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United States Environmental Protection Agency

Project Plan for Tiers 3, 5, 6, and 7 of the National Dioxin Study, including Quality Assurance and Quality Control (QA/QC) Requirements

Prepared by the Office of Water Regulations and Standards in Conjunction with the Regional Dioxin Study Coordinators and the Dioxin Management Task Force

April 30, 1984

Washington, D.C. 20460

DRAFT

This report has been reviewed by the Office of Water, Office of Solid Waste and Emergency Response, and EPA's Regional staff. The report sets forth the overall requirements and the Quality Assurance Project Plan for the National Dioxin Study.

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Office of Water Regulations
and Standards

_____ Michael Cook, Chairman
Dioxin Management Task Force

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FOREWORD

This document serves as the overall description of the Environmental Protection Agency's (EPA) National Dioxin Study.

The study is part of EPA's Dioxin Strategy (Ref. No. 1) released on December 15, 1983, and is designed to determine the nature of environmental contamination from 2378-TCDD, the most toxic dioxin isomer. This document summarizes the important elements of field and laboratory Quality Assurance and Quality Control (QA/QC) and sets forth the basic objectives of the study. The format of the document is in conformance with the Office of Water (OW) Work/QA Project Plan Guidance document (Ref. No. 2). This document draws upon and provides a bridge between the study's field and laboratory manuals. The laboratory protocol document describes the analytical procedures to be followed and the field sampling document recommends specific field sampling techniques.

This project plan is intended to provide specific guidance to those participating in the National Dioxin Study (EPA Headquarters, Regions, Analytical Support Laboratories, and State Agencies). The plan is designed to help ensure uniform controls and an understanding of study objectives so that a valid basis can be established for performing a national assessment.

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I. Introduction

Background

On December 15, 1983, EPA released the "Dioxin Strategy" (Ref. No. 1) which provides a framework under which EPA will:

1. study the nature of dioxin contamination and the associated risks to humans and the environment;

2. implement or compel necessary clean-up actions at contaminated sites; and

3. further evaluate regulatory alternatives to prevent future contamination, as well as disposal alternatives to alleviate current problems.

To facilitate the implementation of the strategy, EPA defined the following study tiers based on decreasing potential for 2378-TCDD contamination:

Tier 1 - 2,4,5-Trichlorophenol (2,4,5-TCP) production sites and associated waste disposal sites.

Tier 2 - Sites (and associated waste disposal sites) where 2,4,5-TCP was used as a precursor to make pesticidal products.

Tier 3 - Sites (and associated waste disposal sites) where 2,4,5-TCP and its derivatives were formulated into pesticidal products.

Tier 4 - Combustion sources.

Tier 5 - Sites where pesticides derived from 2,4,5-TCP have been and are being used on a commercial basis.

Tier 6 - Certain organic chemical and pesticidal manufacturing facilities where improper quality control on certain production processes could have resulted in the inadvertent formation of 2378-TCDD.

Tier 7 - Networks of existing ambient stations where fish and soil will be sampled to determine whether 2378-TCDD is widespread in the environment and, if so, at what levels.

The strategy calls for a complete investigation (including field sampling) at all sites in tiers 1 and 2 because they are suspected of being the most contaminated. A representative sampling of sites in tiers 3 and 6 will be done because the number of sites in these tiers is in the hundreds and the potential for contamination is much less. The work in tier 5 will focus on areas where extensive use of pesticides derived from 2,4,5,-TCP has been documented. The work in tier 7 will use two national networks for sampling ambient conditions.

The initial sampling work at sites in tiers 3-7 constitute the basis of the National Dioxin Study and hence the development of this project plan.

Although the overall objective of the National Dioxin Study is to study the nature of dioxin contamination, sites found to be contaminated with 2378-TCDD will be referred to the Superfund program for any necessary follow-up work.

Implementation

The AA for the Office of Solid Waste and Emergency Response (OSWER) is responsible for implementing the overall dixoin strategy. OSWER will directly manage the investigations for sites in tiers 1 and 2. The Office of Water Regulations and Standards (OWRS) will manage the study of tiers 3 through 7 - the National Dioxin Study. Both efforts will be coordinated by the Dioxin Management Task Force (DMTF). The Office of Air Quality Planning and Standards will manage the work in tier 4 - combustion sources - and will prepare a separate project plan for that study. EPA's regional offices will be responsible for conducting the actual sampling for tiers 3, 5, 6, and 7, following the guidelines presented in this document.

A significant portion of this study involves measuring 2378-TCDD in environmental media, especially in soils and fish. Two major laboratory programs will be involved in these analytical determinations: (1) a configuration of three EPA laboratories (Duluth, Bay St. Louis, and RTP) known as the Troika and managed by the Office of Research and Development (ORD); and (2) the Contract Lab

Program (CLP) managed by OSWER and consisting of commercial laboratories under contract to EPA.

Work in all seven tiers will proceed in a concurrent, parallel fashion. While the basic National Dioxin Study is limited to two years, the comprehensive assessment of sites in tiers 1 and 2 will likely extend beyond two years, especially at sites where enforcement actions and clean-up options are complex.

II. Project and QA Description

1.0 Project Name: "National Dioxin Study"

2.0 Project Requested by: U.S. EPA, as a part of EPA's overall Dioxin Strategy in response to a particular request through the Congressional 1984 appropriation

3.0 Date of Request: October 1, 1983

4.0 Date of Project Initiation: October 1, 1983

5.0 Project Officer: Alec McBride, Chief, (202/382-7046) Water Quality Analysis Branch, Monitoring and Data Support Division (WH-553), Office of Water Regulations and Standards, Office of Water, U.S. EPA

6.0 Quality Assurance Officer: Martin Brossman (202/382-7040), Monitoring and Data Support Division (WH-553), Office of Water Regulations and Standards, Office of Water, U.S. EPA.

7.0 Project Description

7.1 Basic Approach

There are 75 different chlorinated dioxins, divided into eight homologues (groups), each with different physical and chemical properties depending on the number and location of the chlorine atoms. One of the 22 isomers with four chlorine atoms is 2,3,7,8 - tetrachlorodibenzo-p-dioxin (2378-TCDD). This isomer is the principal focus of the National Dioxin Study for three reasons:

(1) it is the most toxic of the chlorinated dioxins,

(2) it is the isomer most often associated with exposure and potential health risks to humans, and

(3) there is sufficient information available on it to allow a targeted study to be developed.

The data reviewed thus far indicate that 2378-TCDD is inadvertently formed during the chemical hydrolysis of tetrachlorobenzene to make 2,4,5-trichlorophenol and that it is not formed through any other properly controlled chemical manufacturing process. EPA's scientific judgement is that most of the 2378-TCDD goes into the still bottom wastes from this process, with the remainder contaminating the product. The contaminated 2,4,5-TCP is then used as a precursor to make other chemicals (e.g., 2,4,5-T

and silvex) thereby "carrying" the 2378-TCDD contaminate through the chemical manufacturing tree. At each step, chemical measures can be taken to "clean-up" the product (i.e, remove impurities like 2378-TCDD).

Once the chemical industry learned about the potential for 2378-TCDD contamination, steps were taken to reduce the levels of contamination. These measures typically resulted in clean-up procedures that removed much of the impurity which was then usually landfilled.

Thus, the characterization of environmental contamination of 2378-TCDD is believed to be two-fold:

(1) A decreasing level of contamination with time from the 2,4,5-TCP chemical manufacturing process, and

(2) a decreasing level of contamination down the chemical tree (i.e., 2,4,5-TCP is more contaminated than 2,4,5-T).

The approach to the National Dioxin Study is based on tiers or categories of contamination; the lower the tier number, the greater the potential for higher levels of 2378-TCDD contamination of both product and wastes. For this reason, all of the facilities involved in making 2,4,5-TCP (tier 1) and 2,4,5-TCP derivatives (tier 2) will be investigated. The investigation in the other production tiers (3 and 6) will be based on a representative

sampling of facilities within these tiers because the potential for significant contamination is low at tier 3 sites and even lower at tier 6 sites.

Sampling at tier 4 will be conducted to determine the presence or absence of 2378-TCDD in combustion sources, both those where material contaminated with 2378-TCDD may have been burned (i.e., municipal incinerators) and those where no 2378-TCDD should have been present in the material being burned (i.e., coal-fired power plants). The later type of sources will be sampled to investigate the theory that 2378TCDD can be created in certain combustion processes. As indicated earlier, a separate work plan will be developed for tier 4.

Sampling at tier 5 will be conducted to determine the prevalance of 2378-TCDD at sites known to be sprayed with 2378-TCDD contaminated herbicides.

Tier 7 is being investigated to determine whether 2378-TCDD is widespread in the environment by a representative sampling of fish and soils at control stations, i.e., stations not associated with tiers 1, 2, or 3.

7.2 Project Description by Tiers

7.2.1 TIER 3

Objectives

Tier 3 consists of facilities which formulate pesticides containing active ingredients which may be contaminated with

dioxin. Certain locations within these facilities may have been contaminated with dioxin if the active ingredients of concern were spilled during handling or formulation. Another possible source of contamination would be the cleaning and disposal of containers which had held the active ingredients. Many of the formulators were probably not aware that they were handling material potentially contaminated with dioxin; therefore, they would probably not have taken special precautions for handling and disposing of materials.

The Dioxin Strategy (Ref. No. 1) contends that significant contamination is less likely at tier 3 facilities than at tier 1 and tier 2 facilities. The objective of the tier 3 study is to determine what percentage of the facilities in tier 3 have concentrations of dioxin in soil above one part per billion (ppb) or in other environmental media (e.g., fish in nearby streams) above approximately one part per trillion (ppt). This is a very important question to address since the answer will provide the Agency with an indication of what, if anything, should be done about the hundreds of tier 3 facilities which are not being sampled as part of the National Dioxin Study. This determination will be based on sampling within each site in a manner which, where possible, is directed towards those specific locations within a site that are most likely to be contaminated. The study will not, however, be able to extrapolate the number of facilities at particular contamination levels (e.g. 1-10 ppb,

10-100 ppb; greater than 100 ppb), since the field sampling at each tier 3 site will not be conducted in a random manner.

The Agency does have information on production for many tier 3 facilities and will be collecting additional data from questionnaires sent to all of the facilities in this tier. It is possible that these data will allow EPA to characterize contaminated and uncontaminated facilities in terms of certain variables, and it is hoped that these characterizations will assist in directing any further investigations beyond the national study which may be necessary for tier 3.

Implementation

The methodology used to accomplish these objective includes: 1) identifying formulated compounds containing 2,4,5-TCP and/or its derivatives, 2) identifying facilities that use these compounds in pesticide formulation, 3) selecting an appropriate number of facilities to sample so that results can be statistically extrapolated to all other facilities in tier 3, 4) identifying which locations to sample at each facility, 5) determining the type of samples to be collected (soils, fish, etc.), and 6) determining whether additional facilities should be selected for dioxin sampling.

Six additional pesticide formulation compounds have been identified to contain 2,4,5-TCP and/or its derivatives. They are 2,4,5-trichlorophenoxyacetic acid (2,4,5-T), silvex,

erbon, ronnel, hexachlorophene, and isobac 20. EPA has identified 583 facilities that potentially used these compounds or 2,4,5-TCP itself in the formulation of pesticide products:

- o 258 facilities were identified from the FIFRA and TSCA Enforcement System (FATES) which provides production levels for each facility for the years 1976-1981.

- o 325 facilities were identified from four other data sources: (1) the Office of Pesticide Programs Registration file, (2) a report entitled Dioxins (Ref. No. 3), (3) regional recommendations, and (4) those originally identified in tiers 1 and 2 but which were found to be formulation rather than production facilities of 2,4,5-T and its derivatives.

Fifty facilities were statistically selected for the initial sampling program from the FATES database of 258 such that an extrapolation could be made to all the pesticide formulators listed in FATES. If 10 percent of the facilities in tier 3 are found contaminated, then the 95 percent confidence interval for the percentage of all contaminated facilities in the FATES database is between two and 18 percent. Large production facilities were statistically represented in the sampling program by first ranking facilities according to production and then selecting a statistical sample of six facilities from the 31 largest. The

remaining 44 facilities were selected based on regional distriibution. This was accomplished by stratifying the facilities into six clusters and selecting an appropriate number based on calculated sampling weights for each cluster.

An additional 34 facilities were identified by the regions as being of particular interest and are also included in the initial sampling program. The results from these 34 facilities will not, however, be used in the extrapolation since they were not randomly selected.

The regional offices will send information request letters under CERCLA authority to each of the 84 facilities to be sampled to verify existing EPA records as well as to obtain additional information (e.g. quantities of waste generated, the disposal method, and location of disposal sites). A sampling plan will be developed by the regional offices for each site based upon the results of these information request letters and on reconnaisance site visits.

Site-specific sampling plans will identify the locations within each facility to sample, focusing on areas most likely to be potenitally contaminated with dioxin. These would include areas where potential spillage and leakage occurs (e.g. loading/unloading areas, storage areas, disposal areas, and stormwater drainage areas). The reason for following a directed sampling plan as opposed to a random one is the belief that only a small

portion of a site is likely to be contaminated and that one can make a reasonable judgement as to where that portion of the site is located. However, using a directed approach does preclude the ability to extrapolate to all of the facilities the levels of contamination found at the different sites.

At sites where the available information is inadequate to establish a directed sampling plan, a random sampling scheme may be developed as described in Section 12 of this document.

EPA also intends to obtain the Office of Management and Budget's (OMB) approval for a questionnaire to be sent to tier 3 facilities not included in the initial 84 to be sampled as well as to any other facilities identified by the Department of Defense as Agent Orange formulators. Responses to these questionnaires will be evaluated to determine if another list of candidate facilities should be created, from which a second set of tier 3 facilities may be selected for investigation. Our initial hypothesis is that most of the facilities not listed in the FATES database may have registered to handle one of the pesticides of concern but never actually handled the pesticides. The questionnaire responses will be used to evaluated that hypothesis. The Agency has not made any provisions for verifying the validity of the questionnaire responses.

The tier 3 investigation focuses only on formulation facilities and does not follow products through the distribution system

(i.e., warehouses, retailers, storerooms of commercial applicators) because of the lower potential for contamination and the limited resources.

7.2.2 TIER 5

Objectives

Tier 5 consists of those areas where pesticides derived from 2,4,5-trichlorophenol (2,4,5-TCP) were used or are being used. Ideally, an investigation for tier 5 would be designed to: 1) initially identify all uses and areas of potential pesticide use for all seven products of concern; 2) conduct a detailed investigation identifying all actual use areas and amounts used; and 3) select a probability sample of sites from the pesticide use population. From this type of study a determination could then be made identifying which particular uses result in detectable levels of dioxin, and subsequently, which uses might represent a human health risk.

However, the available information on uses of these pesticides is not comprehensive or detailed enough to allow this type of approach. Therefore, the tier 5 study will focus on those areas where extensive use of the pesticides 2,4,5-T and silvex has been documented. The rationale for limiting the scope to these pesticides is that, based on preliminary information from the Office of Pesticide Programs, these pesticides have been more heavily used and have a greater potential for human exposure

than the other five pesticides which are of lesser interest due to: (1) low levels of active ingredient pesticide in the end-products, (2) lack of use documentation, (3) use on very small areas, or (4) a wide diversity of uses at low levels of application. The study may include sampling at 2,4,5-TCP use sites (such as leather tanneries or wood preserving facilities) if adequate information can be developed on specific facilities which used this compound as a pesticide.

Implementation

Candidate sites for investigation are being compiled by headquarters and regional personnel working in conjunction with state or local agencies. Sites to be selected will include ones where the major continuing and/or extensive past use of 2,4,5-T and silvex have been documented (i.e., rice fields, sugarcane fields, rangelands, forests, rights-of-way, and recreational areas). The selected sites will be sampled to get a general characterization of each major use and will serve to determine if further investigation of a particular use is required.

Media to be sampled will include soils, stream sediments, fish tissue, vegetation, animal tissue, and/or any other appropriate media as determined by the responsible regional office. Sampling location and methods will follow the detailed protocols in the field guidance manual. Priority will be given to soil and sediment sampling since dioxin applied to an area by pesiticide use will

most likely reside in these media as a result of dioxin transport and fate processes (Ref. No. 4).

The number of soil samples to be collected will be between 24 and 48 discrete samples randomly distributed at each of approximately 20 tier 5 sites (see Section 12 of this document). These samples will be analyzed at the ppt level of detection. This approach results in a 70 - 90 percent level of confidence that dioxin will be detected if it is present at five percent of the area within the site. This approach assumes that one cannot identify "hot spots" within a site and that there is either a uniform or a random distribution of dioxin within the site. This assumption is based on the application methods for 2,4,5-T or silvex.

7.2.3 Tier 6

Objectives

Tier 6 consists of selected organic and pesticide manufacturing facilities where, under unusual or poorly controlled operating conditions, dioxin may or may have been created. The objectives for the tier 6 study are identical to those for tier 3; that is to determine the percentage of facilities which are contaminated at levels of concern and where possible, to characterize those facilities in terms of production variables.

Implementation

The methodology used to accomplish this objective includes: 1) identifying those commercially significant organic and pesticide

compounds where improper quality control on production processes could result in the formation of 2378-TCDD contaminated products, 2) identifying facilities that manufacture these compounds, 3) selecting an appropriate number of facilities so that results can be statistically extrapolated to other facilities, 4) identifying locations to sample at each facility, 5) determining the type of samples to be collected (soils, fish, etc.), and 6) determining whether additional facilities should be selected for dioxin sampling.

Dioxins (Ref. No. 3) identified organic and pesticide compounds (totaling 125) whose production could inadvertently create dioxin based on their molecular structure, process sequence and commercial significance. The production of only 60 of these compounds could potentially lead to 2378-TCDD formation. Dioxins (Ref. No. 3) defined commercially significant products as those produced in quantities in excess of 1,000 pounds per year and/or wholesales reaching $1000 per year. Most of the organic chemicals identified are used as manufacturing intermediates.

EPA identified 60 facilities that manufacture these 60 compounds using four sources of information: (1) the SRI Directory of Chemical Producers (1977-1983), (2) FIFRA and TSCA Enforcement System (FATES), (3) the Dioxins report (Ref. No. 3), and (4) regional suggestions.

Nineteen facilities were statistically selected for the initial sampling program based on regional distribution so that extrapo-

lation could be made to all these manufacturing facilities. This selection was accomplished by stratifying the facilities into five clusters and selecting an appropriate number based on calculated sampling weights for each cluster. If 10 percent of facilities in tier 6 are found contaminated, then the 95 percent confidence interval for all contaminated tier 6 facilities is between zero and 23 percent.

Information collection and field sampling procedures (including the number and allocation of soil samples) for tier 6 facilities will be identical for those used for tier 3 facilities. Particular attention will be given to reported production levels, which for the organics are not currently available.

Tier 6 focuses only on production facilities as a potential source of dioxin release into the environment. The potential for dioxin contamination from these products at distribution facilities (i.e. warehouses, applicators and retail stores) is not expected to be significant and sampling at these facilities is not included as part of this tier.

7.2.4 TIER 7

Objectives

Tier 7 consists of areas other than those where known or suspected sources of 2378-TCDD contamination are located. The basic goal of the tier 7 study is to evaluate the extent and severity of 2378-TCDD contamination in the environment. In addressing this goal, the study will focus on contamination of soil and fish

tissue since these are the media which present the greatest potential exposure to humans. Also, 2378-TCDD tends to adsorb strongly to soil particles and to bioaccumulate in fish tissue.

Specific objectives of the tier 7 study are to: 1) determine the percentage of sites in the EPA Urban and Rural Soil Networks which have measurable levels of 2378-TCDD in in soil and 2) determine the percentage of sites in the U.S. Geological Survey's National Stream Quality Accounting Network (NASQAN) which have measurable levels of 2378-TCDD in fish tissue. If 2378-TCDD is detected at a significant number of locations, the Agency will attempt to determine what typical "background" levels are and whether they are related to specific variables describing the different sites. All tier 7 analyses - both fish and soil - will be done at approximately the part per trillion (ppt) level of detection.

Implementation

Tier 7 consists of two phases: 1) a soil sampling survey, and 2) a fish screening survey. Soils were selected for sampling since dioxin reaching the soil will be strongly sorbed; biodegradability, plant uptake, and leaching are not believed to be important fate processes (Ref. No. 3). Photodegradation is limited to a near-surface phenomenon, and dioxin transport in many cases is due to erosion of contaminated soil which is transported to the water environment. Dioxin enters the atmosphere adsorbed to particulates, and that which is not photodegraded is subsequently deposited. As a result of these fate processes,

soil is an appropriate and informative medium to sample in determining background levels of dioxin.

Soil sampling will be accomplished through use of the Office of Pesticides Program National Soils Monitoring Program (NSMP). The objectives of this program are to monitor for the presence of pesticide residues in urban and rural soils and to determine trends of levels through time (RTI; Ref. No. 5). (Refer to the National Soil Monitoring Program (RTI; Ref. No. 5) and Urban Soils Monitoring Program (RTI; Ref. No. 6) for a complete description of the network designs.) The rural network consists of over 13,000 sites and is a valid probability sample of sites from the 1967 Conservation Needs Inventory (CNI) of rural land areas in the conterminous United States. Sample design, field sampling procedures, site identification, and other protocols are already in place. For tier 7 sample selection, the network has been ordered by EPA regions and states. Five systematic samples of equal size (40) were randomly selected to yield 200 sample sites from which various estimates of soil contamination can be made describing the population of soils of the rural network. If 10 percent of the sites are found contaminated, then the 95 percent confidence interval for all contaminated sites in the network is between seven and 13 percent.

Although the rural network is a valid subsample of the CNI, no valid structure exists to provide the basis for analyzing the CNI, and therefore, the rural network data, except through arti-

ficial methods. Other restrictions in using the rural network are: 1) sample numbers vary considerably from state to state such that reliable estimates of average levels will not be available for some geographic areas and 2) the CNI database is 17 years old, and a number of locations may have changed characteristics.

Three hundred soil sites have been selected from the 20 Standard Statistical Metropolian Areas (SMSAs) monitored in the urban soil network. If 10 percent of the sites are found contaminated, then the 95 percent confidence interval for all contaminated sites in the network is between eight and 12 percent. SMSAs were ordered by EPA regions and states, and five random systematic samples of 60 sites each were selected. In addition to the selected sites, soil samples may be taken at one industrial site in each SMSA; these sites will be selected by regional personnel. Sampling will follow protocols summarized in Section 12 of this document and detailed in the field guidance manual.

Fish are known to bioaccumulate many compounds, including dioxin, to much higher levels than surrounding waters. In addition, fish represent a direct route for human uptake via ingestion. In estuarine and coastal areas, mussels or oysters will be collected to determine background levels. Similar to fish, shellfish are known bioaccumulators and represent a direct route for human exposure through consumption. Although depuration tends to be more rapid in shellfish than in finfish, the migratory behavior of most marine fish may not reflect the actual conditions of the

collection site, thereby making shellfish preferred specimens to collect to meet tier 7 objectives in coastal areas. As with soils, sampling will follow procedures summarized in Section 12 of this document and detailed in the field guidance manual.

Sampling protocols call for collecting specimens of bottom-feeding and game fishes in freshwaters and mussels or oysters in estuarine and coastal waters. Methods specified serve to limit variables reducing the difficulty in interpreting the data. These include establishing target species (to reduce interspecific variations), sampling fish of similar age where possible, and limiting time of sampling to reduce seasonally-related differences (e.g., lipid content). Composite samples of whole bottom-feeding fish, whole game or commercial fish, bottom-feeding fish fillets, and game or commercial fish fillets will be collected. The bottom-feeding whole fish composite will be analyzed first, and if contamination is detected, the other samples will then be analyzed.

As in the case of the soils survey for tier 7, sample design for fish sampling also utilizes existing monitoring networks - specifically the U.S. Geological Survey's National Stream Quality Accounting Network and Benchmark Network. One hundred stations were statistically selected so that the results could be extrapolated to the combined networks. If 10 percent of the sites are found contaminated, then the 95 percent confidence interval for all contaminated sites in the network is between five and 15 per-

cent. Replicate samples will be collected at 25 of these sites in order to estimate the variability at a site. In addition, 315 sites were purposively selected from the networks and from additional locations of regional or national interest. These additional sites represent locations of interest because of nearby population centers, commercial or recreational fishing activity, and availablity of relevant water quality information.

7.3 Monitoring Parameters and Their Frequency of Collection

1. 2,3,7,8-Tetrachlorodibenzo-p-dioxin (2378-TCDD).

This parameter will be measured in all samples which are collected as part of the study. Media collected will include surface water, groundwater, sediment, soil, aquatic orgnisms, and terrestrial specimens. The frequency of collection will be defined in the individual regional site specific plans. It is estimated that samples will be analyzed at the rate of 100 to 150 per month using the EPA Analytical Troika; the rate using the CLP will be somewhat higher.

2. Polychlorinated Dibenzo-p-dioxins (PCDDs) and Polychlorinated Dibenzofurans (PCDFs).

The extent and frequency of these measurements have not been determined. The following groups of isomers are being considered:

Group	Number of Isomers
Tetrachlorodibenzo-p-dioxin	22*
Pentachlorodibenzo-p-dioxin	14
Hexachlorodibenzo-p-dioxin	10
Heptachlorodibenzo-p-dioxin	2
Octachlorodibenzo-p-dioxin	1
Tetrachlorodibenzofuran	38
Pentachlorodibenzofuran	28
Hexachlorodibenzofuran	16
Heptachlorodibenzofuran	4
Octachlorodibenzofuran	1

* Includes 2378-TCDD

The identification of specific isomers within each group depends on the availability of analytical standards and the ability of the selected chromatography columns to resolve isomers. Most determinations will be non-isomer specific (i.e., total tetrachlorodibenzofurans, etc.) and semiquantitative (because analytical standards are not available, the concentrations are estimates).

3. Percent Lipids

OWRS will decide if lipid content of fish will be determined by the Troika depending on the levels of dioxin found and the percentage of fish contaminated. If necessary, the lipid content of each contaminated fish and a representative subsample of uncontaminated fish will be determined.

4. Percent Moisture

The moisture content of all soils and sediments measured at the ppt level will be determined by Troika; the results will be reported on a dry weight basis.

5. Fish Aging

ERL-Duluth will remove and store scale and otolith specimens of each whole bottom-feeding fish sample. Depending on the levels of dioxin found and the percentage of fish found contaminated, OWRS will decide if fish age will be estimated. If aging is necessary, each contaminated fish and a representative subsample of uncontaminated fish will be aged.

6. Determination of weight, size, and species of aquatic organisms and terrestial animals.

Each region will have the responsibility for determining the weight, size, and species for all aquatic organisms and terrestrial animals.

TABLE 1 - PARAMETER TABLE

Parameter	Number of Samples (Estimate)	Sample Matrix	Method Reference	Sample Preservation	Holding Time
2,3,7,8-TCDD	Unknown	Water	7	4°C/Dark	7 days - Extraction 40 days - Analysis
2,3,7,8-TCDD	3800-7400	Soil/Sediment	7,8	4°C/Dark	Same
2,3,7,8-TCDD	600	Fish	7	Freeze/Dark	Indefinite
PCDDs/PCDFs	Unknown	All	7	Same as for TCDD	Same as for TCDD
Lipid	Unknown	Fish	7	Freeze/Dark	(Undetermined) (Undetermined)
Moisture	980-1460	Soil/Sediment	7	4°C/Dark	(To be performed at time of chemical analyses)
Speciation/ Weight/Size	600	Fish	9	None	Indefinite
Aging	Unknown	Fish	9	Freeze/Dark	Indefinite

8.0 Financial Information

The following resources have been earmarked for the National Dioxin Study. They are funded in the Water Quality Monitoring and Analysis program element (53B2F) of EPA's budget.

	Current Operating Plan FY 1984		President's Budget Request FY 1985	
	FTE	AC&C $(000)	FTE	AC&C $(000)
Headquarters				
OWRS (Program office) (AH28)		385.0	5.5[a]	3400.0[e,f]
ORD/OEPER (Troika) (AH63)		835.0		
ORD/OMTS (Troika) (AH60)		50.0		
OPP (Troika) (AH32)		350.0		
Agency reserved (AH92)		165.0		
OAQPS (Tier 4 work) (AH53)		715.0		
Hqs Total	0	2500.0	5.5	3400.0
Regions				
Region 1	1.0	75.0	1.0	
2	1.0	175.0	1.0	
3	1.0	125.0	1.0	
4	1.4	200.0	1.4	
5	1.4	250.0	1.4	
6	1.3	200.0	1.3	
7	1.4	200.0	1.4	
8	.5	75.0	.5	
9	.5	100.0	.5	
10	.5	100.0	.5	
Reg. Total	10.0[b]	1500.0	10.0[b]	0
Total EPA	10.0[c]	4000.0	15.5	3400.0

Footnotes:

a Sources of Headquarters FTE estimates are:

FY84 -- EPA's Budget Request to OMB for FY85 (Form BUD-2), September 1983. FY85 -- OWRS Budget Plans, February 27, 1984.

b Source of Regional FTE estimates is Regional Workload Model for Water Quality Monitoring and Analysis, February 16, 1984.

c Note that many EPA offices are contributing efforts toward the National Dioxin Study which are not reflected in these estimates, since these estimates were made prior to actual initiation of the study.

d $165,000 is being held in Agency reserve in exchange for $165,000 in Salaries and Expenses funds allocated by the Comptroller's office to:

OPP	(AH32)	139,000
OEPER	(AH63)	26,000

e In addition to the $3.4 million, OW has earmarked $250,000 for study of persistent and bioaccumulative pollutants in the FY85 President's Budget request.

f Some portion of these funds will be allocated to other Headquarters offices and to the Regions in FY85.

Abbreviations:

AC&C Abatement Control and Compliances appropriation, commonly referred to as "extramural."

AH Allowance Holder number.

FTE "Full Time Equivalent" employees.

9.0 Schedule of Tasks and Projects

The major items needed for completion of the National Dioxin Study for tiers 3,5,6 and 7 are:

1. Overall regional plan will be prepared and will include: a brief organizational section; information on how the region will arrange sampling in each of the tiers; a plan for using all extramural funds; and a tentative schedule for sampling. Due by June 1, 1984.

2. Site-specific sampling plans will be prepared by each region. These plans will include: information on sampling site location (including latitude/longitude); site sampling plan with discussion of rationale; and site-specific safety and community relations issues. These plans will be submitted to OWRS for review prior to sampling.

3. Review and approval of site-specific plans occurs before the region does any sampling at a site. Site-specific plans for tiers 3 and 6 are due by July 29, 1984 (or sooner) for sites to be sampled in FY 84. Site-specific plans for tier 5 are due by June 30, 1984 (or sooner) for sites to be sampled in FY 84 and and due by June 30, 1985 (or sooner) for sites to be sampled in FY 85.

4. Samples are collected and shipped over a period of time arranged with the Sample Control Center and in-tune with Troika capacity.

5. All National Dioxin Study sites for tiers 3, 5, 6, and 7 are finalized prior to site-specific plan submittal deadline.

6. A certification and audit program for Contract Labs is developed and implemented by EMSL-LV.

7. In December, 1984, OWRS will prepare an interim report describing the status of the study and presenting any results available at that time.

8. OWRS will prepare a final report on the results of the study by December, 1985.

10.0 Project Organization and Responsibility

The following is a list of key study personnel and their corresponding responsibilities.

National Dioxin Study responsibility: Steven Schatzow, Director, OWRS

Dioxin Management Task Force Chairman: Michael Cook, OSWER

Project Director: Alec McBride, OWRS/MDSD

Assistant Project Director: Michael Slimak, OWRS/MDSD

Troika Laboratory Director: Norbert Jaworski, ERL, Duluth

Contract Laboratory Coordination: Stan Kovell, OSWER

Field Sampling Plan Review: Alec McBride, OWRS/MDSD

Quality Assurance Officer: Martin W. Brossman, OWRS

Quality Assurance Task Group:
Martin Brossman, OWRS/OW
Richard Spear, Region II
Gerald McKenna, Region II
James Adams, Region V
Marsha Kuehl, Region V
Charles Hensley, Region VII
Robert Kleopfer, Region VII
Michael Dellarco, QAMS/ORD

Data Management: Alec McBride (STORET)

Laboratory Audit Team (Troika): Two or three members to be designated by the Quality Assurance Task Group

Field Audit Team: Regional QAO with selected support

Data Review and Validation (Total): Alec McBride

Peer Review (Concepts and Reports): To be determined by the Dioxin Management Task Force

National Dioxin Study Regional Coordinators -

Region I	-	Bill Walsh
Region II	-	Rick Spear
Region III	-	John Ruggero
Region IV	-	Rebecca Slack
Region V	-	Howard Zar
Region VI	-	Dave Parrish
Region VII	-	Billy Fairless
Region VIII	-	Bill Geise
Region IX	-	Kathleen Shimmin
Region X	-	Ben Eusebio

11.0 Data Quality Requirements and Assessments

Table 1 summarizes the expected quality of the data in terms of precision, accuracy, and detection limits. Specific details are given in the individual analytical procedures (Ref. Nos. 7 & 8). For purposes of controlling data quality, a sample set consists of the following:

TROIKA	CLP
12 Environmental Samples[a]	20 Environmental Samples
1 Matrix Spike[d]	1 Matrix Spike[b]
1 Performance Sample[e]	1 Performance Sample[c]
1 Method Blank[d]	1 Method Blank[d]
1 Field Blank[e]	1 Field Blank[e]
	1 Field Duplicate[a]

a = Including any field replicates needed
b = Provided by Regions
c = Provided by SMO (through EMSL-LV)
d = Responsibility of laboratory
e = Provided by Regions (through Headquarters) for soils

The data quality of a given set of samples is assessed in relation to the following criteria:

1. Daily verification of isomer specificity.
2. Daily verification of response factor.
3. Qualitative criteria (isotope ratios and retention times) for all positives.
4. All blanks and method blanks must be clean.
5. Performance sample must meet criteria (See Table 2).
6. Spiked sample must meet criteria (See Table 2).
7. For the CLP, the surrogate must be measured to ± 40% in every sample; for the Troika, the internal standard must be recovered to a prescribed percentage.

8. For the Troika effort, one complete set will be split with a contract lab on a quarterly schedule. The specific samples will be selected by Troika.

TABLE 2

Quality Control Summary for 2378-TCDD Measurements

Matrix/Lab	Target Detection Limit	Accuracy	Precision
Soil/CLP	1.0 ppb	50-150%	≤25%
Ambient Water/TROIKA	0.03 ppt	70-130%	<30% or ± D.L.
Soil/TROIKA	1.1 ppt	70-130%	<30% or ± D.L.
Fish/TROIKA	1.0 ppt	70-130%	<30% or ± D.L.
Animal Tissue/TROIKA	1.0 ppt	70-130%	<30% or ± D.L.
Plants/TROIKA	Unknown (5 ppt)	70-130%	<30% or ± D.L.
Wastewater/TROIKA	Unknown (5 ppt)	70-130%	<30% or ± D.L.

ppb = parts per billion

ppt = parts per trillion

11.1 Data Comparability

Measures taken to ensure comparability of analytical work performed by different laboratories include the following:

- Standardized written sampling and analytical procedures.
- Standardized field and compatable analytical data forms, sample identification tags, and chain-of-custody.
- All CLP laboratories will use the same certified standard solution of 2378-TCDD as provided by EMSL-Las Vegas for preparation of all calibration standards. The Troika labs will use a primary analytical standard which has been referenced to the EMSL-Las Vegas standard as well as other verified standards.
- All laboratories will be provided with performance evaluation samples on a regular basis. The Troika labs will also analyze method evaluation samples, periodically throughout the study.
- Standard handling and shipping procedures for all collected samples.
- Replicate analyses will be done on samples in order to evaluate both within and between-laboratory precision.
- A uniform supply of sampling containers will be utilized.
- The results for performance evaluation samples and inter-laboratory duplicate analyses will be the primary means for

verifying the comparability of data within a single laboratory. The Troika QC results will also be used to evaluate method performance.

11.2 Data Representativeness

See Sections 7.0 and 12.0 for a discussion of data representativeness for each tier.

11.3 Data Completeness

The target for completeness of the data in order to meet the project needs is 80%, and the measure to be used in meeting this target is the percent of total reported data classified as valid in the data validation process.

12.0 Sampling Procedures

12.1 Tiers 3 & 6

At most facilities the majority, if not all, samples taken will be soil samples. Where there is a water body near the facility, stream sediment and/or fish tissue samples may be taken. A discussion for sampling soil follows; sampling sediments is discussed under tier 5 (Section 12.2) and sampling fish is discussed under tier 7 (Section 12.3).

Discrete soil samples will be collected at a depth of 3 inches using a two inch diameter tulip bulb planter and can be taken anytime as long as the soil is not frozen. The quantity of soil (excluding rocks, bottle caps, etc.) should be sufficient

to fill a square mason jar one-half full, which OWRS will provide for all sampling crews. Sample handling, preservation, and transport are to follow the protocols set forth in the sampling guidance manual.

Sampling crews are responsible for sending to the appropriate laboratory, in addition to the soil samples from the site, one soil performance sample and one soil field blank per sample set (as defined under Section 11.0). Sample kits sent to the regions will contain the standard reference soils to be included in the set.

The number of environmental samples to be collected at each facility will be between 24 and 48, depending on the size and complexity of the facility. The sampling locations will be based primarily on likelihood of contamination as discussed in Section 7.0. The regions may choose to allocate some samples in a random manner over all or part of the site. In addition, if the region does not have adequate information to identify locations more likely to be contaminated, it may decide to follow a random sampling approach for the entire site.

A random sampling approach consists initially of dividing the facility area into equal size grids with dimensions not exceeding 50 feet by 50 feet. Samples are collected within randomly selected grids (directly in the center of the grid). Grids that contain potential areas of contamination and those that contain buildings are excluded from the random selection

process. For a site which is sampled in a completely random manner, if five percent of the site is contaminated, this sampling approach provides a 70 percent confidence level of detecting contamination with 24 samples and a 90 percent confidence level of detecting contamination with 48 samples.

12.2 Tier 5

Although sampling at tier 5 sites may include several environmental media, priority will be given to soil and sediment sampling since dioxin applied to an area by pesticide use will most likely reside in these media.

Discrete soil samples will be collected using identical methods as in tier 3. Also, appropriate standard reference soils will be included in each sample set (as defined under Section 11.0) for shipment to the laboratory.

Specific sampling methodologies for sediments depend on the nature of material to be collected, depth of water above the sediment, sampling location, and equipment availability. Methods will be determined by responsible regional personnel.

While sampling sediments for 2378-TCDD, it is important not to disturb the top layers of sediment and to minimize loss during sampling. Therefore, scoops and drag buckets are not considered for use as sampling devices. In wadeable waters, the direct use of a Teflon core liner is preferred. Core liners are to serve as sample containers for shipment, thereby eliminating the need

for time consuming extrusions in the field. In waters of greater depth, Ekman or Ponar grab samples are preferred. After retrieval, the sample is to be subsampled with Teflon coring tubes. In terms of volume, 500 grams of sediment is the minimum sample mass to be collected. Sample handling, preservation, and transport are to follow the protocols set forth in the sampling guidance manual.

The number of soil samples to be collected at each site will be between 24 and 48, and the sample collection locations will be identified following the random sampling approach described for tier 3 and 6 sites. Sediment samples will be collected along equally - spaced points on sampling transects.

12.3 Tier 7

Fish samples (both bottom-feeders and game fish) are to be taken at freshwater sites; shellfish samples only are to be taken at estuarine and marine sites.

Enough fish of the same species are to be collected at each site to allow for a minimum sample mass of 500 grams for each of the following four separate samples: one composite of whole bottom-feeding fish, one composite of bottom-feeding fish fillet, one composite of whole game fish, and one composite of game fish fillet.

Target species have been established to reduce interspecific variability. Target species for bottom-feeding fish, in order

of preference, are carp (Cyprinus carpio), white sucker (Catastomus commersoni), and channel catfish (Ictalurus punctatus). Only one species per site is to be collected. Target species for game fish will be selected by responsible regional or state personnel. Several characteristics for selecting the target species are: wide ranging, non-migratory, foodfish, and abundant. (Cyprinids and salmonids are preferred.)

Collection of fish specimens of similar age class (two or greater) and limiting collection to non-spawning periods (such as early fall) are required to reduce seasonally-related differences. Each fish is to be wrapped in foil and placed in a plastic bag and properly labeled for type of analysis (whole or fillet). All filleting will be done in the laboratory.

Target species for estuarine and marine sites are the bivalves Crassostrea virginica (Eastern oyster), Mytilus californianus and M. edulis (commom blue mussel). The minimum sample mass (per species) is 500 grams of tissue (excluding shell). Bivalves should be individually wrapped in foil and placed in a plastic bag for each site.

Specific sampling methodologies for fish and shellfish depend primarily on water conditions, target species for collection, and avaliable equipment. Methods will be determined by appropriate regional and field personnel. Regardless of the method employed, a rapid collection technique is to be employed as not to cause

prolonged stress on the organism; in most cases, therefore, active collection techniques are preferred.

Soil collection techniques at rural and urban sites are identical to those previously described for tier 3 (e.g., tulip bulb planter, 3-inch deep core, 50' x 50' grid, number of performance samples and field blanks, etc.). At designated sampling sites for urban sampling, one discrete sample will be taken at the mid-point of the site. At designated rural 10-acre sites, the area will be divided into equal sized grids from which one will be randomly selected. One discrete soil sample will be collected at the mid-point of the grid.

Sample handling, preservation, and transport are to follow the protocols set forth in the sampling guidance manual.

13.0 Sample Custody Procedures

Sample Control procedures will be in strict conformance with those procedures provided in the Sampling Guidance Manual for the National Dioxin Study (Ref. No. 9) The figure shown below is a flow chart of sample control to be used in the study.

NEIC chain of custory procedures will be followed for all tiers of the National Dioxin Study. Required chain of custody forms will be provided through the Sample Control Center.

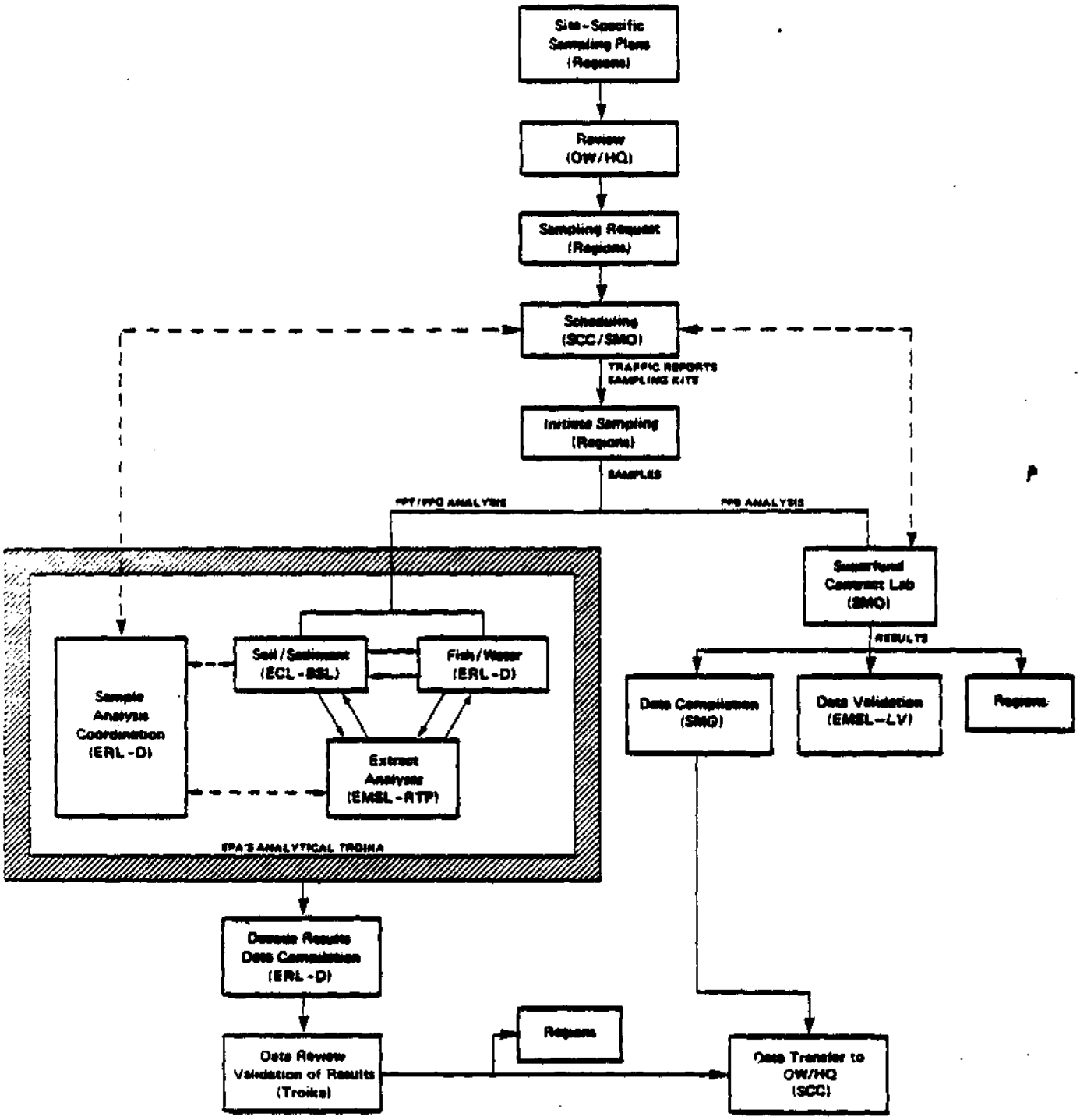

Figure 1 - NATIONAL DIOXIN STUDY, TIERS 1 THROUGH 7 - SAMPLE COLLECTION AND ANALYSIS

14.0 Calibration Procedures and Preventive Maintenance

Calibration and maintenance of field equipment is contained in the Sampling Guidance Manual for the National Dioxin Study (Ref. No. 9). Analytical instrumentation calibration and maintenance procedures are included as part of the Analytical Procedures and Quality Assurance Plan for the National Dioxin Study (Ref. No. 7).

In addition to the referenced SOP's above, each site sampling should be documented in a bound field logbook. This logbook should delineate the exact type and frequencey of field equipment calibration, cleaning and maintenance. All repairs made during the course of the sampling should also be noted. Specific model or serial numbers of all equipment used should be listed, along with the lot or batch numbers of all reagents used to treat or clean any equipment in contact with the samples.

15.0 Documentation, Data Reduction, and Reporting

Documentation, data reduction, and reporting will be in strict conformance with the protocols specified in references 7 and 8. All data will be entered into the STORET system. The data quality will be described in quarterly reports prepared by the Water Quality Analysis Branch.

16.0 Validation

Data will be validated according to procedures specified in references 7 and 8. The data will be coded either valid or invalid depending on adherence to the specified quality control

criteria. The CLP data is anticipated to be reviewed and validated by EMSL-LV, concurrent with reporting to the regions. The Troika data will be reviewed and validated internally (by Troika) and also independently (by contractor) prior to reporting to the regions. The regions are responsible for reviewing the data for reasonablenes based on a knowledge of the site characteristics and the specific locations of individual samples. Any disagreements between the reporting lab and the regional reviews will be resolved by the Quality Assurance Task Force.

17.0 Performance and System Audits

Throughout the National Dioxin Study, audits will be conducted by EPA personnel.

17.1 System Audits

The systems audit consists of an on-site visit to contractor analytical labs by EMSL-LV for the purpose of evaluating laboratory operations and quality control procedures. These site visits to contract laboratories should be made prior to the reception of samples, and periodically during active analytical work. EMSL-LV (Ref. No. 10) gives the Standard Operting Procedure (#QAD1) to be used for the on-site laboratory evaluations.

An audit team consisting of 2 to 3 persons designated by the Quality Assurance Task Force will perform on-site audits of the three Troika laboratories to assess the laboratory operations in

regard to implementation of this quality assurance plan. These audits will be performed at least once a year.

The regional QAO and selected support will perform field audits at least once a year.

17.2 Performance Audits

Performance audits will consist of the analysis of performance evaluation samples supplied to contract laboratories, and in the evaluation of the corresponding analytical results by EMSL-LV. Initially, the laboratory must demonstrate their ability to analyze for 2378-TCDD. EPA will provide to each analytical laboratory two performance evaluation samples. Results of these performance evaluation samples must be determined to be within acceptable limits before a laboratory is permitted to analyze any samples. Contracted laboratories will be required to analyze performance evaluation samples on a periodic basis as a continuing check on performance.

The Troika will also analyze performance evaluation samples with each set of samples. In addition, once per quarter, Troika will select a complete set of samples to be analyzed by a qualified independent lab. The results will be compared and any significant differences will be resolved before other analyses are resumed.

17.3 Deficiencies

Any deficiencies or unacceptable performance noted in the audits will be relayed immediately to the persons responsible. A deadline

for a plan of corrective action and its successful completion will be given. Documentation of corrective action will be required in the form of a follow-up on-site audit or performance evaluation sample.

18.0 Corrective Action

Identifying, correcting, and documenting quality control problems are the most crucial parts of a Quality Assurance Project Plan. Two systems for dealing with corrective action are needed. The technical or analytical trigger points for corrective action are defined in the "Analytical Protocols and Quality Assurance for the National Dioxin Study" (Ref. No. 7). Administrative quality control lapses require a different scheme.

Three operational areas of the plan could trigger the need for corrective action initiating from the administrative level: field sample collection, document control and the data validation processes. When a "defect" or deviation from the QA Project Plan occurs in one of these areas, the following must occur:

1. Responsible person for the problem area as outlined in Project Organization and Responsibility must document the deviation/defect discovered.

2. This documentation must include:
   - Date and time deviation/defect noted
   - Date deviation/defect documented
   - Suspected cause of deviation/defect

- Proposed sequence of action to correct defect
- Person(s) responsible for carrying out corrective action
- Date action completed
- Follow-up dates on effectiveness of action
- Final approval of action by responsible person

3. All such documented deviations/defects should be readily accesible to the on-site audit teams to verify that an effective and timely corrective action system is operational.

19.0 Reports

A series of reports and documents have been prepared which provide background information and on-going guidance for the National Dioxin Study.

The Dioxin Strategy published on November 28, 1983, covers the total agency effort on dioxin including the National Dioxin Study.

The National Dioxin Study Work Plan of January 15, 1984 (Ref. No. 11), assigned to the regions the responsibility for developing sampling plans. The work plan included a tentative list of sites to be studied and underwent revision in a February 24, 1984 package. This list, with minor changes, contains the sites to be sampled exclusive of tier 5 sites. Tier 5 sites are to be selected by June 1, 1984 by the regions with approval by OWRS.

This Project Plan serves as the Quality Assurance Project Plan for the National Dioxin Study and provides an overview of the

entire study. It also serves as a integrated description of requirements in the field (Ref. No. 9) and laboratory (Ref. Nos. 7 and 8). The document provides specific QA guidance to the regions.

Two types of regional plans are required; each region will provide an overall work plan and a series of site-specific plans.

Contents of the regional work plan are to include: (1) a brief organizational section; (2) a tentative schedule for sampling at tiers 3, 5, 6, and 7; (3) a plan for using all the extramural funds; (4) arrangements (e.g., ESD, FIT, contractor, states, etc.) for sampling within each tier; and (5) a tier 7 sampling plan. Regional work plans are due to Headquarters on June 1, 1984.

A site-specific plan is required for each site in tiers 3, 5, and 6 from each region. Headquarters must review and give approval for each site plan. Site-specific plans for tiers 3 and 6 are due by July 29, 1984 (or sooner) for sites to be sampled in FY 84. Site-specific plans for tier 5 are due by June 1, 1984 (or sooner) for sites to be sampled in FY 84. Sampling is not to be initiated until the site-specific plans have been approved. A thorough physical description of the site, description of sampling and a statement concerning safety and community relations is to be included in the site-specific plan.

The following details should be included in the physical description of the site: (1) name/address; (2) maps that include

latitude/longitude; (3) reconnaisance information; (4) copies of the questionnaires, (5) applicable permit numbers and (6) any other additional information.

The description of sampling should include: (1) location of actual sampling sites; (2) types of samples (media); (3) number of samples by media; (4) techniques used for representativeness (e.g., grids, random selection, etc.); (5) methods for sample collection; (6) safety procedures to be used and (7) tentative schedules.

OWRS will be responsible for evaluating and analyzing the results of the study on a continuing basis. The major focus of analysis will be on assessing the extent and severity of contamination in each of the tiers and across tiers. In December, 1984, OWRS will issue an interim report describing the status of the study and presenting any results available at the time.

Regional write-ups on the sampling results at sites in tiers 3,5, and 6 are due to Headquarters as the results come in.

OWRS will prepare a final report on the results of the study by December, 1985.

REFERENCES

1. "Dioxin Strategy", Office of Water Regulations and Standards and the Office of Solid Waste and Emergency Response, EPA, November 28, 1983.

2. "Office of Water Work/QA Plan Guidance", Office of Water Regulations and Standards, QA-1, 1983.

3. Esposito, M.P., T.O.Tiernan, and F.E. Dryden. 1980. Dioxins. U.S. EPA - 600/2-80-197.

4. U.S. EPA. 1980. An exposure and risk assessment for 2378 Tetrachlorodibenzo-p-dioxin. Interim draft. Washington, D.C.

5. "National Soil Monitoring Program", Research Triangle Institute, RTI No. 1964/14/03-01I, March 1981.

6. "National Soil Monitoring Program: Urban Soils Monitoring Network", Research Triangle Institute, RTI No. 1864/14/03-02I.

7. "Analytical Procedures and Quality Assurance Plan for the National Dioxin Study", EMSL-RTP/ECL- Bay St. Louis/ERL-Duluth, January 1984.

8. EPA Contract Lab Program, Dioxin IFB #WA84-A002, January 1984.

9. "Sampling Guidance Manual for the National Dioxin Study", Office of Water Regulations and Standards, February 27, 1984.

10. Standard Operating Procedures, EMSL-LV, 1984.

11. "National Dioxin Study Work Plan", Office of Water Regulations and Standards, U.S. EPA, January 15, 1984.