shading indicates combined sewer and overflow monitoring locations (Project 1233)
LT = Long-Term monitor location

MALCOLM PIRNIE

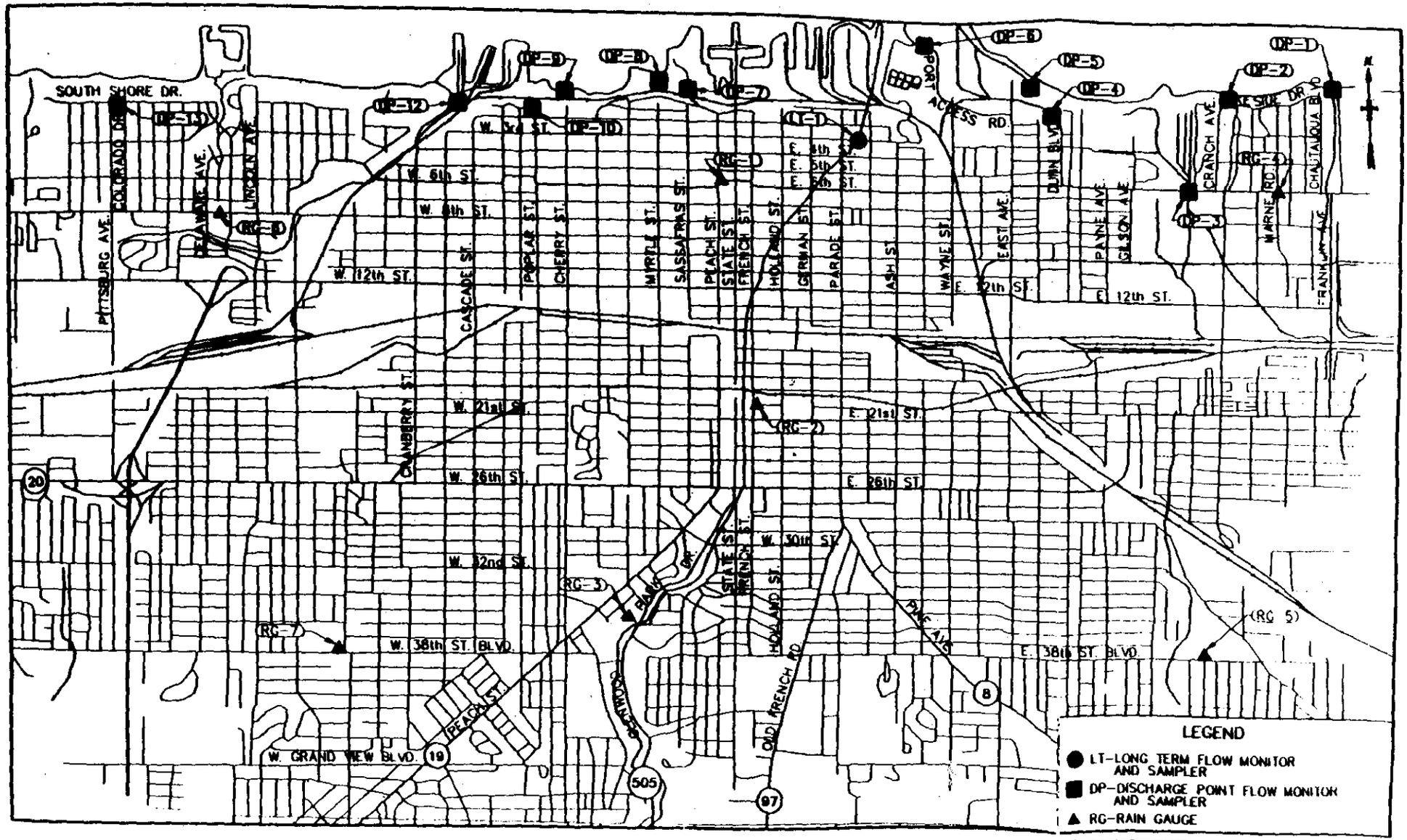
CITY OF ERIE
MILL CREEK TUBE POLLUTION STUDY

LOCATION OF SHORT-TERM FLOW MONITORS AND SAMPLERS

Monitor Identifier	Monitor Location	Location Justification	Flow Monitor	Sample Location
ST1	57" West Side Interceptor CSO	Downstream of LT1	X	X
ST2	33" Front St. and Wallace St. Storm Sewer	Storm Water; Downstream of LT1	X	X
ST3	36" East 4th St. and Ash St. Combined Sewer	Upstream of EPARADE	X	X
ST4	15" East 2nd St. and Holland St. Combined Sewer	Average: Peak Flow CS Ratio	X	X
ST5	18" East 21st St. and State St. Combined Sewer	Average: Peak Flow CS Ratio	X	X
ST6	15" 11th Street Combined Sewer	Possible Low Intercept Ratio	X	X
ST7	15" 11th Street Combined Sewer	Possible Low Intercept Ratio	X	
ST8	66" 38th Street Storm Sewer	Storm Water; Upstream of LT2	X	X

NOTES:

CSO = Combined Sewer Overflow
CS = Combined Sewer
ST = Short-Term monitor location
LT = Long-Term monitor location



Map

CITY OF ERIE
OTHER SOURCES OF POLLUTION STUDY
MONITORING L[illegible]IONS

CITY OF ERIE — OCTOBER 1992

MALCOLM PIRNIE

CITY OF ERIE
OTHER SOURCES OF POLLUTION STUDY

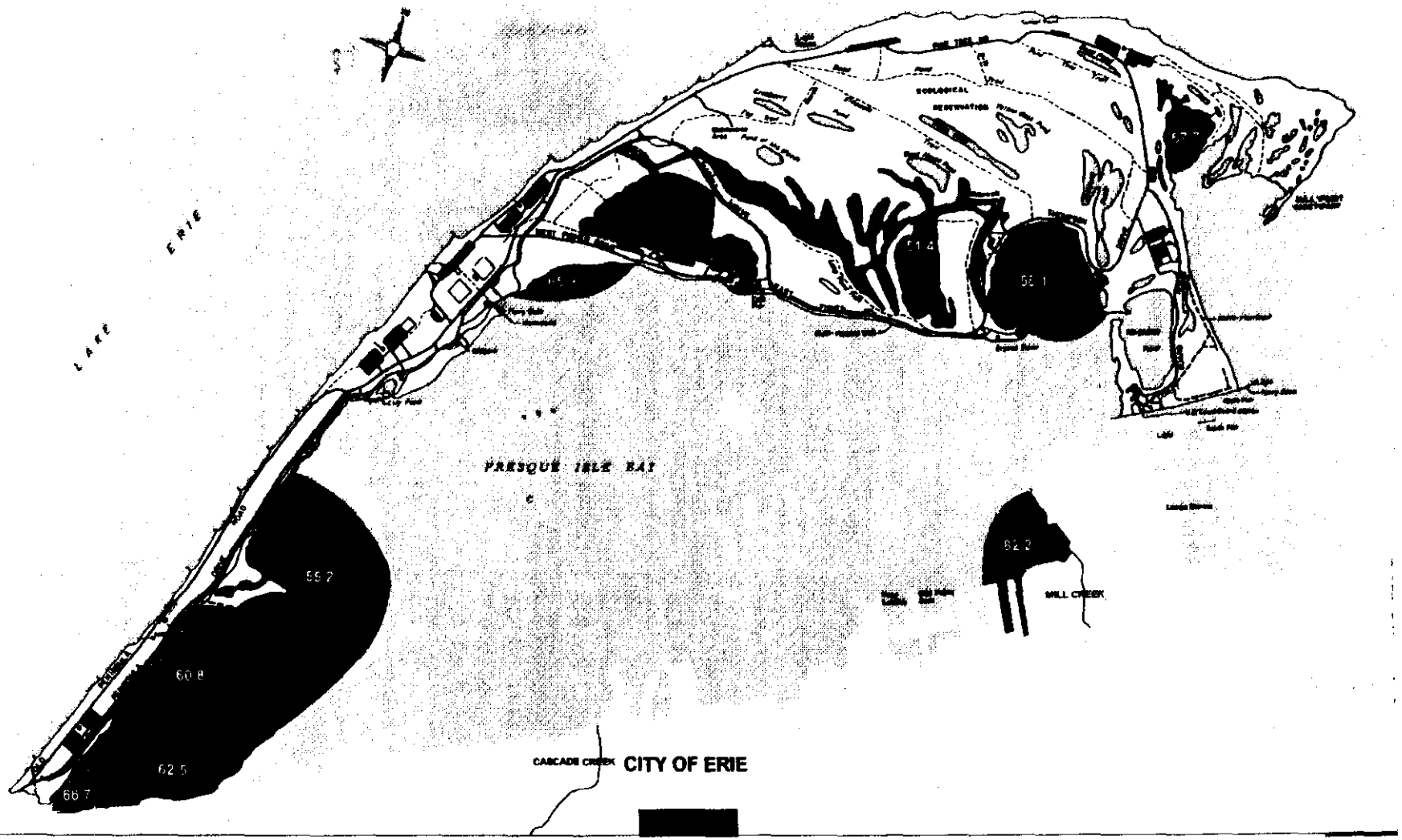
LOCATION OF SHORT-TERM FLOW MONITORS AND SAMPLERS

Monitor I.D.	Location	Associated Upstream Overflows
DP1	McDaniel Run Channel	PS # 046, 047 and East Lake Road west of Chautauqua Blvd.
DP2	84" Cemetery Run	PS# 044
DP3	Motch Run Channel	Storm Water
DP4	54" Dunn Blvd. Storm Sewer	PS# 043
DP5	36" East Avenue Storm Sewer	PS# 042
DP6	96" Garrison Run Enclosure	PS# 049, 050, 052, 053, East 23rd St. between East Ave. & Pennsylvania Ave. and intersection of 24th Street & Pennsylvania Ave.
DP7	48" Sassafras Street Storm Sewer	PS# 035, 037 and north of West 2nd St. between Peach St. and Sassafras St.
DP8	4' x 5' Myrtle Street Storm Sewer	PS# 036
DP9	48" Cherry Street Storm Sewer	PS# 033 & 034
DP10	54" Poplar Street Storm Sewer	PS# 039
DP12	Cascade Creek Channel	PS# 038
DP13	42" Colorado Drive Storm Sewer	PS# 032
LT1	Mill Creek Tube Discharge	PS# 002 thru 031 and East 22nd St. & French St.

NOTES:

DP = Discharge Point monitor location
LT = Long-Term monitor location
PS# = NPDES Point Secure Number
DP11 = 18" Plum Street Storm Sewer was eliminated from the proposed study list when the City of Erie eliminated the potential overflow by installing a new sanitary sewer line connected directly to the West Side Interceptor.

MAP 80 F SQUE ISLE BAY BULLHEAD EXTERNAL TUMOR R ES PER SITE FOR 1992.
(c n rate > 100)



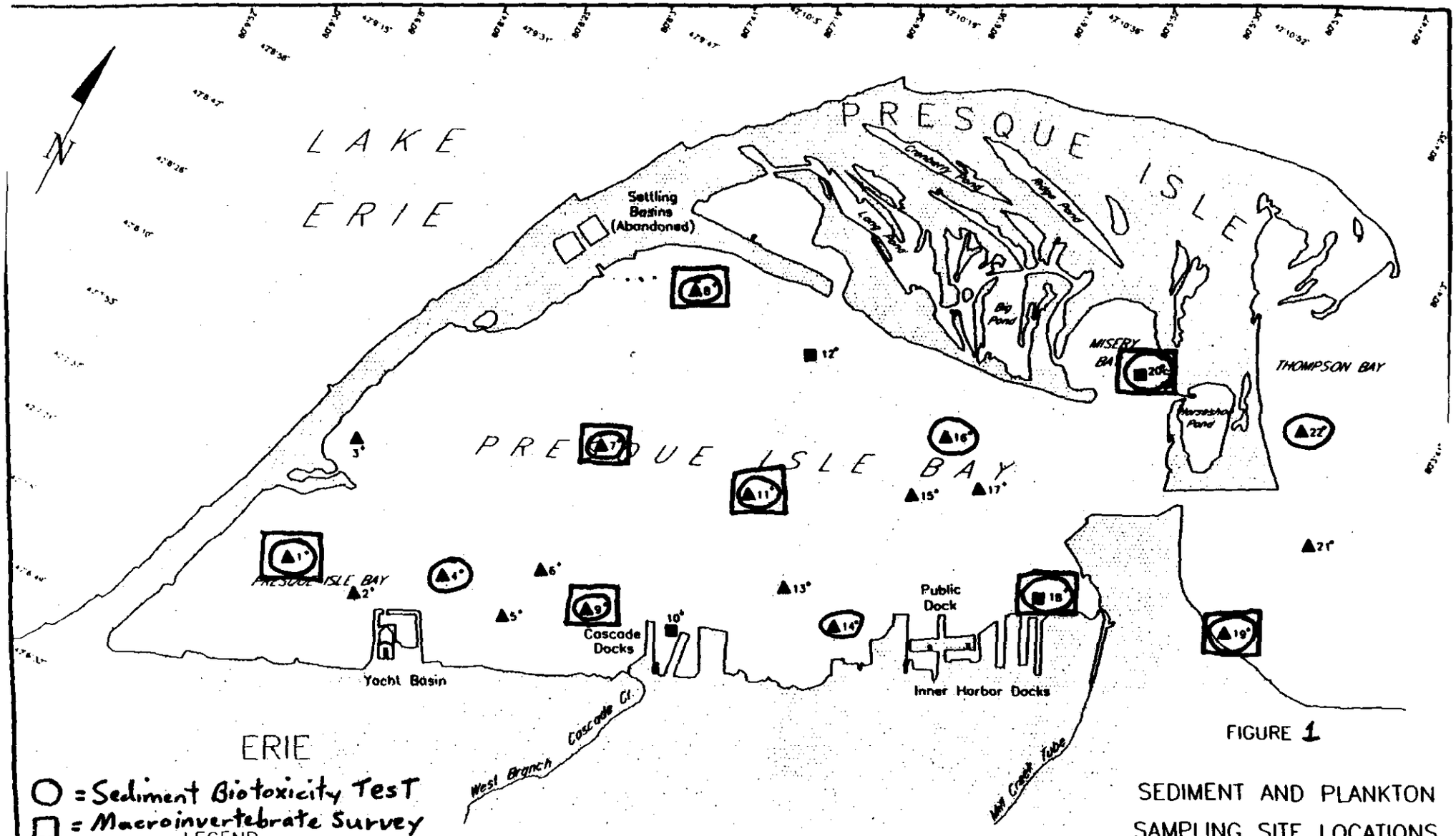


FIGURE 1

SEDIMENT AND PLANKTON SAMPLING SITE LOCATIONS

GANNETT FLEMING, INC.
FEBRUARY 1993

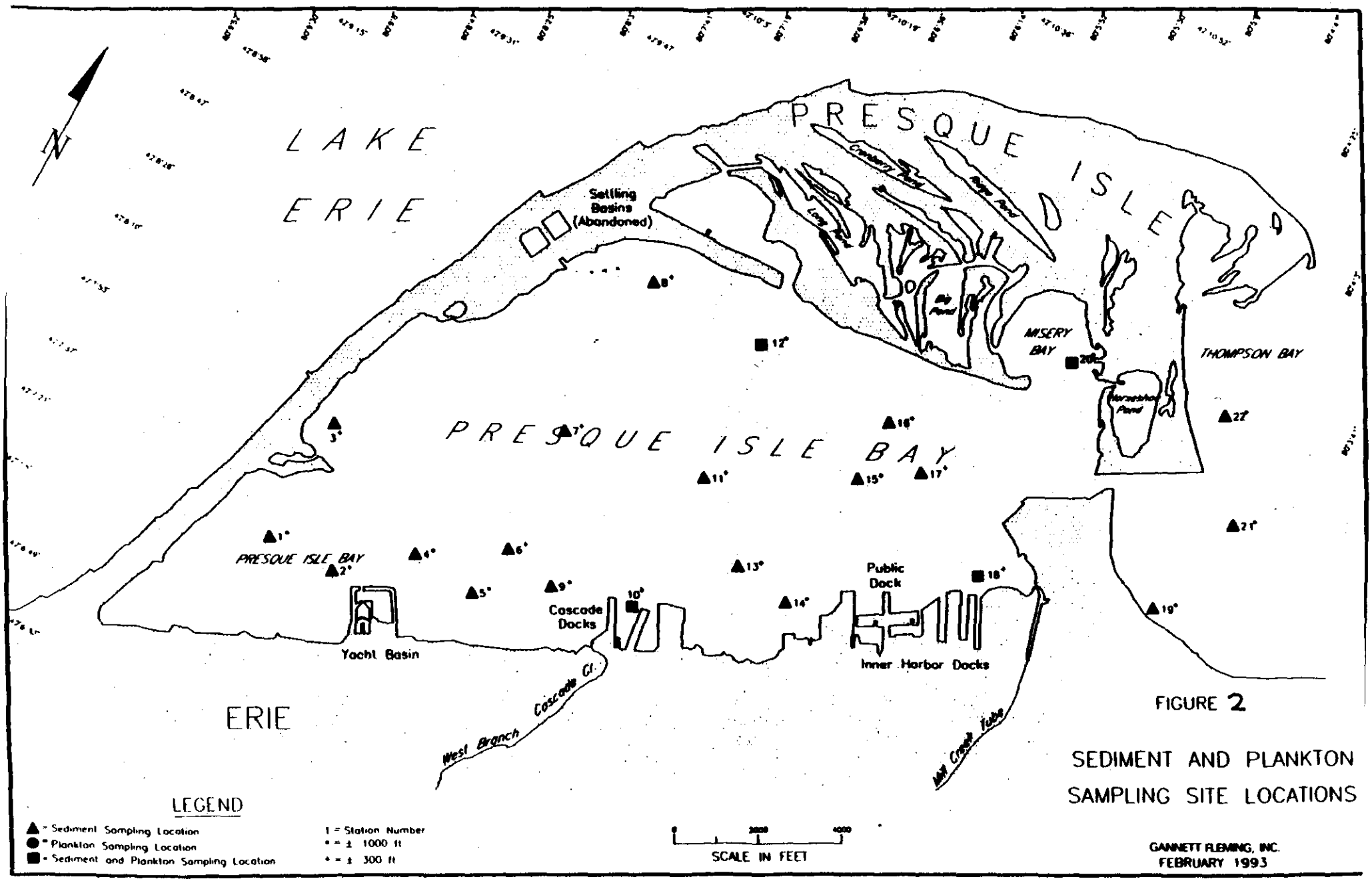


FIGURE 2

SEDIMENT AND PLANKTON SAMPLING SITE LOCATIONS

GANNETT FLEMING, INC.
FEBRUARY 1993

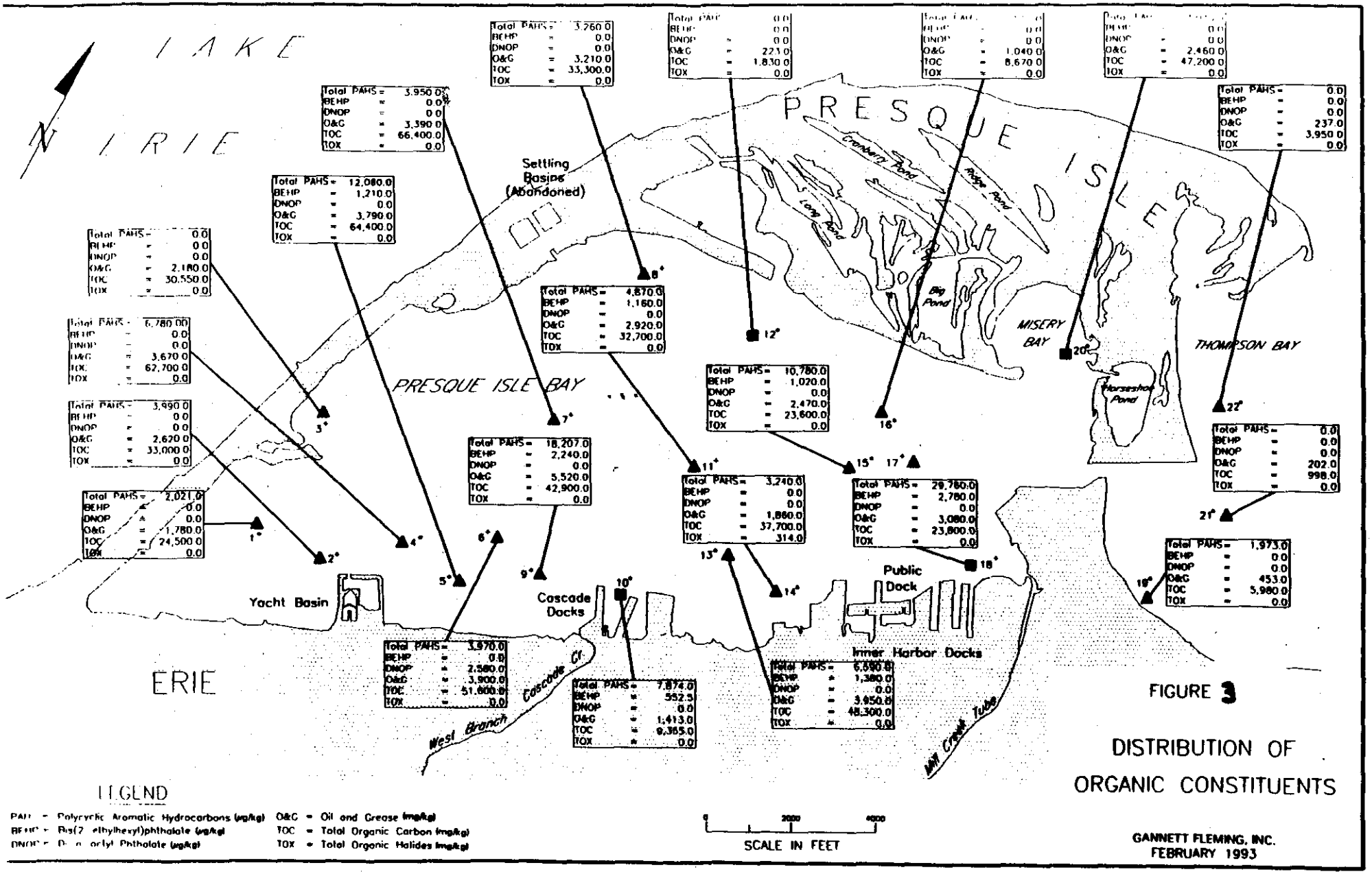


FIGURE 3

DISTRIBUTION OF ORGANIC CONSTITUENTS

GANNETT FLEMING, INC.
FEBRUARY 1993

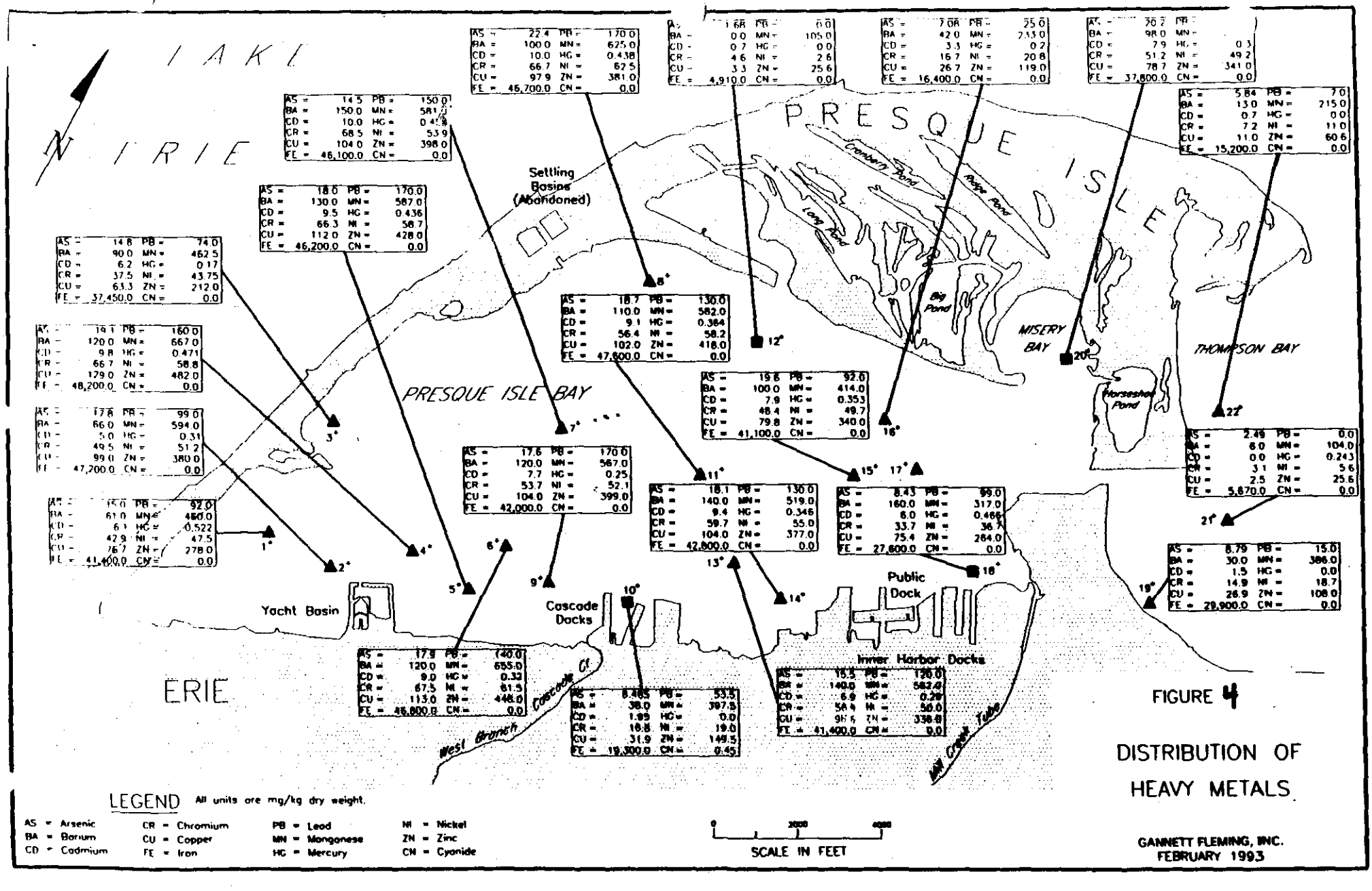


FIGURE 4

DISTRIBUTION OF HEAVY METALS

LEGEND All units are mg/kg dry weight.

AS = Arsenic
BA = Barium
CD = Cadmium
CR = Chromium
CU = Copper
FE = Iron
PB = Lead
MN = Manganese
HG = Mercury
NI = Nickel
ZN = Zinc
CN = Cyanide

GANNETT FLEMING, INC.
FEBRUARY 1993

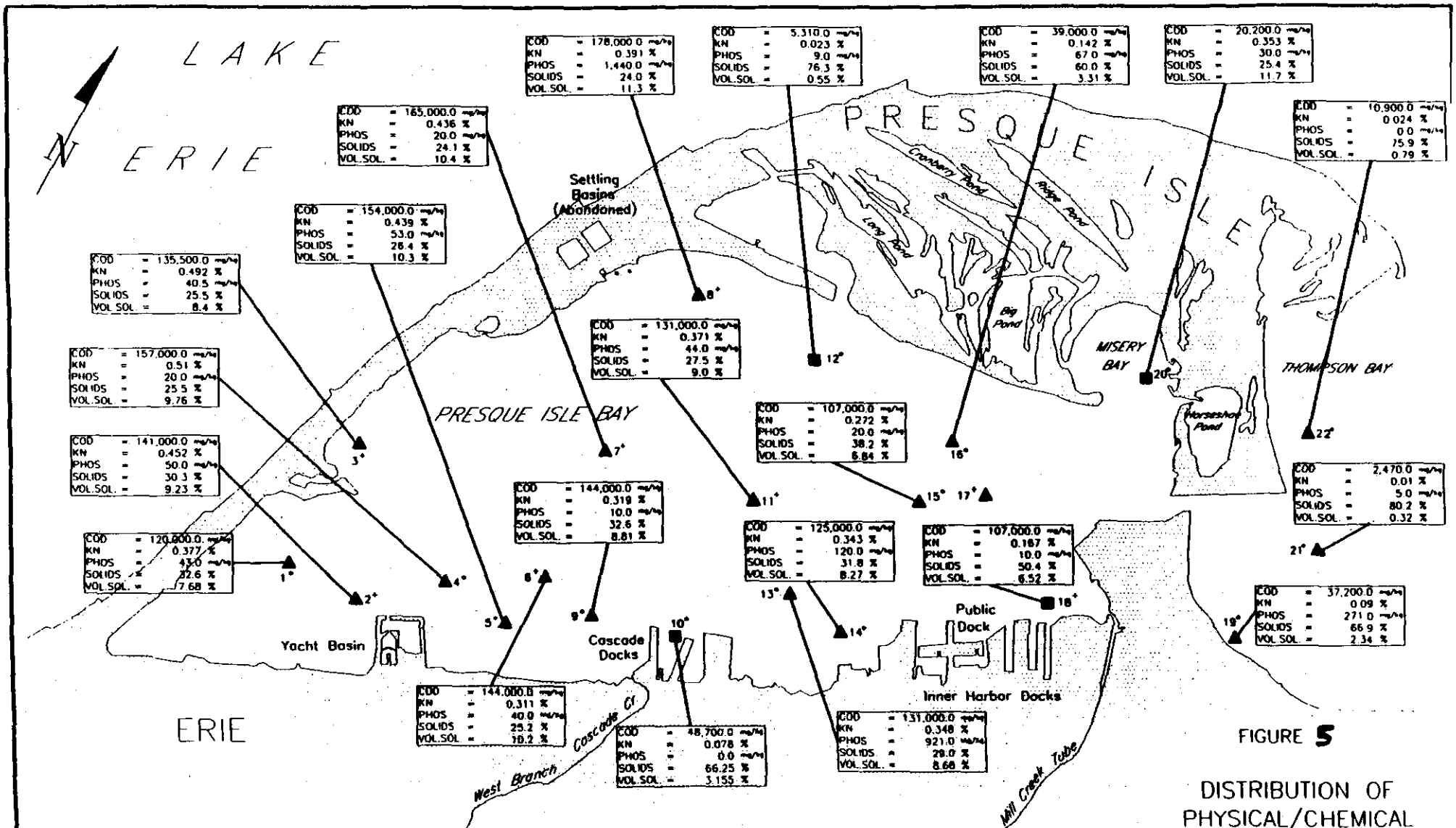


FIGURE 5

DISTRIBUTION OF PHYSICAL/CHEMICAL PARAMETERS

GANNETT FLEMING, INC.
FEBRUARY 1993

Figure 6: Locations of Bioassay Sampling Sites

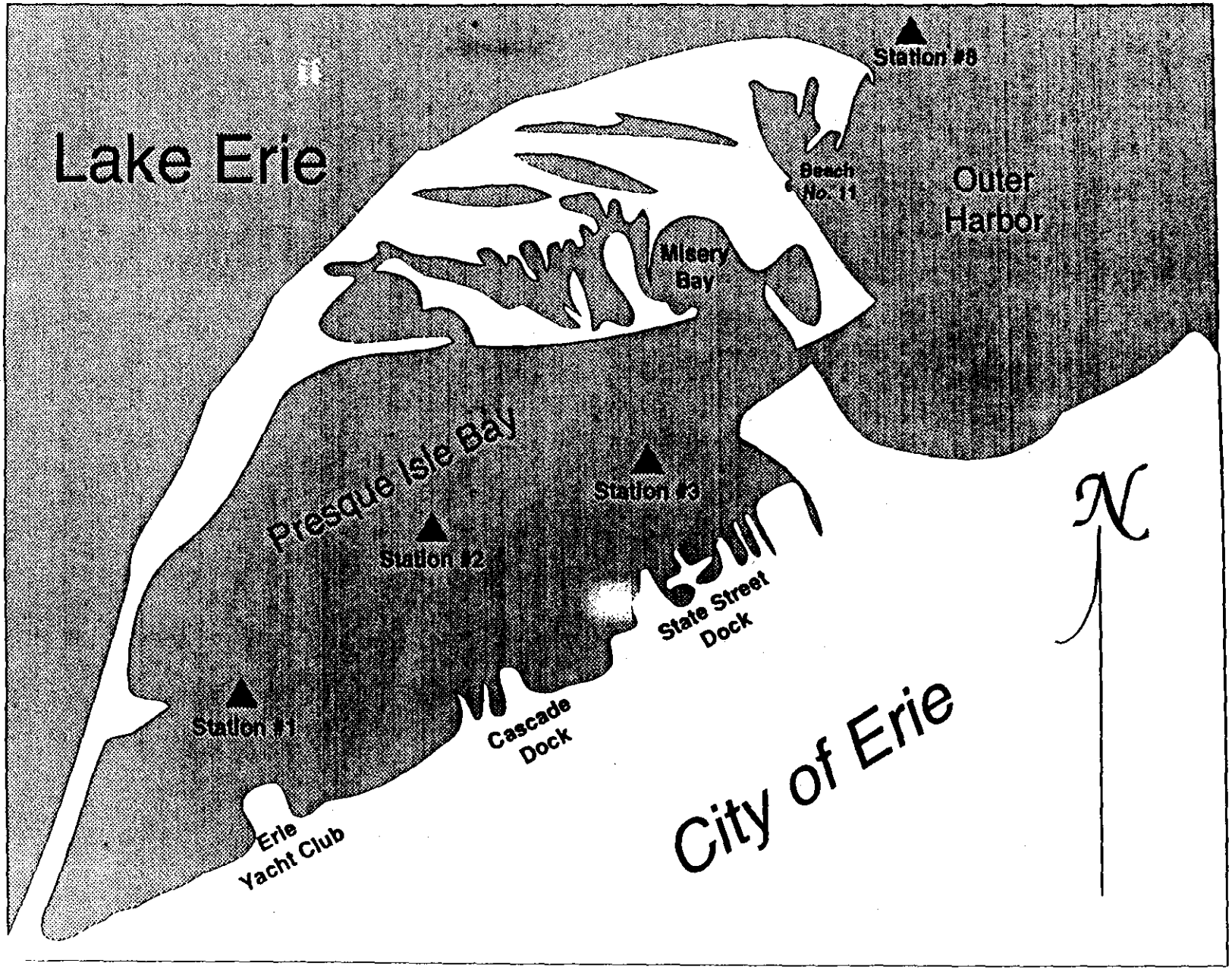


FIG 7. PRESQUE ISLE BAY SEDIMENT SAMPLING SITES 1993.

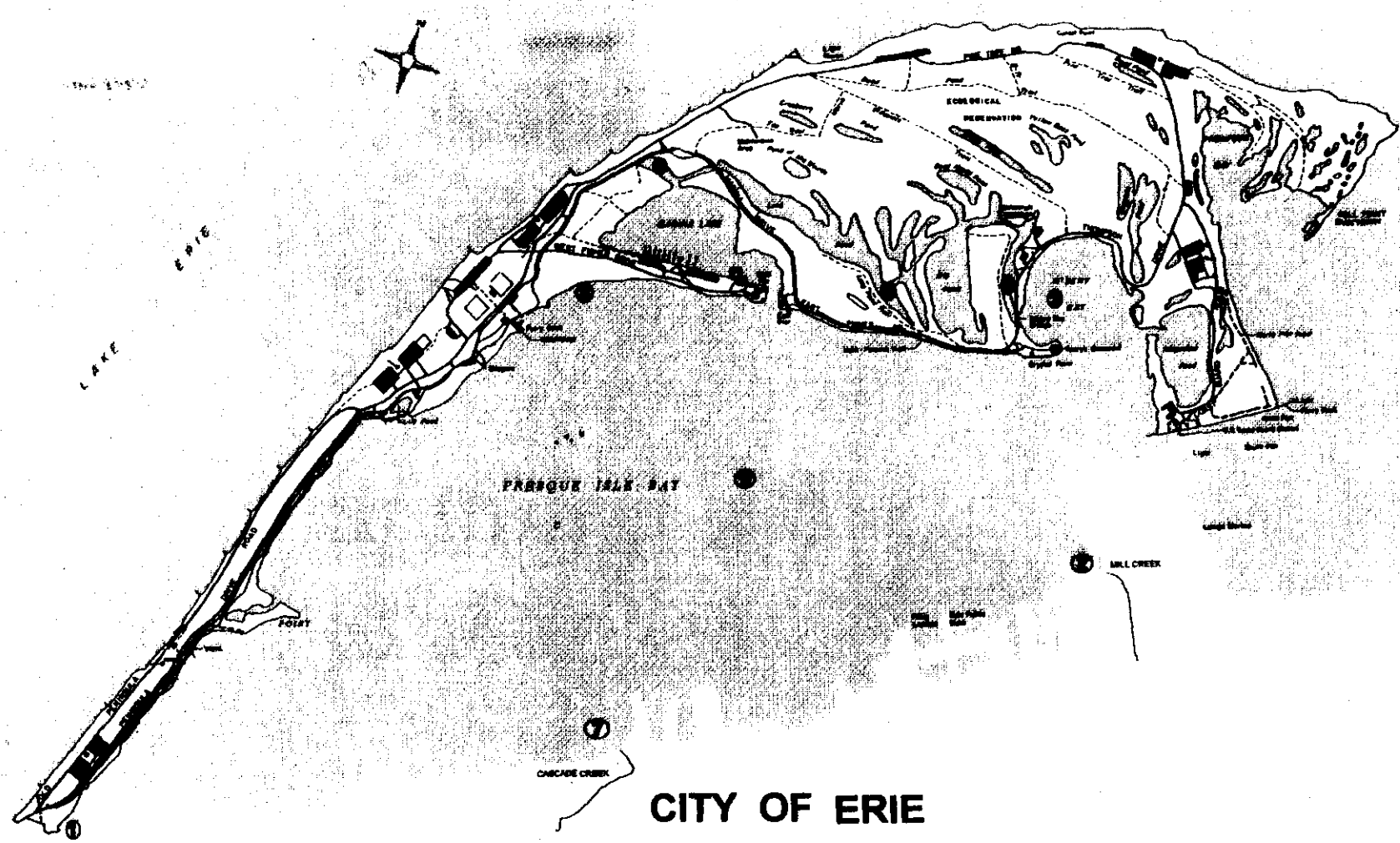


Table 1 Presque Isle Bay Brown Bullhead Bile Analyses Results for PAH Metabolites, Collected on May 4&5, 1992.

Sample No.	Collection Site	Length	Weight	Sex	(PAH Metabolites Ng/G) Nap	Phen	BAP
1C (Clean)	Misery Bay	303mm	397g	-	39,000	10,000	<100
2C "	" "	307mm	426g	-	52,000	15,000	140
3C "	" "	333mm	483g	-	34,000	9,700	<100
1A (Tumored)	Point	360mm	795g	-	*110,000	33,000	260
2A "	"	345mm	568g	M	94,000	27,000	190
3A "	"	355mm	454g	-	88,000	23,000	220
4A "	"	301mm	312g	-	*190,000	57,000	*550
5A "	"	345mm	511g	-	84,000	40,000	210
6A "	"	304mm	256g	F	59,000	18,000	210
7A "	"	307mm	312g	M	69,000	23,000	190
8A "	"	330mm	454g	M	74,000	27,000	200
9A "	"	317mm	426g	M	70,000	22,000	140
10A (Severe Tumors)	Lagoons	360mm	540g	-	*120,000	37,000	230
11A (Tumored)	"	293mm	284g	-	*130,000	78,000	*420
12A "	"	310mm	369g	F	86,000	37,000	220
13A "	"	318mm	398g	-	*130,000	38,000	270
14A "	"	340mm	511g	-	83,000	24,000	<100

* Capable of tumor promotion at this concentration.

Nap = Naphthalene
Phen = Phenanthrene
BAP = Benzo(a)pyrene

TABLE 2

VARIOUS SEDIMENT QUALITY CRITERIA OR GUIDELINES THAT ARE EXCEEDED FOR CHEMICALS DETECTED IN SEDIMENT SAMPLES

PRESQUE ISLE BAY, ERIE, PENNSYLVANIA

Chemical/Analyte	EPA'S SQC (EPA, 1993)	EPA'S Threshold Concentration (EPA, 1985)	State of Washington SQC[3]	State of Washington SCS[3]	ER-M Value (Long & Morgan, 1991)[4]	ER-M Value (MacDonald, 1992)	ABT Value (Long & Morgan, 1992)[5]	EPA Disposal Criteria (EPA, 1977)
Benzo(a)anthracene	—	No	No	No	Yes	Yes	Yes	—
Benzo(a)pyrene	—	No	No	No	No	Yes	Yes	—
Benzo(b)fluoranthene	—	—	—	—	—	—	—	—
Benzo(g,h,i)perylene	—	—	Yes	Yes	—	—	—	—
Chrysene	—	No	Yes	No	No	No	Yes	—
Fluoranthene	No	—	Yes	No	Yes	No	Yes	—
Indeno(1,2,3-cd)pyrene	—	No	Yes	Yes	—	—	—	—
Phenanthrene	No	No	Yes	No	Yes	Yes	Yes	—
Pyrene	—	No	No	No	Yes	Yes	Yes	—
Total PAHs	—	—	—	—	No	No	Yes	—
Bis(2-ethylhexyl)phthalate	—	—	Yes	Yes	—	—	—	—
Di-n-octyl phthalate	—	—	No	No	—	—	—	—
Arsenic, total	—	No	No	No	No	No	No	Yes[1]
Barium, total	—	—	—	—	—	—	—	Yes[1]
Cadmium, total	—	No	Yes	Yes	Yes	Yes	Yes	Yes[1]
Chromium, total	—	Yes	No	No	No	No	—	Yes[2]
COD on solid sample	—	—	—	—	—	—	—	Yes[1]
Copper, total	—	No	No	No	No	No	No	Yes[1]
Cyanide, total	—	Yes	—	—	—	—	—	Yes[1]

TABLE 2 (cont.)

VARIOUS SEDIMENT QUALITY CRITERIA OR GUIDELINES THAT ARE EXCEEDED FOR CHEMICALS DETECTED IN SEDIMENT SAMPLES

PRESQUE ISLE BAY, ERIE, PENNSYLVANIA
(Continued)

Chemical/Analyte	EPA'S SQC (EPA, 1993)	EPA'S Threshold Concentration (EPA, 1985)	State of Washington SQC[3]	State of Washington SCS[3]	ER-M Value (Long & Morgan, 1991)[4]	ER-M Value (MacDonald, 1992)	AET Value (Long & Morgan, 1992)[4]	EPA Disposal Criteria (EPA, 1977)
Iron, total	---	---	---	---	---	---	---	Yes[1]
Kjeldahl Nitrogen, total	---	---	---	---	---	---	---	Yes[1]
Lead, total	---	Yes	No	No	Yes	No	No	Yes[1]
Manganese, total	---	---	---	---	---	---	---	Yes[1]
Nickel	---	Yes	---	---	Yes	Yes	---	Yes[1]
Oil and Grease	---	---	---	---	---	---	---	Yes[1]
Phosphorus, total	---	---	---	---	---	---	---	Yes[1]
Solids, total	---	---	---	---	---	---	---	---
Solids, total volatile	---	---	---	---	---	---	---	Yes[1]
Total Organic Carbon	---	---	---	---	---	---	---	---
Total Organic Halogen	---	---	---	---	---	---	---	---
Zinc, total	---	No	Yes	No	Yes	Yes	Yes	Yes[1]
Mercury, total	---	No	Yes	No	No	No	No	No

--- = Not Available
[1] = Exceeds guideline for heavily polluted sediments (EPA, 1977).
[2] = Exceeds guideline for moderately polluted sediments (EPA, 1977).
[3] = Source: Ginn and Pastorok, 1992
[4] = Source: EPA 1992__

Table 3. Water Quality and Sediment Chemical Results for Presque Isle Bay Nitrosamine Sampling, 1993, Station No. 1.

Description		Dates Sampled 5/4	5/19	6/8	6/24	7/6	7/21	8/12	8/24	9/9	10/7
(Field)											
Water Temp		15.2	12.9	19.1	21.2	27.8	24.6	23.3	22.3	18.8	13.0
pH		7.4	7.8	7.4	7.4	7.8	7.7	7.9	7.7	6.6	6.9
DO		8.1	11.2	12.5	12.4	7.2	10.4	6.9	2.1	2.7	7.6
Sp Cond		355	375	385	405	310	350	317	373	390	385
(WQ Chem)											
AS	ug/l	< 4.0	< 4.0	< 4.0	<100.0	<100.0	<100.0	<100.	-	<100.	<100.0
BA	"	500.0	111.0	44.0	55.0	51.0	57.0	40.0	-	76.0	59.0
CD	"	< 0.2	< 10.0	<10.0	14.0	< 10.0	< 10.0	<10.0	<10.0	<10.0	< 10.0
CR	"	< 4.0	< 50.0	<50.0	< 50.0	< 50.0	< 50.0	<50.0	<50.0	<50.0	< 50.0
J	"	< 50.0	< 10.0	<10.0	53.0	< 10.0	< 10.0	68.0	<10.0	<10.0	< 10.0
FE	"	871.0	1660.0	908.0	1210.0	523.0	866.0	265.0	497.0	1760.	253.0
PB	"	< 4.0	< 50.0	<50.0	50.0	< 50.0	< 50.0	<50.0	<50.0	<50.0	126.0
MN	"	111.0	169.0	141.0	143.0	153.0	80.0	52.0	131.0	463.0	< 50.0
NI	"	< 50.0	< 25.0	<25.0	43.0	27.0	25.0	<25.0	<25.0	<25.0	< 50.0
ZN	"	12.0	16.0	<10.0	< 10.0	< 10.0	16.0	<10.0	20.0	21.0	< 10.0
AL	"	483.0	855.0	250.0	590.0	207.0	390.0	<135.0	157.0	709.0	205.0
HG	"	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	<1.0	-	<1.0	<1.0
(Sed Chem)											
AS	MG/KG	15.4	19.2	< 2.0	70.9	12.2	16.5	12.0	15.2		<3.0
BA	"	63.0	80.0	72.0	65.0	53.0	65.0	80.0	73.0		88.0
CD	MG/K	< 2.6	< 3.0	< 2.7	< 2.5	< 2.2	< 2.6	< 2.9	< 2.5		<2.7
CR	"	28.5	28.7	28.9	28.4	25.9	26.7	38.9	34.7		30.8
CU	"	56.0	68.0	68.2	61.6	48.0	59.6	72.3	67.8		70.2
FE	"	28000.0	29500.	29700.	28100.	23900.	30900.	35400.	31400.		30300.
PB	"	61.0	86.3	67.0	63.0	61.5	71.9	72.0	69.0		71.8
MN	"	786.0	987.0	960.0	778.0	608.0	902.0	1020.0	97.2		973.0
NI	"	43.0	38.7	17.0	15.0	18.1	24.0	25.0	20.0		23.0
ZN	MG/KG	190.0	215.0	202.0	191.0	162.0	200.0	243.0	24.3		239.0
AL	"	10100.0	9840.0	9970.0	9830.0	8640.0	9810.	13400.	11500.		10500.
HG	"	0.21	0.162	<0.1	0.164	< 0.1	0.153	0.132	0.127		0.149
(Nitrosamines)											
NDMA	ug/kg				92.	600.	0.0	0.0	0.0	3360.	
NDPA	"					18.	0.0	368.0	39.8	74.0	

Table 4. Water Quality and Sediment Chemical Results for Presque Isle Bay Nitrosamine Sampling, 1993, Station No 2.

Description	Dates Sampled 4/29	5/19	6/8	6/24	7/6	7/21	8/12	8/24	9/9	10/7
(Field)										
Water Temp	10.3	13.5	16.7	21.3	24.2	24.4	23.0	24.3	21.9	12.7
pH	7.7	7.8	7.5	7.6	7.6	7.5	7.7	8.0	7.2	7.4
DO	10.8	9.9	9.0	7.4	8.0	6.8	6.5	7.2	7.9	10.7
Sp Cond	321.0	308.0	315.0	308.0	299.0	296.0	325.0	299.0	290.0	288.0
(WQ Chem)										
AS ug/l	< 4.0	< 4.0	< 4.0	<100.0	<100.0	<100.0	<100.	-	<100.	<100.0
BA "	26.0	24.0	43.0	33.0	23.0	27.0	28.0	-	30.0	28.0
CD "	< 10.0	<10.0	< 10.0	13.0	< 10.0	< 10.0	<10.0	<10.0	<10.0	< 10.0
CR "	< 50.0	<50.0	< 50.0	< 50.0	< 50.0	< 50.0	<50.0	<50.0	<50.0	< 50.0
CU "	< 10.0	<10.0	10.0	31.0	< 10.0	< 10.0	<10.0	<10.0	<10.0	< 10.0
FE "	136.0	65.0	1780.0	440.0	285.0	124.0	266.0	379.0	745.0	87.
PB "	< 50.0	<50.0	< 50.0	50.0	< 50.0	64.0	<50.0	<50.0	<50.0	121.
MN "	16.0	15.0	42.0	24.0	20.0	23.0	45.0	50.0	35.0	10.0
NI "	< 25.0	<25.0	< 25.0	45.0	< 25.0	< 25.0	<25.0	<25.0	<25.0	< 25.0
ZN "	< 10.0	11.0	28.0	< 10.0	10.0	< 10.0	10.0	22.0	19.0	< 10.0
AL "	135.0	135.0	1070.0	347.0	172.0	135.0	<135.0	312.0	307.0	158.0
HG "	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	-	<1.0	< 1.0
(Sed Chem)										
AS MGKG	2.5	19.1	< 1.0	3.0	1.5	3.9	2.5	4.0	3.1	2.0
BA "	24.6	101.0	16.0	52.0	19.5	28.0	56.0	44.0	58.2	16.0
CD MG/K	< 1.4	3.2	< 1.3	1.8	< 1.4	< 1.4	< 1.8	< 1.4	< 1.6	<1.3
CR "	9.8	39.6	6.0	12.2	5.3	11.0	17.0	11.2	14.2	5.5
CU "	14.8	72.0	8.5	29.5	8.5	14.5	28.5	21.5	27.8	7.6
FE "	7380.	30000.	5410.	8980.	4240.	10200.	12000.	8790.	10300.	5300.
PB "	23.5	122.0	15.0	46.2	14.0	30.0	50.0	33.0	42.6	23.0
MN "	100.0	624.0	68.8	109.0	52.4	121.0	150.0	120.0	168.0	74.8
NI "	12.0	52.9	6.0	8.7	6.3	9.4	14.0	11.0	12.0	7.8
ZN MGKG	59.2	283.0	45.0	95.4	41.1	81.0	122.0	92.9	121.0	46.4
AL "	2490.	11800.	1720.	2920.	1520.	3010.	4210.	3180.	4020.	1780.
HG "	< 1.0	0.291	0.296	0.227	<0.1	0.121	0.106	0.113	0.18	<0.1
(Nitrosamines)										
NDMA ug/kg				0.0	1080.	0.0	0.0	0.0	5144.	
NDPA "				0.0	0.0	0.0	337.8	21.0	56.0	

Table 5. Water Quality and Sediment Chemical Results for Presque Isle Bay Nitrosamine Sampling, 1993, Station No. 3.

Description	Dates Sampled 4/29	5/19	6/8	6/24	7/6	7/21	8/12	8/24	9/9	10/7
(Field)										
Water Temp	9.9	14.1	17.4	23.0	26.1	25.1	24.5	24.1	21.8	12.9
pH	7.6	7.8	7.5	7.6	8.9	8.1	8.5	8.3	7.8	7.8
DO	10.3	9.4	7.3	5.9	10.1	8.0	6.4	7.1	9.1	12.2
Sp Cond	318	311	296	289	270	270	270	262	252	282
(WQ Chem)										
AS ug/l	< 4.0	< 4.0	< 4.0	<100.0	<100.	<100.0	<100.0	-	<100.	<100
BA "	27.0	28.0	32.0	25.0	18.0	28.0	29.0	-	27.0	32.0
CD "	< 10.0	< 10.0	<10.0	< 10.0	<10.0	< 10.0	<10.0	<10.0	15.0	10.0
CR "	< 50.0	< 50.0	<50.0	< 50.0	<50.0	< 50.0	<50.0	<50.0	<50.0	< 50.0
CU "	< 10.0	< 10.0	<10.0	12.0	<10.0	< 10.0	<10.0	<10.0	<10.0	< 10.0
FE "	355.0	466.0	469.0	128.0	231.0	541.0	927.0	1060.0	427.0	742.0
PB "	< 50.0	< 50.0	<50.0	53.0	<50.0	< 50.0	<50.0	<50.0	<50.0	81.0
MN "	46.0	30.0	111.0	28.0	48.0	60.0	100.0	116.0	33.0	36.0
NI "	< 25.0	< 25.0	<25.0	< 25.0	26.0	< 25.0	<25.0	<25.0	<25.0	< 25.0
ZN "	< 10.0	10.0	<10.0	11.0	<10.0	< 10.0	20.0	24.0	<10.0	10.0
AL "	252.0	592.0	221.0	135.0	137.0	229.0	385.0	521.0	<135.0	518.0
HG "	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	<1.0	-	<1.0	< 1.0
(Sed Chem)										
AS MGKG	4.7	3.7	17.9	11.2	20.3	19.5	11.1	22.9	17.2	10.0
BA "	23.0	15.0	93.0	57.0	95.0	90.0	87.0	102.0	83.0	51.0
CD MG/K	< 1.8	< 1.4	6.6	3.8	7.6	8.3	5.0	7.8	6.9	4.6
CR "	9.9	6.3	47.0	30.0	55.4	49.8	42.8	54.2	47.5	25.4
CU "	11.0	8.8	69.1	38.4	83.3	74.4	54.2	78.6	64.0	35.9
FE "	7880.	5990.	26900.	17100.	36700	34500	26300	35700	29500	16100
PB "	21.0	<14.0	93.9	69.6	123.0	116.0	95.8	104.0	93.6	66.0
MN "	120.0	83.4	415.0	281.0	563.0	531.0	447.0	654.0	468.0	265.0
NI "	16.0	13.2	27.6	18.0	40.7	36.8	32.0	37.0	34.8	26.0
ZN MGKG	64.1	61.0	260.0	178.0	336.0	309.0	234.0	319.0	286.0	183.0
AL "	2330.	1940.	10200.	6650.	13100.	11900.	9580.	11400	10200.	5350.
HG "	< 0.1	<0.1	< 0.284	0.445	0.52	0.571	0.419	0.527	0.532	0.254
(Nitrosamines)										
NMA ug/kg				2500.	1620.	2000.	0.0	0.0	26240.	
NDPA "				0.	24.	0.	349.8	0.0	304.0	

Table 6. Water Quality and Sediment Chemical Results for Presque Isle Bay Nitrosamine Sampling, 1993, Station No. 4.

Description	Dates Sampled 5/4	5/19	6/8	6/24	7/6	7/21	8/12	8/24	9/9	10/7
(Field)										
Water Temp	13.6	14.4	18.3	23.5	26.4	25.5	24.4	24.5	21.8	12.9
pH	7.6	7.7	7.3	7.7	8.6	8.2	8.2	7.6	7.5	7.3
DO	9.9	9.4	7.8	7.3	9.3	9.1	7.7	6.7	8.3	10.1
Sp Cond	315.	309.	297.	287.	275.	271.	272.	267.	257.	280.
(WQ Chem)										
AS ug/l	< 4.0	< 4.0	< 4.0	<100.	<100.0	<100.0		-	<100.	<100.0
BA "	<500.0	27.0	32.0	27.0	21.0	26.0		-	27.0	32.0
CD "	< 0.2	< 10.0	< 10.0	<10.0	< 10.0	< 10.0		<10.0	<10.0	< 10.0
CR "	< 4.0	< 50.0	< 50.0	<50.0	< 50.0	< 50.0		<50.0	<50.0	< 50.0
CU "	50.0	< 10.0	< 10.0	<10.0	< 10.0	< 10.0		<10.0	<10.0	< 10.0
FE "	275.0	293.0	658.0	280.0	312.0	762.0		660.0	165.0	240
PB "	< 4.0	< 50.0	< 50.0	<50.0	< 50.0	< 50.0		<50.0	<50.0	67.
MN "	< 50.0	65.0	69.0	60.0	59.0	111.0		49.0	23.0	19.0
NI "	< 50.0	< 25.0	< 25.0	<25.0	26.0	< 25.0		<25.0	<25.0	< 25.0
ZN "	< 10.0	< 10.0	< 10.0	<10.0	< 10.0	< 10.0		<10.0	25.0	10.0
AL "	189.0	<135.0	<135.0	101.0	<135.0	<135.0		<135.0	<135.0	<135.0
HG "	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0		-	<1.0	< 1.0
(Sed Chem)										
AS MGKG	6.5	9.7	9.7	7.7	7.2	5.7	3.9	7.4	3.7	7.8
BA "	9.6	9.4	14.0	7.59	< 7.0	< 7.2	7.7	11.0	9.0	8.0
CD MG/K	< 1.4	< 1.5	< 1.6	< 1.8	< 1.4	< 1.4	< 1.5	< 1.4	< 1.4	<1.4
CR "	5.1	1.5	7.3	5.46	2.9	4.0	5.1	5.0	4.4	4.0
CU "	3.2	< 3.6	6.9	3.34	< 3.6	< 3.6	< 3.9	3.6	< 3.5	<3.6
FE "	5610.0	1830.0	9160.0	6950.	4660.	5860.	7170.	6690.	5710.	6180.
PB "	< 14.0	< 15.0	< 16.0	10.6	<14.0	< 14.0	<15.0	< 14.0	< 14.0	<14.0
MN "	80.9	32.9	140.0	95.1	88.9	92.3	109.0	109.0	71.4	124.0
NI "	9.5	< 5.8	< 6.2	2.0	< 5.8	< 5.7	< 6.2	< 5.5	< 5.5	6.9
ZN MGKG	22.7	8.1	37.1	31.1	18.0	28.2	23.4	26.3	22.6	23.0
AL "	1490.0	465.0	2060.0	1520.	1320.	1370.	1630.	1750.	1440.	1280.
HG "	0.122	< 0.1	< 0.1	< 0.1	< 0.1	0.015	<0.1	< 0.1	< 0.1	<0.1
(Nitrosamines)										
NDMA ug/kg			2500.	1620.	2000.	0.0	0.	12926.		
NDPA "			0.	24.	0.	311.2	0.	268.0		

Table 7. Water Quality and Sediment Chemical Results for Presque Isle Bay Nitrosamine Sampling, 1993, Station No. 5.

Description	Dates Sampled 4/29	5/19	6/8	6/22	7/6	7/21	8/12	8/24	9/9	10/7
(Field)										
Water Temp	12.9	14.6	20.0	24.6	28.2	25.8	24.6	23.6	21.9	15.7
pH	7.4	7.3	7.3	7.2	7.9	7.7	7.8	7.5	6.8	6.9
DO	9.9	6.0	7.2	4.0	5.9	6.8	5.5	3.2	5.9	7.7
Sp Cond	293	315	299	291	294	297	289	289	274	291
(WQ Chem)										
AS ug/l	7.95	< 4.0	< 6.33	<100	<100.0	<100	<100.0	-	<100.	<100.
BA "	34.0	29.0	38.0	73.0	29.0	33.0	44.0	-	39.0	36.0
CD "	< 10.0	< 10.0	< 10.0	<10.0	< 10.0	<10.0	<10.0	<10.0	<10.0	< 10.0
CR "	< 50.0	< 50.0	< 50.0	<50.0	< 50.0	<50.0	<50.0	<50.0	<50.0	< 50.0
CU "	< 10.0	10.0	< 10.0	28.0	14.0	<10.0	<10.0	<10.0	<10.0	< 10.0
E "	1600.	455.	1380.	16700.	583.0	1530.	4290.0	2150.0	1380.0	624.
PB "	< 50.0	< 50.0	< 50.0	<50.0	< 50.0	<50.0	<50.0	<50.0	<50.0	71.0
MN "	68.0	108.0	119.0	395.0	68.0	122.0	141.0	252.0	88.0	35.0
NI "	< 25.0	< 25.0	< 25.0	<25.0	< 25.0	<25.0	<25.0	<25.0	<25.0	< 25.0
ZN "	< 10.0	10.0	< 10.0	106.0	< 10.0	<10.0	14.0	14.0	<10.0	< 10.0
AL "	304.0	238.0	201.0	2940.	<135.	<135.	625.0	140.0	148.0	153.
HG "	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0		<1.0	-	<1.0	< 1.0
(Sed Chem)										
AS MGKG	104.2	20.1	97.5	125.8	114.3	110.4	85.9	111.9	126.5	101.0
BA "	124.0	57.0	110.0	125.0	118.0	110.0	100.0	124.0	130.0	120.0
CD MG/K	< 12.0	3.5	< 10.0	<10.0	<11.0	<12.0	<11.0	< 8.3	< 8.7	<12.0
CR "	55.0	30.0	37.0	42.0	37.8	40.0	40.2	38.1	43.3	42.0
CU "	65.0	39.0	68.0	66.0	70.0	60.0	57.0	55.0	64.6	76.0
FE "	62000.	19800.	51300.	62400.	57300.	58200.	57300.	53600.	61300.	59600.
PB "	151.0	57.0	122.0	176.0	130.0	<120.0	<110.0	87.0	114.0	170.0
MN "	723.0	337.0	747.0	916.0	830.0	875.0	798.0	813.0	977.0	831.0
NI "	55.0	35.0	<41.0	<38.0	<11.0	<50.0	<45.0	<33.0	<35.0	<48.0
ZN MGKG	259.0	188.0	194.0	250.0	239.0	231.0	237.0	222.0	241.0	257.0
AL "	9700.	7350.	7120.	9490.	15600.	7940.	7850.	7460.	8460.0	8700.0
HG "	0.356	0.281	0.122	0.472	0.368	0.556	0.511	0.463	0.529	0.443
(Nitrosamines)										
NDMA ug/kg				0.0	0.0	1400.	0.0	0.0	0.0	
DPA "				0.0	22.0	0.0	298.2	0.0	534.0	

Table 8. Water Quality and Sediment Chemical Results for Presque Isle Bay Nitrosamine Sampling, 1993, Station No. 6.

Description	Dates Sampled 5/4	5/19	6/8	6/22	7/6	7/21	8/12	8/24	9/9	10/7
(Field)										
Water Temp	15.2	14.9	19.0	22.9	27.5	24.4	23.6	23.5	20.5	14.8
pH	7.6	7.5	7.3	7.4	8.2	7.4	7.8	7.5	7.6	7.1
DO	9.5	9.1	7.0	6.1	7.7	5.0	5.1	6.0	12.5	9.4
Sp Cond	310	317	303	300	296	300	296	295	271	299
(WQ Chem)										
AS ug/l	5.8	< 4.0	<100.0	<100	<100	<100	<100.0	-	<100.	<100
BA "	< 500.0	27.0	30.0	36.0	35.0	30.0	40.0	-	32.0	38.0
CD "	< 0.2	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
CR "	< 4.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0
CU "	< 50.0	<10.0	<10.0	14.0	<10.0	<10.0	<10.0	<10.0	10.0	<10.0
FE "	1830.	264.	729.0	5680.	722.	784.	2280.0	1140.0	1430.0	449.
PB "	< 4.0	<50.0	<50.0	63.0	<50.0	<50.0	<50.0	<50.0	<50.0	50.0
MN "	83.0	41.0	43.0	187.0	126.0	66.0	64.0	47.0	130.0	19.0
NI "	< 50.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0
ZN "	< 10.0	<10.0	<10.0	23.0	19.0	<10.0	<10.0	13.0	<10.0	<10.0
AL "	330.0	<135.0	<135.0	825.0	135.0	<135.0	152.0	<135.0	<135.0	<135.0
HG "	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	<1.0	-	<1.0	< 1.0
(Sed Chem)										
AS MGKG	133.4	170.2	160.4	233.7	49.3	138.5	199.0	158.3	173.2	124.2
BA "	150.0	132.0	150.0	180.0	141.0	145.0	160.0	234.0	161.0	135.0
CD MG/K	8.0	< 8.0	< 9.4	< 7.5	< 7.8	6.9	< 7.0	9.0	< 8.5	8.1
CR "	42.0	40.4	42.0	45.0	50.0	38.1	48.2	51.0	53.0	38.0
CU "	62.0	55.9	75.0	62.0	68.8	59.6	45.4	76.0	69.0	59.0
FE "	79100.	78500.	81200.	113000.	86800.	92800.	117000.	95300.	110000.	85100
PB "	103.0	115.0	146.0	119.0	124.0	118.0	110.0	123.0	120.0	132.0
MN "	1800.	1730.	1730.	2460.	1830.	2020.	2440.	1900.	2310.	1840.
NI "	59.1	56.7	<38.0	<30.0	<31.0	<28.0	<30.0	<36.0	<34.0	<27.0
ZN MGKG	215.0	198.0	209.0	227.0	219.0	219.0	196.0	249.0	246.0	200.0
AL "	7160.	6460.	7730.	6770.	7300.	6570.	5550.	7930.	8320.	7160.
HG "	0.358	0.294	<0.1	0.405	0.331	0.429	0.393	0.388	0.488	0.329
(Nitrosamines)										
NDMA ug/kg			4760.0	0.0	2000.0	0.0	0.0	0.0		
NDPA "			0.0	22.0	0.0	88.4	86.6	668.0		

Table 9. Water Quality and Sediment Chemical Results for Presque Isle Bay Nitrosamine Sampling, 1993, Station No. 7.

Description	Dates Sampled 4/29	5/19	6/8	6/24	7/6	7/21	8/12	8/24	9/9	10/7
(Field)										
Water Temp	9.8	13.8	16.0	21.2	23.9	24.0	23.3	23.8	21.2	12.7
pH	7.5	7.4	7.5	7.9	7.7	7.9	8.0	7.8	7.5	756
DO	10.4	9.6	7.4	8.3	6.4	7.1	6.5	3.8	8.9	10.7
Sp Cond	322	308	309	422	294	322	303	402	306	284
(WQ Chem)										
AS ug/l	< 4.0	5.6	<100	<100	<100	<100	<100.0	-	<100.	<100
BA "	26.0	36.0	30.0	39.0	23.0	32.0	29.0	-	29.0	24.0
CD "	<10.0	<10.0	<10.0	13.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
CR "	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0
CU "	<10.0	<10.0	10.0	42.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
FE "	169.0	1310.	335.0	982.0	126.0	831.0	368.0	313.0	192.0	79.0
PB "	<50.0	<50.0	<50.0	55.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0
MN "	17.0	115.0	49.0	171.0	48.0	143.0	52.0	75.0	34.0	18.0
NI "	<25.0	<25.0	<25.0	48.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0
ZN "	<10.0	11.0	17.0	<10.0	11.0	11.0	<10.0	28.0	<10.0	<10.0
AL "	179.0	156.0	218.0	616.0	<135.0	421.0	171.0	185.0	<135.0	<135.0
HG "	<1.0	<1.0	<1.0	6.87	<1.0	<1.0	<1.0	-	<1.0	<1.0
(Sed Chem)										
AS MGKG	16.4	169.3	12.7	12.5	14.6	14.3	10.5	12.0	12.6	11.7
BA "	102.0	105.0	74.0	78.0	67.0	86.8	78.4	90.0	115.0	72.0
CD MG/K	3.8	<11.0	2.1	2.7	2.8	2.9	3.7	2.8	< 2.6	3.2
CR "	42.3	39.0	25.0	28.4	27.3	29.8	34.9	31.0	62.6	25.3
CU "	86.8	56.0	67.0	72.9	60.1	76.5	72.8	68.7	62.6	66.3
FE "	30700.	53600.	23100.	24700.	22900.	28900.	28300.	26400.	24400.	25100.
PB "	153.0	115.0	91.7	121.0	99.4	125.0	132.0	115.0	78.6	97.0
MN "	455.0	706.0	519.0	527.0	497.0	535.0	534.0	512.0	584.0	563.0
NI "	54.9	49.0	24.6	27.0	32.1	32.2	37.8	34.2	29.0	35.0
ZN MGKG	290.0	239.0	231.0	219.0	219.0	269.0	274.0	247.0	245.0	234.0
AL "	11100.	8070.	7900.	8640.	7830.	9420.0	9800.0	8730.0	9250.0	7460.
HG "	0.308	0.413	0.145	0.27	0.161	0.264	0.623	0.208	0.253	0.195
(Nitrosamines)										
NDMA ug/kg				14.0	0.0	0.0	0.0	0.0	17858.	
NPA "				0.0	0.0	0.0	0.0	0.0	708.0	

Table 10. Water Quality and Sediment Chemical Results for Presque Isle Bay Nitrosamine Sampling, 1993, Station No. 8.

Description	Dates Sampled 4/29	5/19	6/8	6/24	7/6	7/21	8/12	8/24	9/9	10/7
(Field)										
Water Temp		13.8	16.5	21.5	26.2	24.9	23.7	23.8	20.9	13.4
pH		7.9	7.7	8.3	8.9	8.6	8.5	8.7	7.8	7.6
DO		10.3	9.8	10.1	11.4	12.5	9.9	8.6	9.9	11.0
Sp Cond		310	306	289	257	267	278	279	272	284
(WQ Chem)										
AS ug/l	<4.0	< 4.0	<100	<100	<100	<100	<100.0	-	<100.	<100
BA "	26.0	23.0	25.0	21.0	19.0	22.0	24.0	-	27.0	25.0
CD "	<10.0	<10.0	-	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
CR "	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0
CU "	<10.0	<10.0	<10.0	21.0	<10.0	<10.0	<10.0	<10.0	18.0	<10.0
FE "	281.0	36.0	36.0	165.0	25.0	77.0	66.0	58.0	220.0	73.
PB "	<50.0	<50.0	<50.0	<50.0	<50.0	60.0	<50.0	<50.0	<50.0	<50.0
MN "	20.0	10.0	<10.0	30.0	<10.0	16.0	19.0	22.0	50.0	22.0
NI "	<25.0	<25.0	<25.0	25.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0
ZN "	<10.0	<10.0	<10.0	<10.0	<10.0	35.0	<10.0	<10.0	22.0	<10.0
AL "	264.0	<135.0	<135.0	<135.0	<135.0	<135.0	<135.0	<135.0	<135.0	<135.0
HG "	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	<1.0
(Sed Chem)										
AS MGKG		5.0	2.0	2.6	3.3	2.7	2.4	3.4	3.2	2.9
BA "		<7.0	<7.0	<7.0	<6.9	<7.2	8.0	8.0	9.0	<6.8
CD MG/K		<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.3	<1.4
CR "		2.9	3.2	6.7	2.2	2.6	3.6	11.0	3.2	2.1
CU "		<3.4	<3.5	<3.5	<3.5	<3.6	<3.6	<3.4	<3.2	<6.8
FE "		3350.	1970.	2500.	2700.	2960.	3500.	2920.	3000.	2340.
PB "		5.6	<14.0	<14.0	<14.0	<14.0	<14.0	<14.0	<13.0	<14.0
MN "		52.0	33.3	51.0	66.8	49.9	76.0	45.0	46.7	61.7
NI "		9.9	<5.6	<5.5	5.5	<5.8	<5.7	<5.5	<5.2	7.5
ZN MGKG		565.0	14.0	14.0	16.6	15.1	18.1	15.0	15.9	15.8
AL "		1020.0	671.0	833.0	865.0	857.0	1170.0	1110.0	1070.0	916.0
HG "		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
(Nitrosamines)										
NDMA ug/kg				2940.0	0.0	1600.0	0.0	0.0	15268.	
NDPA '				0.0	52.0	8.0	105.0	117.8	1102.0	

Table 11. Water Quality and Sediment Chemical Results for Presque Isle Bay Nitrosamine Sampling, 1993, Station No. 9.

Description		Dates Sampled 4/29	5/19	6/8	6/24	7/6	7/21	8/12	8/24	9/9	10/7
(Field)											
Water Temp		8.4	14.0	14.2	21.4	21.1	24.5	23.0	24.0	21.8	12.5
pH		7.5	7.5	7.4	7.8	8.0	7.7	8.1	8.2	7.5	7.4
DO		10.8	10.0	8.2	8.5	7.6	7.9	6.7	7.2	9.0	11.0
Sp Cond		325	307	296	296	277	289	295	287	281	281
(WQ Chem)											
AS	ug/l	<4.0	<4.0	<100	<100	<100	<100.0	<100.0	-	<100.	<100
BA	"	26.0	24.0	28.0	22.0	24.0	27.0	30.0	-	27.0	32.0
CD	"	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	17.0	<10.0	<10.0
CR	"	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0
CU	"	<10.0	<10.0	<10.0	25.0	14.0	<10.0	<10.0	<10.0	11.0	12.0
FE	"	281.0	179.0	172.0	144.0	76.0	938.0	978.0	677.0	313.0	1640.0
PB	"	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0
MN	"	20.0	15.0	23.0	19.0	19.0	53.0	67.0	98.0	30.0	72.0
NI	"	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0
ZN	"	<10.0	<10.0	<10.0	22.0	<10.0	<10.0	12.0	<10.0	17.0	28.0
AL	"	264.0	210.0	146.0	212.0	166.0	590.0	726.0	424.0	<135.0	1220.0
HG	"	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	<1.0
(Sed Chem)											
AS	MGKG	17.8	30.0	15.3	17.3	17.4	17.3	12.7	18.7	16.7	15.7
BA	"	138.0	158.0	163.0	146.0	134.0	141.0	158.0	139.0	155.0	128.0
CD	MG/K	10.0	7.5	9.3	8.6	8.5	8.9	9.8	8.5	8.9	9.9
CR	"	81.5	69.4	60.0	71.6	64.0	62.1	73.3	59.2	64.4	75.0
CU	"	115.0	97.4	92.7	105.0	102.0	95.1	105.0	87.5	97.8	102.0
FE	"	42200.	41800.	33700.	42000.	41600.	38100.	42500.	33700.	38900.	36200.
PB	"	182.0	151.0	130.0	161.0	156.0	141.0	167.0	110.0	123.0	183.0
MN	"	589.0	8750.	570.0	611.0	796.0	4330.0	665.0	551.0	585.0	551.0
NI	"	74.9	74.1	43.6	46.9	44.0	51.0	55.6	50.4	56.0	50.6
ZN	MGKG	415.0	398.0	344.0	405.0	356.0	350.0	387.0	353.0	365.0	420.0
AL	"	17700.	18100.	13500.	19100.	17400.	16500.	21800.	13500.	16700.	15400.
HG	"	0.676	0.489	0.351	0.546	0.561	0.616	0.658	0.566	0.767	0.964
(Nitrosamines)											
NDMA	ug/kg				5540.	6.0	960.0	0.0	0.0	17626.	
NDPA	"				0.0	24.0	0.0	86.8	278.2	736.0	

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