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DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR THE SAFE COLLECTION, TRANSPORTATION AND FINAL DISPOSAL OF U.S. DEPARTMENT OF DEFENSE STOCKS OF DDT

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3. Summary

This is a generic Environmental Impact Statement for the preparation of specifications for the safe collection, transportation, and final disposal of Department of Defense DDT stocks. These stocks, which include 240,662 gallons of liquid and 210,311 pounds of powder, are located at 79 military depots in 34 states, Puerto Rico, Guam, and three foreign countries. These specifications will define the requirements for the handling of DDT during the aforementioned phases. Disposal methods to be permitted under these specifications are ocean incineration and on-land incineration as well as secure landfill and return to the manufacturer of DDT under certain circumstances.

4. Comments on this draft must be received by ____________________.

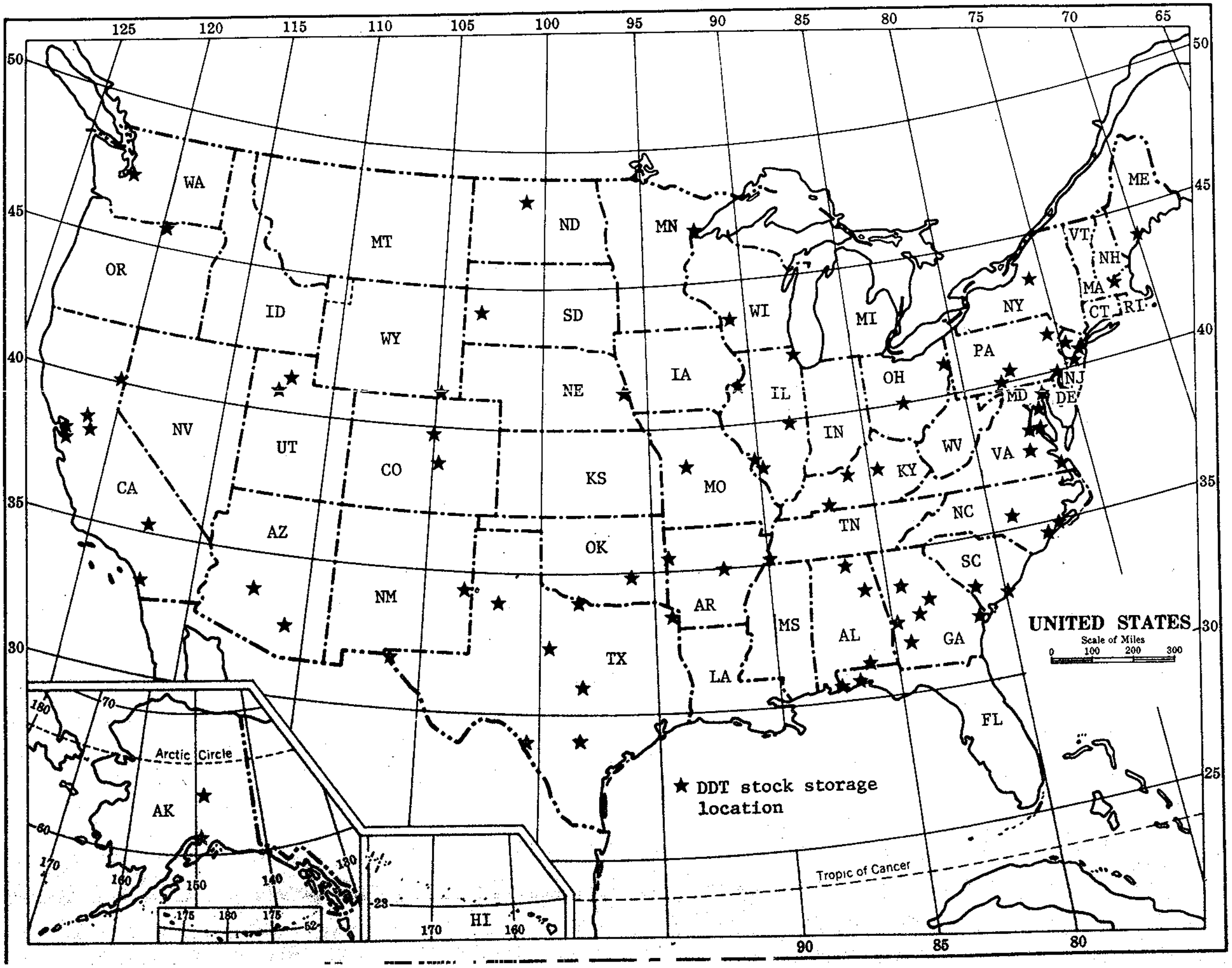
I. SUMMARY

1. Dichloro-diphenyl-trichloroethane (DDT) was a commonly used pesticide that was banned for general use in the United States in 1972. At that time the armed services held large stocks of DDT that became surplus. The Defense Property Disposal Service (DPDS) has been assigned to dispose of all Department of Defense (DoD) surplus material, including hazardous material. DPDS proposes to prepare specifications for the safe disposal of DoD DDT stocks worldwide, which includes 240,662 gallons of liquid, 210,331 pounds of powder, and 62,258 aerosol cans and pressurized containers. These stocks are in 38 different formulations varying from 2% to 100% concentration. They are currently located at 79 military depots in 34 states, Puerto Rico, Germany, Italy, Japan, and Guam. The location of these stocks in the U.S. is shown in Figure I.1-1.

2. It is proposed that performance specifications be prepared to cover the collection, transportation, and disposal of this DDT by private contractors in a safe and environmentally sound manner. This Draft Environmental Impact Statement (Draft EIS) analyzes alternative means of handling these stocks and defines those considered environmentally satisfactory, including any necessary special restrictions. As DPDS does not have control over DDT stocks overseas this EIS only considers stocks from their entry into the U.S. Overseas commands have the option of either returning their stocks to the U.S. for disposal, or disposing of them locally in accordance with the laws of the host country. It is proposed to issue specifications to limit the methods of collection, transport, and disposal. The preferred alternative, which is the issuance of these specifications, will therefore encompass all of these allowable methods.

3. There are two alternative means of collection: in bulk or in containers. It is expected that these two means will be used in combination. The stocks are currently stored in containers varying in size from 2 ounce "spice boxes" to 85 gallon drums. Bulk loading into tankers is only suitable for liquids. In this case, the liquid formulations would be vacuumed out of their existing containers and pumped into road tankers or rail tank cars. The containers would then be triple rinsed and disposed of by landfill or remelting as scrap steel. The rinsate would be disposed of together with the liquid DDT. As long as precautions are taken to contain any spills during loading, as would be specified, no potential impacts are foreseen from this operation. If the DDT is shipped in containers, it may be shipped in existing containers, repacked into new containers, or "overpacked" by placing existing

Figure I.1-1
DDT STOCK DISTRIBUTION
IN THE UNITED STATES



containers into larger ones. The condition of existing containers varies greatly depending on the age of materials, type of storage, local climate at storage area, type of formulation, etc. It is estimated that half the existing containers are suitable for shipment and half will require repacking or overpacking. The specifications will include criteria and inspection standards for determining whether particular containers require repackaging or overpacking. Requirements will also be established to contain spills and provide for clean-up during repackaging. These provisions will minimize risks of impact during collection.

4. Four modes of transport were considered for the shipment of DDT from the storage sites to a disposal site: barge, air, truck, and rail. Barge was rejected because of the relatively small volume of material, its wide dispersal away from inland waterways, the requirement for transshipment at waters edge, and the greater environmental impact of spills in water than on land. Air transport is not favored because it requires additional transshipment. It will, however, be allowed in the specifications for small quantities stored in a remote location.

5. An analysis of risk of spillage failed to define a determinable difference between rail and truck transport. Both are therefore equally acceptable and will be subject to U.S. Department of Transportation (USDOT) regulations for the shipment of hazardous materials. The regulations define requirements for packaging, marking, handling, hours of service, reporting of incidents, etc. In addition, recently promulgated U.S. Environmental Protection Agency (USEPA) regulations require the use of a manifest, which the receiver of the wastes is to sign and return to the DPDS depot. In addition to these regulatory requirements, it is intended that restrictions be added to the proposed specifications to further safeguard shipments from the risk of spillage and to minimize impacts if spills do occur.

6. The following alternative methods of disposal have been considered:

(a) on-land incineration
(b) ocean incineration
(c) landfill
(d) return to a manufacturer of DDT
(e) physical/chemical treatment
(f) deepwell injection
(g) reprocessing
(h) no action

7. Physical/chemical treatment, deepwell injection, and reprocessing are considered infeasible and have been eliminated for reasons elaborated on in Section III.C.6.

8. Each of the alternatives has been analyzed in detail in Table I.1-1, and Table I.1-2 indicates the suitability of each method of disposal for different classes of materials.

9. Land incinerators under consideration are specialized commercial incinerators for the safe destruction of hazardous wastes. There are currently four such incinerators operating in the U.S. that offer service to outside clients. At the time of the preparation of this EIS there were no federal standards for the incineration of DDT. Polychlorinated biphenyls (PCBs) are similar in chemical and combustion characteristics to DDT. Therefore, it is proposed that disposal of DDT by land incineration be limited to incinerators permitted by USEPA to burn PCBs. At present, no incinerator has such a permit, but three applications have been submitted, and it is expected that these facilities will be licensed by the fall of 1980. In addition, it is proposed that a guaranteed minimum destruction efficiency of 99.999% be required, a level the incinerator operators indicate they can meet. This efficiency level is more stringent than proposed federal standards under the Resource Conservation and Recovery Act (RCRA).

10. To analyze the possible environmental impacts of the incineration of DDT, two factors have to be considered: the products of combustion of DDT and concentrations of these products and unburned DDT in the environment. The products of the complete combustion of DDT are hydrochloric acid, chlorides, carbon dioxide, and water. Some concern exists that in the event of an incinerator malfunction, certain highly toxic substances could be produced, notably dibenzofuran and dioxin. While dibenzofuran and dioxin are formed of the same elements as DDT, it has not been proven theoretically possible to produce either compound from the combustion of DDT due to the differences in their molecular structures from that of DDT. In addition, none of these highly toxic substances has been noted in the analysis of previous burns of DDT that have been reviewed. It is believed that there is no risk that these substances might be formed. Hydrochloric acid, also toxic, is removed and neutralized by wet scrubbers.

11. If the land incinerators burn the DDT wastes at their minimum guaranteed efficiency of 99.999%, they will emit approximately 3 pounds of DDT out of the total of 286,000 pounds burned. In practice, their average efficiency will be higher and hence emissions will be less. These emissions have been analyzed using an accepted plume dispersion model and assuming worst case geographical locations and

Table I.1-1

SUMMARY OF DISPOSAL ALTERNATIVES

ALTERNATIVE	DESCRIPTION	SUITABILITY	AVAILABILITY	REGULATORY REQUIREMENTS	SPECIAL RESTRICTIONS TO BE DETAILED IN SPECIFICATIONS	COST	REMARKS
Ocean Incineration	Incineration on M/T Vulcanus at Gulf Designated Site	Most desirable but for liquids only	M/T Vulcanus based in Netherlands Gulf only site designated by USEPA	USEPA Ocean Incineration Permit USEPA permit for loading point		[1] DDT only $1,240,000 Combined with another burn $477,630	Requires special procedure for consolidation, transportation & loading of ship
On Land Incineration	Commercial land based high temperature waste incinerators	All materials	Ensco, El Dorado, AK Rollins, Bridgeport, NJ Rollins, Deer Park, TX all subject to issuance of USEPA PCB permit	State permit where required	PCB incineration permit required. 99.999% destruction efficiency	[2] Option I (powders burned as slurry) $911,500 Option II (powders burned in rotary kiln $401,200	Issuance of PCB license expected in fall of 1980
Landfill	Secure landfill in Western U.S.	Least desirable for powders Suitable for rinsed containers	A number of suitable sites available	State permit where required	Rainfall less than 15 inches Evaporation exceeds precipitation by 20 inch minimum Natural low permeability	Powders $30,495 Containers $10,560	Only to be considered if incineration is not feasible
Return to Manufacturer	Return to Montrose Chemical Corp. for reprocessing	Certain powder formulations only	Montrose indicated acceptance of 69,000 lbs of powder	USEPA exemption from pesticide registration		$3,500 for 69,000 lbs	
Special Disposal Techniques	Special techniques for handling aerosol cans and pressurized cylinders	Aerosol cans & pressurized cylinders	Requires disposer to install special equipment		Propellant gases must be collected and incinerated	$72,000 (excludes special equipment)	
Physical/ Chemical Treatment	Various treatments to change DDT into non-toxic substance	Not feasible					
Reprocessing	Re-use as raw material in chemical process	Not feasible					
Deep Well Injection	Injection into deep isolated aquifer	Not acceptable Not feasible					
No Action	Continued storage at military bases	Not desirable				$210,000 per annum	To be considered for powders if incineration is not feasible Option to consolidate at high grade warehouse

Notes:
1 - Liquids only
2 - Liquids, Powders & Mixed Materials

Table I.1-2

SUITABILITY OF METHODS OF DISPOSAL BY CLASS OF MATERIAL

Method of Disposal	Materials				
	Liquids	Powders	Aerosol Cans	Pressurized Cylinders	Mixed Materials
Land Incineration	yes	yes	yes	yes	yes
Ocean Incineration	yes	no	no	no	no
Landfill	no	if incineration is not feasible	no	no	no
Return to Manufacturer	no	for limited quantities	no	no	no

meteorological conditions in the U.S. The low maximum concentrations and deposit rates that were calculated based on these conservative assumptions are within the range of background levels of DDT to be found in the environment. Incineration is therefore unlikely to have a measurable impact.

12. Emissions have also been analyzed assuming a malfunction of the incinerator and a period to correct it. No significant impact is foreseen since land incinerators are required to be equipped to stop burning wastes and contain emissions in the event of a malfunction.

13. Therefore, given the conditions above, land incineration at incinerators having a USEPA permit to burn PCBs with a minimum destructive efficiency of 99.999% will not have a discernible environmental impact or present a hazard to public health. It is proposed to allow land incineration for all types of materials under the specifications.

14. Ocean incineration is subject to the conditions of the Ocean Dumping Act, and an ocean incineration permit is required prior to a burn. There is currently only one incinerator ship, the *Vulcanus*, capable of meeting U.S. standards; it is based in Rotterdam, Netherlands. The one designated ocean burning site is in the Gulf of Mexico, located at approximately 27°N latitude and 94°W longitude.

15. Because the incinerator ship is not equipped with a scrubber, it will emit hydrochloric acid in addition to carbon dioxide and water. Based on probable destruction efficiency of 99.99% it is estimated that 0.18 pounds of unburnt DDT will be emitted during a burn time of four days. The impacts of these emissions have been analyzed based on extensive tests of previous burns by the Vulcanus of similar organochlorine wastes at the Gulf site. These burns were found to have no significant impact on the environment. On this basis, ocean incineration will not have any discernible impact on the environment.

16. The *Vulcanus*, however, is only equipped to handle liquids. It would be costly to bring this ship from Rotterdam solely to burn the liquid DDT while not offering significant environmental benefits over land incineration. Furthermore, land incineration may be completed over a longer period as materials are brought to the incinerator. For ocean incineration to be practicable all the liquids must be collected and loaded at one time, thus requiring short-term interim storage.

17. It is therefore proposed to allow ocean incineration for liquids under the specifications. Actual selection of this

alternative will depend on the availablity of other materials in the U.S. for a sequential ocean incineration program, the availability of funding for accelerated collection, and the issuance of permits to burn PCBs at land incinerators.

18. Landfill of hazardous wastes can be made secure and is extensively practiced. The USEPA is currently imposing regulations to ensure that landfill sites handling hazardous and toxic wastes are secure. However, the public and DPDS share a common concern over the long-term potential impact of such a persistent pesticide as DDT in a landfill. Congress has shown its views in that the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) indicates incineration as a preferred method of disposal of pesticides over landfill. Nevertheless, should land incinerators either not accept the DDT or not obtain permits to burn PCBs, the only remaining disposal alternative is landfill because ocean incineration cannot destroy powders. It is proposed to allow landfill of powders that cannot be incinerated or returned to the manufacturer. The decision whether to exercise this option or to continue to store powders will be deferred until the time of disposal. It is further proposed that the specifications limit landfill (in addition to limits imposed by USEPA regulations) to sites where both the geologic and climatic conditions would render the possibility of leaching of DDT into the environment unlikely. If this option is selected, liquids would have to be drained from mixed materials for ocean incineration, and the remaining solids would have to be landfilled under the same conditions as the powders.

19. The other alternative considered is the return of the DDT to a manufacturer. There is at present only one manufacturer of DDT, Montrose Chemical Corporation of California. Montrose supplies DDT for the few special applications allowed in the U.S. by USEPA. The firm also exports DDT to countries that still allow its use, and it uses DDT as an intermediate in the production of other chemicals. Montrose has indicated that it would accept only powders of certain formulations that can be reprocessed. Considerable objection has been voiced that this alternative will indirectly involve the Federal Government in the export to foreign countries of a substance proven to be hazardous and banned in the U.S. Montrose has stated that returned DDT will replace virgin DDT. It will not, therefore, change the volume produced or exported. Instead this alternative will reduce the resources required to manufacture the DDT it replaces. It is an environmentally and economically sound method of disposal. It is therefore proposed to allow return of DDT powder formulations under the specifications.

20. The "no action" alternative, i.e., not to dispose of the DDT, would involve leaving the DDT in storage, inspecting it regularly, and repackaging as required to prevent leakage. In the short term, this should not present any significant environmental risk. In the long term, there is a potential for accidents, mishandling, improper storage, and consequent release of the DDT to the environment. This alternative requires the continued expenditure of public funds for storage, inspection, and repackaging. Continued storage of DDT is a feasible alternative if the DoD is unable to obtain bids conforming to the requirements of these specifications at reasonable cost. In particular it is a viable alternative to placing the powders in a secure landfill if they cannot be incinerated. This will be considered at the time of disposal.

21. In conclusion, it is recommended that specifications that present minimal hazards to public health and environment be prepared for the collection, transport, and disposal of DoD DDT. It is preferable to prepare these specifications and dispose of the DoD DDT stocks rather than leave them in storage, the no action alternative. After thorough evaluation of alternative methods of collection, transportation, and disposal, DPDS has selected several acceptable alternatives. These are briefly described above and detailed in the body of the EIS. It is proposed that they be included in the specifications subject to the restrictions described in the EIS.

22. This EIS was prepared in conjunction with a program of national public participation. Forty-five public interest groups were contacted; those expressing an interest were interviewed. The results of this program are included in the text of the EIS, and the list of organizations contacted and interview reports are included in Appendix A. The views expressed in this program have been taken into account in the formulation of the preferred alternative.

23. This EIS was prepared by Louis Berger & Associates of East Orange, assisted by Centaur Associates (Public Participation), Chester Engineers (Technical Analysis), and TerEco Corporation (Ocean Incineration), under contract to the U.S. Army Corps of Engineers, Omaha District.

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II. PURPOSE AND NEED

This section is divided into six components. The first component is a description of the Defense Property Disposal Services (DPDS) Charter, which is followed by a description of the DPDS environmental policy as it relates to the disposal of a hazardous material. The third component provides a brief background description of the Department of Defense (DoD) DDT stocks, the location of the stocks, and the quantities that will ultimately be disposed. The fourth element is a brief history of DDT, which examines how the pesticide came into existence, why it became so controversial, and why it was banned by the U.S. Environmental Protection Agency (USEPA). Fifth is a discussion that defines the need for a generic EIS addressing specifications for the safe collection, transport, and disposal of DoD stocks of DDT rather than a specific plan of disposal. Finally, a description of the regulatory environment that affects the disposal of DDT stocks is provided.

A. ROLE AND MISSION OF THE DEFENSE PROPERTY DISPOSAL SERVICE

1. Statutory Basis for Establishment

The Federal Property and Administrative Services Act of 1949, as amended, assigns the responsibility for disposition of excess and surplus government property to the Administrator of General Services. The Act further assigns the responsibility for the disposition of Department of Defense (DoD) foreign excess property to the Secretary of Defense. The Administrator of General Services has also delegated to the Secretary of Defense the responsibility for disposition of domestic excess and surplus property generated by the DoD. The Secretary of Defense established the Defense Logistics Agency (DLA) in 1962 and assigned to it the responsibility to provide logistical support to the military services. DLA's responsibilities include administration of the Defense Personal Property Disposal Program. The Defense Property Disposal Service (DPDS) was established as a primary level field activity of DLA and was assigned responsibility for operation and organization of this program in 1972. Its major objectives are to:

(1) insure maximum DoD and federal utilization of personal property through transfer to other federal users

(2) permit donation to authorized recipients

(3) obtain optimum monetary return to the government for property sold

(4) recover, when economically feasible, precious metals from surplus items

(5) minimize the need for abandonment or destruction

2. Method of Operations

The DPDS mission is accomplished through the following steps:

(1) receipt of personal property assets, which become excess to the needs of the individual military services

(2) screening of these assets for possible reutilization by other DoD activities

(3) screening by GSA for other U.S. and local government agencies

(4) sale of items that survive screening

(5) ultimate disposal (e.g., incineration, burial, or terminal storage) of those items that were not or could not be reutilized or sold

3. Operating Characteristics

DPDS operates at 226 locations in 21 countries. Its activities include one precious metals recovery office, three detachments, 146 disposal offices and 70 offsite branches, five regional offices, and the headquarters, which is located in Battle Creek, Michigan. The federal inventory system stocks approximately 5.4 million items of supply that can be issued to DoD components. About 50,000 of these items are considered hazardous. In any given year, DPDS processes for disposal more than 2.5 million line items of personal property that have become excess to the needs of DoD activities. Management of the disposal program, centralized at Battle Creek and the five regions, is based on a highly automated property accounting system and the management by exception concept, which identifies those hazardous or environmentally sensitive items requiring special analysis and handling procedures.

B. ENVIRONMENTAL POLICY OF THE DEFENSE PROPERTY DISPOSAL SERVICE

1. Basic Disposal Policy

The basic policy of DPDS is to dispose of all material in an environmentally acceptable manner as required by the National Environmental Policy Act (NEPA). Consideration of the environmental consequences of proposed actions is integrated in the daily decision-making process at all echelons of operation and management. The first action echelon is required to review disposal actions for potential environmental consequences. Any action involving unknown or potentially significant environmental impacts, either present or future, is elevated to higher echelons for environmental analysis. DPDS organizational elements document environmental concerns in the following manner:

(1) The Defense Property Disposal Office (DPDO), the first action echelon, considers environmental impacts of proposed disposal actions. Questions concerning environmental impacts are referred to the next higher echelon, the Defense Property Disposal Regions (DPDRs).

(2) The DPDR Commander and staff review questions referred by the DPDOs. They document a finding of no significant impact with an Environmental Memorandum for Record. If such a finding cannot be justified, the DPDR Commander will forward the matter to DPDS Headquarters for resolution.

(3) DPDS prepares an Environmental Memorandum for Record to document reviews when further analysis is clearly not required

(4) DPDS prepares an Environmental Assessment (EA) when further analysis is warranted. The EA will be used by the DPDS Commander to determine the need for an Environmental Impact Statement (EIS) and to select a course of action. The DPDS Commander will insert a Record of Decision in the file prior to implementing every irreversible action.

(5) DPDS prepares an EIS when significant environmental impact appears likely or when an action is environmentally controversial.

2. Methods of Disposal

There are three categories of disposal methods: reuse, recycling and reprocessing, and ultimate disposal via techniques such as incineration and landfill burial. Each of these categories will be explained in the ensuing paragraphs. The hierarchy of desired methods for disposition of property is the same for all items, although the hazardous characteristics of some items may preclude the implementation of certain actions. DPDS disposes of items in the following order of priority and performs the level of environmental analysis as indicated.

(1) Reuse. Reuse is always the preferred alternative if it can be done in an environmentally acceptable manner. Reuse effectively prolongs the useful life of articles and eliminates the necessity to produce or procure more of them. Five mechanisms for effecting such reuse have been established by DoD directive. Their priorities are:

(a) Continued Use Within DoD. Reuse within DoD is considered a supply function supporting normal operations. As such, primary responsibility rests with the receiving activity to properly assess its utilization of that item as required by NEPA. Since the disposal operation is considered a part of the item supply system in actions of this type, DPDS will not make environmental assessments of items reissued to DoD activities.

(b) Foreign Military Sale (FMS). If approved by the U.S. Department of State, certain items may be sold to foreign governments. Under provisions of Executive Order 12114, Environmental Effects Abroad of Major Federal Actions, as implemented by 32CFR Part 197, DoD has declared that FMS actions are exempt from the requirements of NEPA. DPDS will not perform environmental analyses regarding FMS.

(c) Transfers to Other Federal Government Agencies. Such items are requested through GSA upon whose authority the items are issued. Since DPDS has no operational control and acts only as the transfer agent, DPDS will not assess the use to which that federal entity will put the items or the environmental consequences attendant to such use.

(d) Donation. Items that remain in the DPDS inventory may be donated to authorized recipients, usually states or other public agencies. The donation program is also administered by the GSA Under the rationale used above (i.e., operational control), DPDS is not required to assess these donations further. A portion of the donation program involves institutions of special interest approved by the military services. Issues of items in such cases are viewed in the same manner as reutilization within DoD.

(e) Sale

i. Items that remain after all screening discussed above may be sold to persons or companies who presumably use those materials in the manner or for the purpose originally intended. Sale of items to persons or concerns outside of the Federal Government will generally not be assessed for environmental consequences if those items are commercially available. Persons or concerns that trade or deal with these commercial items do so on a regular basis and are familiar with their characteristics and the environmental constraints on their use. DPDS includes warnings in the sales invitation apprising bidders of the hazardous nature of the items and appropriate safety precautions. However, since purchaser utilization of such items sold by DPDS will be no different from that which would follow normal commercial practice, DPDS will not assess the environmental consequences of such sales. In those instances where it appears that items may be used in ways that generate potentially hazardous waste streams, an end-use certificate may be required from the purchaser. Additionally, DPDS scrutinizes sales with due regard for quantities and degrees of hazard and will determine whether these factors require further environmental analysis.

ii. Under certain circumstances, DPDS may provide sales services only to generate activities in order to dispose of material in a timely and environmentally prudent manner. In these cases, if an EA or EIS is necessary, it will be prepared by the generator and approved by DPDS prior to initiation of sales actions for disposal purposes.

(2) Recycling and Reprocessing. When items cannot be reused, the preferred alternatives are recycling and reprocessing. Reprocessing or recycling may be implemented by two methods.

(a) Sale. If market analysis and contacts with waste exchanges, trade associations, representative firms, state agencies, and EPA offices indicate that unsold items are good candidates for recycling or reprocessing, an environmental document will be prepared. Upon a finding of no significant impact and continued evidence of marketability, a separate invitation for bid will be prepared in which materials are grouped for sale in lots that maximize their appeal to reprocessors. DPDS, in conjunction with the Sales Contracting Officer, will then investigate the high bidder to ascertain whether its operation conforms to sound environmental practice. This investigation will include a pre-award type of survey, involving checking with applicable state and EPA regional personnel. This procedure is more fully discussed in paragraph 3 below.

(b) Procurement of Disposal Services. Those items that contain recoverable resources, but that could not be reused or sold, may be disposed of via recycling or reprocessing under the terms of a disposal service contract.

i. Since service contracts for disposal are normally awarded to the firm offering the most economical method meeting environmental considerations, it follows that resource recovery must compete unsuccessfully, on a cost basis, with other disposal alternatives. Under present statutory authority, DPDS cannot subsidize resource recovery in the sense of a price support to a particular industry to the competitive disadvantage of another industry. Further, entities of the government may expend appropriate funds only for authorized purposes. Although USEPA has authority in this area under the Resource Conservation and Recovery Act, DPDS is not so empowered. Additionally, DPDS has no authority to fund research and development efforts in resource recovery. Since the statutory authorities for the conduct of sales and procurements are separate and distinct, they may not be mixed together in a single transaction. Therefore, although such subsidization may be desirable in some cases, it is not a course of action open to DPDS.

ii. When procuring disposal services, DPDS is subject to the Armed Services Procurement Act (ASPA), as implemented by the Defense Acquisition Regulation (DAR). These documents require that goods and services be procured on a competitive basis to the maximum extent feasible, consistent with the quality and nature of the item or service being procured. The DAR mandates that the procuring activity define its minimum needs. Once that has been accomplished, the procurement must be publicly advertised to obtain the maximum competition. Expenditure of appropriate funds in excess of the justifiable minimum needs is not authorized. This is not to imply, however, that the lower-cost environmentally acceptable option must always be utilized. A determination of justifiable minimum needs could result in the selection of a higher cost option if that option is preferable from an environmental or public health standpoint. In any case, where the lower cost option is not used, the records will reflect the rationale for disregarding it in favor of a more costly option. Moreover, the Council on Environmental Quality (CEQ) regulations, 40CFR 1505.2, requires that a Record of Decision be prepared identifying the environmentally preferable alternative(s) and preference among alternatives based upon relevant factors, including economic and technical considerations and agency statutory mission. Thus, the relative merits of diverse disposal alternatives will be surfaced in the decision-making process. The foregoing will be accomplished in a manner that assures there is no unnecessary degradation of the environment and minimal environmental controversy.

iii. Reprocessors competing for disposal service contracts must do so on the same basis as other ultimate techniques, as discussed in paragragh 3 below.

(3) Ultimate Disposal. When an item remains in the DPDS inventory following all attempts at reuse and recycling/reprocessing discussed above, it must be considered waste and disposed of accordingly. There are several methods that may be used to facilitate or finalize ultimate disposal (e.g., incineration, landfill burial, detoxification, deep well injection, and chemical treatment). Each such method is, under the proper conditions, an approved disposal technique that poses no significant threat to the environment. Circumstances peculiar to a specific disposal action, however, may limit the practicability of some methods that are technically possible. Lack of approved facilities, for example, may preclude use of incineration as a disposal method in some areas. Detoxification is also a possible alternative, but may not be economically competitive with other methods. Chemical treatment, unless 100% effective, produces a diluted substance that is less hazardous but that still may require burial in a hazardous waste landfill. The resulting volume, in fact, is frequently greater than the original waste. Therefore, although circumstances may eliminate certain options from a practical point of view, there normally remains a number of environmentally acceptable options for disposal of hazardous items. Selection of the specific disposal method, however, follows from the procurement process described above, with due regard to environmental considerations.

3. The Contracting Process

The following discussion applies equally to contracting of sales and procurement of disposal services.

(1) The Sales or Procurement Contracting Officer is the official authorized to act on behalf of the U.S. Government in a contractual capacity. DPDS, the Sales or Procurement Contracting Officer, the applicable state, and the EPA regional office may all be involved in preparation of the solicitation. Once responses have been received, the Sales or Procurement Contracting Officer must determine if the prospective contractor is a responsible concern, that is, whether the responsive bidder has the capability to perform the contract in accordance with the advertised terms or has the ability to obtain such capability. This investigation will be in the form of a type of pre-award survey. A statement in the body of the EA and implementing solicitation will include applicable environmental criteria that must be met as well as those generally the subject of a pre-award survey. The Sale or Procurement Contracting Officer will assure that stated environmental criteria receive adequate review.

(2) Responsibility factors of general concern include, but are not limited to, technical expertise, financial capacity, organization abilities, record of past performance, and integrity. DPDS will, with the assistance of state and federal advisors as necessary, require that definitive responsibility criteria be imposed, as appropriate, and verified by the Sales or Procurement Contracting Office prior to award. They include:

(a) a copy of the state permit or permits authorizing the facility's operation

(b) documentation of any limitations or restrictions placed upon the site's operation

(c) specific authorization from the state agency charged to oversee the disposal of hazardous materials that the items may be disposed of at the specific site

(d) a copy of any site surveys that discuss the physical aspect of the site for the intended purpose or evidence that such surveys were submitted to knowledgable permit-granting authorities

(e) a copy of the standard operational and safety procedure(s) at the site

(f) spill contingency prevention and control plan covering bidder operations from the time the bidder assumes custody until ultimate disposal

(g) a certificate from the prospective contractor indicating the intended ultimate disposal site

(3) The Sales or Procurement Contracting Officer will ascertain from the agency or agencies within the state charged with responsibility to oversee the program and from the appropriate EPA regional office the past performance of the bidder with due regard for noncompliance with permit limitations and violations of environmental standards, if any. The Sale or Procurement Contracting Officer will coordinate the adequacy of the bidder's proposed operational plan with EPA and state officials. The Sales or Procurement Contracting Officer will document his files to reflect his findings in the stated areas incident to his determining the bidder responsible. Copies of all documentation compiled by the Sales or Procurement Contracting Officer will be forwarded to DPDS for inspection and retention. Once these have all been reviewed and the DPDS Commander signs the Record of Decision, a contract may properly be awarded.

(4) After contract award, the Sales or Procurement Contracting Officer is responsible to determine that the contractor's proposed operational plan is properly implemented. This duty may be delegated to a Sales or Procurement Contracting Officer representative. Copies of any documentation resulting from monitoring the contractor's implementation will be forwarded to DPDS to be maintained in its files. The Sales or Procurement Contracting Officer will be required to obtain a certificate of disposal from the contractor stating that the items were properly disposed of and indicating the date of actual disposal and method of disposition. This documentation will also be maintained by the Sales or Procurement Contracting Officer in his file and a copy forwarded to DPDS for retention.

4. Summary

The DPDS policy represents a balance of environmental, cost, technical, and agency mission considerations. Implementation of the policy will accommodate these sometimes competing concerns while providing adequate protection of the environment, discharging DPDS mission responsibility, and considering the impact on the public purse.

C. BACKGROUND AND DESCRIPTION OF THE DEPARTMENT OF DEFENSE DDT STOCKS

1. Background

The DDT products being addressed in this EIS are comprised of assets from all supply echelons in the Department of Defense (DoD), i.e., from each military activity, including unit assets, depot level stocks, and war reserve stocks. The DoD, in very general terms, maintains depot level stocks to support worldwide requirements with inventory levels based upon demand history. During the time that DDT was an acceptable pest control product in general use in the public and private sectors, DDT products were also stocked for DoD use. Since the ban of DDT, assets in DoD's inventory have been suspended from use and stored until an environmentally safe disposal plan is developed.

2. Description of DDT Stocks

a. The DDT stocks are located at 79 military depots in 34 states, two U.S. territories, and three foreign countries. They vary in formulation but exist in two basic forms, liquids and powders. The inventory is divided into four groups: 1) liquids, 2) powders, 3) "other," which includes liquids in aerosol cans and pressurized cylinders and some small packets of powders, and 4) mixed materials. The mixed materials refer to some 226 55-gallon drums in which repacked liquids and powders have been mixed. A distribution of the stocks is shown in Figure I.1-1.

b. The DDT inventory consists of 240,662 gallons of liquid, 210,311 pounds of powder, and 62,258 of other units. More specifically, the breakdown is as follows: approximately 169,773 gallons of the liquid DDT formulations containing 5% DDT, 6,752 gallons containing 10% DDT, 31,265 gallons containing 20% DDT, and 32,701 gallons containing 25% DDT. In 165 gallons of the liquid DDT, the percentage of DDT in the formulations is unknown. The inventory of stocks is shown in Appendix B.

c. Visits were made to eight sites where DDT is currently stored in order to determine the condition of the DDT containers. In general, containers of the liquid DDT formulations were noted to be in good condition. However, light rust was present on some of the containers. A few containers with bulged heads or apparent leaks were also observed. Some of the containers did not meet Department of Transportation specifications. At two of the sites, internal corrosion problems were apparent with the DDT formulation having stock number 253-3892 (contains 5% DDT).

d. The containers of powder DDT were generally in fair condition. Many of the secondary boxes holding small containers of powder DDT were generally in fair condition; however, many need replacement. Light rust was present on some of the primary containers. Some of the containers were also dented; however, no leaks were apparent. A majority of the powder was manufactured and packaged more than ten years ago.

e. Secondary containers (e.g., cartons) containing "other" units, such as aerosols, were generally noted to need replacement. The primary packages were in good condition, although light rust was present on some.

f. The DDT is contained in numerous types of containers. They are grouped as liquids, powder, "others," and mixed and are summarized below:

(1) Liquids

CONTAINER TYPE	QUANTITY
5-gallon can	13,061
55-gallon drum	3,072
1-gallon can	323
50-gallon drum	57
1-quart bottle	15
5-quart can	5
25-gallon drum	3
30-gallon drum	2
35-gallon drum	1
15-gallon drum	1
20-gallon drum	1

(2) Powder

CONTAINER TYPE	QUANTITY
5-pound can	10,214
20-pound can	5,140
25-pound can	523
5-gallon can	298
50-pound drum	114
15-pound pail	106
55-gallon drum	93
17-pound pail	20
85-gallon drum	4
30-gallon drum	4
1-gallon bottle	3
1-pound box	2
10-pound can	2
Conex container	2
35-pound container	1
50-gallon drum	1
88-pound drum	1
190-pound drum	1
7-pound can	1

(3) "Others"

CONTAINER TYPE	QUANTITY
1-pound cylinder	17,155
2-oz can	16,520
5-gram cartridge	14,544
13-gram cartridge	7,488
12-oz low pressure aerosol can	4,014
16-oz can	1,272
miscellaneous packets	1,200
12-oz aerosol can	65

(4) Mixed. The mixed materials contain a mixture of liquid, powder, and possibly "others." It was noted that Ft. Lewis, Washington and Hermiston, Oregon account for a total of 226 containers of such materials, which are in overpacks and are not included above. (Disposal contractors will be required to identify these prior to disposal.)

g. Included in the above quantities are those containers of DDT stored outside the U.S. Liquid DDT in U.S. territories and foreign countries is stored in 89 55-gallon drums, 334 5-gallon cans, and 14 1-gallon cans.

h. Powder containers stored outside the U.S. are 44 55-gallon drums, 288 5-gallon cans, 32 25-pound cans, 53 50-pound cans, 11 15-pound pails, 251 20-pound cans, and 132 5-pound cans.

i. Miscellaneous packages stored in U.S. territories and foreign countries are 1,272 16-ounce cans, 86 2-ounce cans, and 2,160 13-gram cartridges.

j. The total liquid inventory contains approximately 176,953 pounds as DDT based upon the percentage of DDT in the formulations and assuming a weight of 7.5 pounds per gallon. The total liquid inventory, including solvents, is estimated at 1,805,000 pounds.

k. A total of 210,311 pounds of powder DDT formulations is currently in storage. The majority (67%) or 141,123 pounds of the powder DDT formulations contain 75% DDT. Approximately 56,263 pounds of the powder contain 10% DDT, 1,450 pounds contain 25% DDT, 441 pounds contain 50% DDT, and 11,034 pounds contain 100% DDT.

l. The concentration of DDT in the miscellaneous packages ranges from 2% to 42.5%. There is only 2% DDT in the 12- and 16-ounce aerosol cans. The 1-pound cylinders contain 6% DDT. In the 2-ounce cans, there is 10% DDT. Each packet contains 12.5% DDT. The greatest concentration of DDT, 42.5%, is found in the 5- and 13-gram cartridges.

m. The total amount of DDT in the "other" units is approximately 1,711 pounds, which is less than 0.6% of the total DDT in the inventory.

3. DDT Formulations

a. The Department of Defense DDT formulations vary in form, composition, diluent solvent, carrier, propellants and hence in final package. Each formulation is assigned a stock number by which it is identified. The seven-digit numbers are prefixed by 6740. LSN (local stock numbers) have been assigned in some instances after repackaging or for other reasons. The exact identification of these stocks is not possible. However, the percentage of DDT has been indicated based upon the LSN formulation specification inventory where noted.

b. The following three tables depict the ingredients in the various formulations and show their respective percentages. Where possible, the identifiable ingredients have been calculated based upon the formulation. It should be noted that the breakdown by formulation will differ with overall breakdown, as discussed in the foregoing section, because LSN formulations do not give solvent percentages.

c. As shown in Table II.C.3-1 for liquid formulations, the solvent makeup consists of approximately 55% kerosene (875,338 pounds), 31% auxilliary solvent (492,458 pounds), approximately 2.6% (42,031 pounds) tetrachloroethylene, about 12% (187,618 pounds) of emulsifier and aromatic petroleum derivative solvents, and a minor percentage of motor oil. Solvents in the LSN numbered stocks cannot be identified. Lindane in one formulation amounts to approximately 1,013 pounds. The calculated DDT, based on formulation percentages identifiable, is approximately 175,571 pounds.

d. The breakdown of powder formulations shown in Table II.C.3-2 shows that of the total powder inventory of 210,311 pounds, approximately 58.6% (123,237 pounds) is DDT and the remaining 41.4% (85,864 pounds) are inerts, talc, and pyrophyllite.

e. Table II.C.3-3 for the "others" category shows the DDT in the formulation amounts to 1,711 pounds. The botanical insecticides, pyrethrin and allethrin, amount to 1,390 pounds. The total insecticide percentage is 13.4% of the total ingredients. The remaining ingredients include 7.6% (1,748 pounds) solvents, 9.6% (2,210 pounds) talc or pyrophyllite, and 69.4% (15,981 pounds) of the propellants dichlorodifluoromethane or trichloromonofluoromethane. The latter are also used as refrigerants in domestic refrigerators and air conditioners, i.e. Freon 11 and Freon 12.

Table II.C.3-1

LIQUID DDT FORMULATIONS

COMPONENTS (PERCENTAGE)		Stock Numbers*** 253-3892	655-8287	281-3462	285-4307	246-6432 264-6432	543-4038	598-7314	281-1990	242-4210	LSN-3025	LSN-3005	LSN-3333	LSN-9999	6840-00-LSN	543-4016	Lb. Solvent*	Pounds Pesticides**
Solvents and Emulsifiers	Kerosene	70	70														875,338	
	Tetrachloroethylene				83												42,031	
	Auxiliary Solvent	25	25			75	75	75									492,458	
	Non-Ionic Emulsifier																	
	Non-Ionic Polyhydric Alcohol																	
	Alcohol Ether Type Emulsifier									75							187,618	
	Aromatic Petro. Deriv. Solvent			80														
	Motor Oil				5												2,532	
Pesticides	Lindane				2				Unknown					Unknown				1,013
	DDT	5	5	20	10	25	25	25		25	25	5	5		5-25	5-25		175,571
	TOTAL PERCENTAGE	100	100	100	100	100	100	100		100								
	TOTAL POUNDS																1,599,977	176,584

*Pounds of Solvent calculated as per formulation identification. Where solvents were unknown no calculation was performed.

**Pounds of Pesticides calculated as per formulation identification.

***Prefix Number 6840-

Table II.C.3-2
POWDER DDT FORMULATIONS

Stock Numbers***

	COMPONENTS (PERCENTAGE)	00-240-2540	252-3002(1)	00-058-1934	00-264-6692	00-598-7313	242-4221(1)	00-242-4222	290-6274(1)	00-576-5008	LSN-1010	LSN-1050	LSN-1111	LSN-1075	LSN-1100	LSN-1025	264-6688	POUNDS
	Inerts			25	25**	25												85,864
Carriers	Talc	90	90															
	Pyrophyllite																	
	DDT	10	10	75	75	75					10	50	25	75	100	25		123,237
	Technical Grade B "DDT"						100	100	100	100								
	TOTAL PERCENTAGE	100	100	100	100	100	100	100	100	100								
	TOTAL POUNDS																	209,101 1,210*
																Total		210,311

*Approximately 1210 pounds of DDT powder were not assigned a stock number (DPDO, McClellan), hence not shown in the formulation breakdown above.

** Bio-Inert

*** Prefix Number 6840

Table II.C.3-3
DDT FORMULATIONS (OTHER CATEGORY)

	COMPONENTS (PERCENTAGE)	Stock Numbers***										
		00-180-6142	00-180-6143	00-254-8770	264-6694(1)	00-274-5415	00-766-9631	254-8770	LSN-4012	POUNDS OF COMPONENTS	SUB TOTAL POUNDS COMPONENTS	COMPONENTS % IN OTHER UNITS	% DDT IN OTHER UNITS
Solvents	Deodorized Kerosene			7.4						223	1,748	7.6	
	Aromatic Pet.Der.Solvent			5	8					1,522			
	Cyclohexanone						5			2			
	Lub. Oil						2			1			
Carrier	Talc or Pyrophyllite					90				2,210	2,210	9.6	
Propellant	Propellant						85			42	15,981	69.4	
	Dichlorodifluoromethane			42.5	78					14,660			
	Trichloromonofluoromethane			42.5						1,279			
Pesticides	Pyrethrin				8		1		Unknown	1,372	3,101	13.4	
	Sesame (Solvent)												
	Allethrin			0.6						18			
	DDT	5*	** 13	2	6	10	3	2		1,711			7.4
	TOTAL PERCENTAGE			100	100	100	100					100	
	TOTAL POUNDS									23,040	23,040		

* 5 gm units - assumed 100% DDT
** 13 gm units - assumed 100% DDT

*** Prefix Number 6840-

f. Formulations containing less than 100% DDT are either carried by inert carriers or dissolved in solvents, such as kerosene, and emulsifiers. A summary of the various auxiliary chemicals appears in Table II.C.3-4.

g. Some of the DDT formulations are combined with other pesticides: lindane, pyrethrin, and allethrin. The chemical and physical properties of these materials are presented in Appendix C. Further descriptions of each of these pesticides follow:

(1) Lindane, 1, 2, 3, 4, 5, 6-hexachlorocyclohexane, sometimes erroneously called benzenehexachloride (BHC), is present in one of the DDT formulations in the amount of 1,013 pounds. Unlike DDT, lindane is effective in controlling various mites infesting man and livestock. Because of its high vapor pressure it also possesses fumigant properties. Lindane is heat stable to 350°F., and decomposes in the presence of alkaline media. At high temperatures it will be destroyed.

(2) Pyrethrum is one of the oldest insecticides known, dating to 400 B.C. Pyrethrins are derived from flowers and originally were marketed in the form of finely ground dried flowers, although (0.6-0.15%) mineral oil extracts of pyrethrins became more popular. The demand for aerosols to dispense solutions of 1-2% pyrethrins required processes for preparing concentrates. The amount of pyrethrin existing in the aerosol formulations is 1,372 pounds. Pyrethrins are heat and light sensitive and are easily oxidized.

(3) Allethrin is a synthetic pyrethroid and described as a synthetic homolog of the six identified components of natural pyrethrum. It may be used in edible product areas of food plants. It is exempt from the requirement of a tolerance on growing crops.

Table II.C.3-4

CARRIERS, SOLVENTS, EMULSIFIERS, PROPELLANTS, AND INERTS IN DDT FORMULATIONS

CARRIERS IN POWDER

Talc	(Carrier-Silicate Type)
Pyrophyllite	(Carrier-Silicate Type)
Inerts	(Carrier)
Technical	(Grade B)

SOLVENTS AND EMULSIFIERS IN LIQUID

Kerosene	(Mineral Oil Type Solvent if crude 8-10% DDT solution)
Auxilliary Solvent	(Not Specified)
Tetrachloroethylene	(Solvent - 64% DDT Solubility)
Non-ionic Polyhydric Alcohol	
Alcohol Ether Type Emulsifier	(Ether type linkage)
Aromatic Pet. Deriv. Solvent	(Probably aromatic naphthas)
Non-ionic Emulsifier	(Probably organic)
Motor Oil	

SOLVENTS, PROPELLANTS, INERTS IN OTHERS

Aromatic Pet. Der. Solvent	(Probably aromatic naphthas)
Deodorized Kerosene	(Mineral Oil Solvent 4% DDT sol.)
Cyclohexanone	(Solvent - 116% DDT solubility)
Lube Oil	
Talc or pyrophyllite	(Carrier - Silicate Type)
Inerts	(Not specified)
Dichlorodifluormethane	(Propellant)
Tricbloromonfluormethane	(Propellant)

General Notes: (1) Aromatic solvents are classified as Xylene, Xylene substitutes, heavy aromatic naphthas. (2) Aliphatic solvents include kerosenes and mineral spirits (naphtha)

(4) Carriers

(a) By definition, an inert ingredient is one without active, primarily chemical, properties. It is generally agreed that inert materials used in the manufacture of dry pesticidal products do not have any inherent pesticidal activity in the same sense as the organic poisons; however, these materials are not entirely inert. It has been found that some carriers and diluents react chemically with the impregnated pesticide, decomposing it and rendering it pesticidally inactive. The carrier can also impart certain desirable physical properties to the product.

(b) The term "carrier" is generally used to denote the inert ingredient used to dilute the pesticide. However, some restrict its use to those inert materials with high absorptivities, whereas the term "diluent" has been used with materials having low or medium absorptive capacities.

(c) Inert materials can be divided into two general categories: inorganic minerals and botanicals. They may be further divided into two other classes: dusts and granules. Mineral carriers are usually silicates and are clays such as attapulgite, morillonite and bentonite clays, granular diatomaceous earths, or pyrophyllites and talc. The carriers identified in the DDT formulations are either pyrophyllite or talc. Otherwise, the carriers are identified as inert.

(d) The flowability indices of the five different inerts are as follows: attapulgite 100, talc 112, pyrophyllite 89, kaolin 12, and diatomaceous earth 8. Mesh size for granular products used for herbicides and insecticides applied above the ground are 25/50 and 30/60 meshes. The first number indicates the screen number with the large holes through which most of the material will pass, and the second number indicates the screen number with the small holes on which most of the material will be retained.

(e) The carriers used in the DDT stocks are either talc, pyrophillite, or other inerts not identifiable.

(5) Liquid Solvents and Diluents

(a) When more concentrated liquid insecticide formulations, especially those containing multiple toxicants, i.e., a mixture of toxaphene, DDT, and methyl parathion, became feasible by using a blend of emulsifiers, high purity xylene-type solvents were introduced to hold the ingredients in solution at low temperatures.

(b) Aromatic solvents are derived from xylene and are classified as heavy aromatic naphthas, which are 78% to 90% aromatics extracted from kerosene or distillates from aromatic crudes. These naphthas are used extensively in herbicide preparations and in formulating granular insecticides.

(c) Aliphatic solvents include the kerosenes and mineral spirits (naphtha). Naphtha, used as a paint and varnish thinner, is any of a number of narrow-boiling-range petroleum fractions from the 100° to 150°C range. Kerosenes have a boiling range of 150° to 300°C and were used extensively for DDT formulations.

(d) Aside from the general class of solvents described above, other solvents in the DDT formulations are listed in the aforementioned table. The only specific solvents that are identifiable, other than kerosene, are cyclohexanone and tetrachloroethylene, which have DDT solubilities of 64% and 116%, respectively.

(6) Emulsifiers

(a) Emulsifiers or emulsifying agents belong to that group of chemical compounds known as surface active agents. One variety is hydrophilic or water soluble, the other hydrophobic or water insoluble. Usually, the hydrophobic portion will be lipophilic, i.e., exhibit solubility in organic liquids. Because of the hydrophilic-lipophilic (or polar) character of these molecules in solution, they exhibit certain properties that are not characteristic of other types of materials.

(b) Surface-active agents used as emulsifiers can be divided into five principal classes. These are 1) anionic, 2) cationic, 3) non-ionic, 4) ampholytic, and 5) water-insoluble.

(c) Specific identification of those surface-active agents in the DDT formulations is not possible with the information at hand. However, it would be safe to say that the compounds are of the non-ionic type, which would indicate linkages of the ether or ester type to the solubilizing groups. These compounds are in the organic chemical class of products derived from fatty acids and alcohols called esters and may be stearates, oleates, and others.

D. HISTORY OF DDT

a. DDT (dichloro-diphenyl-trichloroethane) was first synthesized in 1874. Its effectiveness as an insecticide, however, was not discovered until 1939. Shortly thereafter, the U.S. began producing large quantities of DDT for the control abroad of vector-borne diseases, such as typhus and malaria. After 1945, agricultural and commercial usage of DDT became widespread in the U.S. The early popularity of this pesticide was due to its reasonable cost, effectiveness, persistence, and versatility. It soon became the most widely used pesticidal chemical.

b. With the usage of DDT, problems began to arise. It was found that some non-target insect populations increased due to removal of predator species, while in other cases these non-target insects were also killed by spraying DDT. In addition, some insects began building up resistance to this pesticide and others.

c. In the late 1950s, it was discovered that DDT was biologically magnified. DDT residues were found to be passed from one trophic level (feeding group such as herbivores and carnivores) to another with an associated accumulation in concentration. For example, low level residues were found to be increased by predation in the food chain, especially in the aquatic environment.

d. In 1958 the U.S. Department of Agriculture (USDA) began to phase out its use of DDT after having applied approximately 9.5 million pounds of the chemical in its federal-state control programs since 1945. They reduced spraying of DDT from 4.9 million acres in 1957 to just over 100,000 acres in 1967.

e. In the 1960s, there occurred a tremendous rise in public interest and concern over the quality of the environment. This involvement revolved primarily around the apparent occurrence of increasing concentrations of a multitude of unnatural chemical substances. In 1962, the public's participation was triggered by Rachel Carson's book entitled Silent Spring. After Carson's alert to the public regarding the dangers of improper pesticide use and the need for better pesticide controls, DDT came under intensive investigation (USEPA, 1974). In response to the public indignation, the federal government initiated programs designed to determine just how serious pesticide overuse really was. Analytical studies indicated that there were indeed potentially hazardous substances in the environment.

f. In 1972 the U.S. Environmental Protection Agency banned almost all uses of DDT because of its persistence, its ill effect on wildlife, and its possible health hazards to people. It has remained off the market since that time for all but a few special uses to protect health, such as controlling rabid bats.

g. DDT is intensely poisonous for many insects, but is less toxic for plants and other animals. DDT and its metabolites (product of metabolism) persist for years. It has been found to kill or concentrate in some non-target organisms and displays a variety of adverse biochemical and physiological effects. DDT threatens to reduce or eliminate some non-target species and lowers the marketability of fish and shellfish. Toxicity may be acute and kill the organism relatively quickly, or may be chronic and have gradual effects on activity, feeding, reproduction, and general physiology.

E. THE NEED TO PREPARE SPECIFICATIONS FOR THE COLLECTION, TRANSPORT, AND DISPOSAL OF DDT

a. There is a need to collect, transport, and dispose of the DoD DDT stocks in a safe and environmentally sound fashion. This EIS defines a range of acceptable means of disposal that protects the public health and safety and avoids degradation of the environment. Each of these disposal methods is defined by specifications concerning the collection and transport of DDT as well as its ultimate disposal. Any element of these specifications forms part of the preferred alternative and, as such, is in conformance with Section 102(2) of the National Environmental Policy Act (NEPA).

b. Two fully acceptable means of safe final disposal have been determined: land based incineration at incinerators permitted to burn polychlorinated biphenyls (PCBs), and ocean incineration on the incinerator ship Vulcanus. There are currently no incinerators permitted to burn PCBs in the United States. Three incinerators have applied for permits, and it is anticipated that the first permits will be issued between July and October 1980.

c. The Vulcanus and the land based incinerators are all privately owned, and the owners have absolute discretion regarding the acceptance of DDT stocks for incineration. The three land based incinerators are owned by two corporations: Rollins Environmental Services of Wilmington, Delaware and Ensco of El Dorado, Arkansas.

d. The Vulcanus is owned by Ocean Combustion Service B.V. of Rotterdam, Netherlands and is based in Rotterdam. It has not visited U.S. waters since 1977. For this alternative to be economically attractive to the owners, the ship would require two loads of approximately 4,500 metric tons of material to burn. Alternatively, the Vulcanus must be time chartered on a daily basis for an amount of time that includes the round trip transatlantic voyage, loading the material, traveling to the burn site, burning, and cleaning. This would increase the cost of incineration several times.

e. The owners are currently negotiating to burn other wastes off the U.S coast. If these burnings could be combined with the incineration of DDT, this alternative would be attractive.

f. The Vulcanus cannot incinerate powders or mixed materials, which make up approximately 11% of the inventory. Land based incinerator owners have not indicated any interest in only burning these materials in view of the small profit in relation to the high public exposure. Because of this attitude, secure landfill, a less desirable but still acceptable method of disposal, must be considered for these materials if ocean incineration is selected for the liquids and incineration of the powders is not feasible.

g. It has been determined that specifications are needed that explicitly define safe and environmentally sound means of achieving the collection, transport, and final disposal of DoD DDT stocks. Thus, any disposal method conforming to these specifications would safeguard public health and the environment. The DPDS would have the discretion to select a conforming method of disposal that would allow them to dispose of this hazardous and toxic material by the most expeditious means and at the least cost to taxpayers.

h. This EIS is necessary to review the environmental consequences of disposal in accordance with these specifications, the action proposed, and other alternatives available.

F. GENERAL REGULATORY ENVIRONMENT

1. Introduction

The regulatory environment that affects the disposal of DDT stocks emanates from many sources and is undergoing substantial revision. Rising public awareness concerning the handling and disposal of hazardous wastes has led to the creation of new regulatory powers and reorganized or reemphasized others. The regulatory reorganization is an attempt to control more of the hazardous waste life cycle than ever before. Hazardous material generators, handlers, disposal facilities, and the various governmental entities involved will be undergoing a major period of adjustment for many years.

2. Federal Regulatory Environment

a. The U.S. Environmental Protection Agency (USEPA) is the agency with the greatest regulatory influence over the DDT project. Important statutory authority has been granted under the Resource Conservation and Recovery Act (RCRA) of 1976 and the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). Other significant USEPA jurisdiction has been granted under the Toxic Substances Control Act, the Clean Air Act, the Safe Drinking Water Act, the Clean Water Act, and the Marine Protection, Research and Sanctuaries Act of 1972, which includes the Ocean Dumping Act and subsequent amendments to this legislation.

b. Regulations have recently been promulgated for portions of RCRA. RCRA is the single most important regulatory concern of the DDT project, as it is an attempt to provide a cradle-to-grave system of tracking and providing for the safe handling of hazardous wastes. On February 26, 1980 USEPA promulgated regulations under Sections 3002 and 3003 to take effect after six months. These regulations establish standards for the generators and transporters of hazardous waste, which attempt to ensure, among other things, proper recordkeeping and reporting, the use of a manifest system to track shipments, the use of proper labels and containers, and the delivery of the waste to properly permitted treatment, storage, and disposal facilities.

c. Important RCRA sections promulgated May 5, 1980 are Section 3001 (identification of the characteristics of hazardous waste and a listing of particular wastes as hazardous) and Sections 3004 and 3005 (standards concerning, among other things, locations, design, construction, operation, and closure of disposal sites).

d. The U.S. Department of Transportation (USDOT) has considerable authority over the transportation of hazardous materials, although much is being transferred to USEPA under RCRA. The rule for transportation regulations promulgated through USDOT is 49CFR, which gives comprehensive standards for classification, paperwork, marking and placarding of vehicles, labeling of containers, handling for different transportation modes, hours of service, reporting of incidents for hazardous materials, and other areas of transportation.

e. A section on transportation regulations of concern to the shipping of wastes in this project is included in Appendix D. Specific regulatory requirements for ocean incineration, incineration on land, landfill, and shipment to a manufacturer are discussed in Section III.C.

f. The Occupational Safety and Health Administration (OSHA) is concerned with the DDT project because it has set standards for acceptable ceiling concentrations for air contaminants. This would be of particular concern to the repackaging and possibly the reprocessing or reformulating operations. OSHA also has regulations governing the storage and handling of flammable and combustible materials.

3. State Regulatory Environment

a. The promulgation of USEPA regulations under RCRA will cause a minor crisis within some states, but will eventually do much to standardize supervision at this level of regulatory activity. The goal of RCRA is to accomplish the regulation of hazardous materials at the state level. Under Section 3005 of RCRA, states will submit hazardous waste management plans to USEPA for evaluation within 180 days of promulgation of RCRA regulations. USEPA will then have 180 days to approve or reject a state plan, approval judged on the basis that its requirements are "at least as strict" as the federal RCRA requirements.

b. It is unlikely that all states will be able to comply in the established time frame. A large amount of new legislation has been introduced to various state legislatures, mostly modeled after USEPA proposed RCRA standards, but the part-time nature of many of the state bodies may prevent or hinder timely compliance. USEPA has been granted authority to supercede state control where plans are not approved, but the agency would probably be reticent to take over.

c. For the DDT project this situation implies that in most states, federal standards will suffice because RCRA will force more uniformity. A few states may have stricter rules, and these will be observed by the contractor.

d. State regulations are often enforced by a variety of agency types. For the DDT project, these may include departments of environmental protection, health, agriculture, transportation, natural resources, and other variations. Most states have adopted 49CFR by reference, and many states that have not adopted these regulations have no specific requirements in this area.

e. A few states vest control over hazardous materials to local (city, county, or equivalent) authorities. Localities also may, on occasion, regulate all or part of the hazardous materials activities without a specific delegation of authority from the respective state. The disposal or other treatment of DDT and other materials included in this project will be conducted in compliance with all applicable state and local regulations. Appendix F lists state legislation and regulations for the management of hazardous waste.

III. ALTERNATIVES

A. COLLECTION

1. Introduction

a. This section describes the handling and loading of DDT stocks for transport. It includes repackaging and loading requirements both for bulk shipments and for individual containers, as well as the handling and disposal of empty containers. It also includes the handling at current locations and rehandling at consolidation points.

b. The total quantities of DDT to be collected are 240,662 gallons of liquid including solvents, 210,311 pounds of powder, and 62,258 "other" units, such as aerosol cans, pressurized cylinders, and small packets.

2. Alternatives For Collection

a. The following technically and environmentally feasible alternatives for collection have been considered:

(1) Inspection of the DDT stocks, overpacking as required; subsequent loading on trucks or rail cars, and directly shipping to disposal point(s).

(2) Emptying of liquid DDT from containers and bulk loading onto tank trucks or rail tank cars. Inspection of all other DDT materials, overpacking as required, and loading onto trucks or rail cars for shipment to consolidation point(s), which would be centrally located storage areas, and from there to disposal site(s). The empty containers would be cleansed and disposed of.

(3) Inspection of the DDT stocks, overpacking as required, and shipment to consolidation point(s). At consolidation points, bulk loading of the DDT liquids onto tank trucks or rail tank cars, and loading other materials onto trucks or rail cars for shipment to the disposal point(s). The empty containers would be cleansed and disposed of.

b. The following operations, which will be included in the collection procedure, are described further below: inspection for overpacking, the actual overpacking, handling and disposal of containers, and bulk loading of the liquid DDT.

3. Inspection For Overpacking

a. All containers planned for shipment, other than bulk shipment, will have to be inspected to determine overpacking (primary package placed into larger, secondary container) requirements. If any of the following situations exist, overpacking will be required:

(1) the primary package is leaking

(2) the primary package is rusted from the interior

(3) the primary package has bulging heads or ends

(4) the primary package has leaking closures

(5) the primary package is dented

(6) the secondary containers and/or fastening methods are broken/aged such that small primary packages are not contained

(7) the primary package has a manufacture date and/or repackaging date of more than ten years

(8) the existing container does not meet U.S. Department of Transportation requirements for the transport of hazardous wastes

b. A conservative assumption, based upon these overpackaging criteria, is that 50% of the DDT material needs overpacking.

4. Overpacking

a. Containers of powder DDT material determined to need overpacking will be placed into 35-gallon fibre drums. Containers of liquid DDT that need to be overpacked will be placed in 85-gallon metal overpack drums. Other units of DDT will be overpacked, as required, in both 35-gallon fibre drums and 85-gallon metal overpack drums. With overpacking, the opening of existing containers and subsequent transferral of their contents to new containers would be eliminated, thus minimizing the chance of a spill occurring.

b. At each storage site, sand bags, oil-sorb, and plastic film will be made available to protect against potential spills. The overpackaging vendor will be experienced in hazardous waste containment, cleanup, and materials transfer.

c. In the unlikely event of a spill, contaminated absorbent and cleanup materials will also be considered and handled as hazardous waste. Required spill containment and contingency plans will reduce the potential for a spill and the time necessary for cleanup.

5. Handling and Disposal of Containers

a. Regardless of the collection option utilized, all large containers (greater than 50 gallon capacity) of liquid DDT will be emptied either before reaching the disposal site(s) or at the disposal site(s). Triple rinsing of the empty containers will be required for decontamination. Triple rinsing would be done at the disposal site(s) where both safety equipment and cemented, diked areas to contain spills are available. The internal surfaces of the containers would be flushed three times with solvent or fuel oil. During each rinse the container would be filled one-fifth to one-quarter full. Sludge produced during rinsing from solids in the containers could be pumped in a slurry from the containers.

b. All empty, smaller metal containers of liquid DDT will be disposed of by incineration.

c. Triple rinsed containers could be returned to a reconditioner for reuse, to a scrap dealer for recycling, or placed in an approved secure landfill. Reconditioning firms will pay an average of $3 per used 55-gallon drum. A commercial market currently does not exist for reconditioned 85-gallon drums. In order for a drum reconditioning firm to completely clean the crevasses of the empty containers, the head of the containers would be cut away and the containers burned in a furnace. Crushing of the drums is recommended prior to recycling for scrap or landfilling. If containers are recycled as scrap, residual amounts of DDT in the rinsed containers would be destroyed during melting of the metal.

d. The impact of spills would be minimized during rinsing of the empty containers by rinsing only where safety equipment is nearby and in cemented areas diked to contain spills.

6. Bulk Loading of Liquid DDT

a. Bulk loading will involve the vacuuming of liquid DDT from its containers and pumping into tank trucks or rail tank cars. Safety equipment to handle spills will be available at the bulk loading site. With bulk loading, mixing of the various formulations of liquid DDT will occur. However, these formulations are compatible and no risks will result from their mixture.

b. Depending on the transportation modes utilized, liquid DDT may be transferred from tank trucks to rail tank cars. In order to minimize the amount of hose required for the transferral, and hence the potential for spillage, tank trucks holding liquid DDT will pull up as close as possible to rail tank cars. Safety equipment would be available for spill containment and clean-up.

c. Reference to spills and safety precautions in handling hazardous wastes may be seen in Table C-3, Key to Cautions, appearing in Appendix C.

7. Consolidation Points

Storage sites that currently have large stocks of DDT and are geographically convenient to other storage sites will be chosen as consolidation points. The storage sites designated as potential sites for all formulations are: Albany, GA; Memphis, TN; Richmond, VA; Mechanicsburg, PA; Fort Lewis, WA; Herlong, CA; Barstow, CA; Alameda, CA; and Ogden, UT. The storage sites selected as potential consolidation sites for powders only are: Stockton, CA; Elgin, FL; and Rome, NY. Most important, the consolidation points shall be storage sites that have an impervious construction and are capable of containing any runoff or spills that might occur. The storage sites chosen should not be located on or near active fault zones or in areas where they could be inundated by a 500-year flood. In addition, the sites should be dry, well-ventilated, designed to prevent fire, and separated from other structures or rooms that contain food. Unauthorized entry should be prevented.

8. Acceptable Methods of Collection

a. The alternatives for collection previously discussed, subject to the restrictions regarding inspection for overpacking, the actual overpacking, loading, and handling and disposal of empty containers, are considered to be equally satisfactory from an environmental standpoint. The specifications will permit any combination of these collection alternatives subject to the aforesaid restrictions. In addition, should it be appropriate, transfer of liquid DDT from tank trucks to rail cars will be allowed in order to facilitate the preparation of a shipment for loading onto the Vulcanus, as described in Section III.C.2.

b. The following feasible collection options are used as the basis for cost estimates and for the transportation analysis that follows. These options do not necessarily represent the collection and transport plan to be adopted.

(1) Option I - Regional Consolidation

(a) Under the regional collection scheme, a disposal vendor specializing in the repackaging and transportation of hazardous material would arrive at each storage site with containers to overpack 50% of the liquid and powder DDT and other units. The overpacked materials and containers in good condition would be loaded onto closed flat bed trucks and shipped directly to the nearest consolidation point.

(b) At the consolidation point, all liquids would be pumped from their containers into tank trucks; containers of powders, other units, and empty liquid containers would be loaded onto closed trucks. Fully loaded tank trucks and closed trucks would proceed from the consolidation sites directly to the disposal site. At the disposal site(s), the larger, metal drums (85-, 55-, and 50-gallon size) would be emptied and triple rinsed prior to container disposal or reconditioning.

(2) Option II - Partial Consolidation

(a) With partial consolidation all liquids at storage sites containing over 500 gallons of liquid would be bulk loaded onto road tankers or rail tank cars and shipped directly to the disposal point. Powders, "others," empty containers, and liquid from storage sites with less than 500 gallons would be trucked to regional consolidation points.

(b) Partial consolidation would involve a disposal vendor who specializes in the repackaging and transportation of hazardous materials arriving at all storage sites with enough containers to overpack 50% of the powder formulations and other units of DDT. At those storage sites having liquid amounts of DDT less than 500 gallons, 50% of the liquid containers would also be overpacked. The overpacked DDT containers together with containers in good condition would be transported in closed trucks to consolidation sites where large amounts of DDT are currently stored. At the consolidation sites, the liquid DDT would be vacuumed from its containers and pumped into tank trucks. Materials would be shipped from the consolidation sites directly to the disposal site(s).

(c) While the consolidation of DDT powder and small DDT liquid amounts is occurring, liquid formulations of DDT would be sequentially collected from twenty-eight storage sites having amounts of liquid DDT greater than 500 gallons. Approximately 98% of the liquid DDT inventory would be collected in this manner. These liquids would be vacuumed from their containers and pumped into tank trucks. The tank trucks would go from storage site to storage site until full tankloads are obtained. Full tank trucks would proceed directly to the disposal site(s).

(d) Empty liquid containers that had leaks would be enclosed in polyethylene bags to prevent leakage during transport to the consolidation points and later to the final disposal site(s). These polyethylene bags would be incinerated.

(e) Empty liquid containers would be triple rinsed at the disposal site(s) for subsequent reconditioning or disposal.

(3) Option III - Direct Collection

(a) For direct collection, a disposal vendor specializing in the repackaging and transportation of hazardous materials would arrive at each site with containers for overpacking 50% of the liquid and powder DDT. The overpacks and containers in good condition would then be loaded onto closed flatbed trucks. The trucks would proceed directly from the storage sites to the disposal site(s). At the disposal site(s), the larger, metal drums (85-, 55-, and 50-gallon size) would be emptied and triple rinsed prior to container disposal or reconditioning.

(b) Bulk loading, the transferral of liquid DDT from containers to tank trucks, has a greater potential for spillage than with overpacking, in which the contents of the containers of DDT remain undisturbed. Safety equipment available during bulk loading will minimize the potential for and impact of spills. Both regional and partial consolidation involve greater handling of the containers of DDT than the direct collection option. Direct collection, however, involves a greater number of shipments of smaller amounts of DDT.

8. Mitigating Measures

Collection carried out as described in this statement contains a number of mitigating measures that will minimize environmental and health risks. No further measures are considered necessary or proposed.

9. Collection Costs

The estimated costs for each of the collection options are presented in Table III.A.9-1. The breakdown of these costs is shown in Appendix E, Detailed Costs.

Table III.A.9-1

COLLECTION COSTS

	OPTION I Regional Consolidation	OPTION II Partial Consolidation	OPTION III Direct Collection
1. Labor-overpacking	$ 57,000	$ 30,000	$ 57,000
2. Container costs	192,000	57,000	192,000
3. Bulk loading charges	88,000	93,000	63,000
4. Rinsing costs	83,000	45,000	83,000
5. Other related costs	42,000	23,000	40,000
TOTAL	$462,000	$248,000	$435,000

B. TRANSPORTATION ALTERNATIVES

1. Introduction

a. This chapter is divided into eight sections. The section following this Introduction is a brief description of the public safety and environmental considerations taken when transporting hazardous materials. The third section is a description of the regulatory requirements as they relate to the collection and shipment of hazardous materials. A more detailed description of the applicable regulations is found in Appendix D. The fourth component describes the alternative modes of transportation and the options available for shipment--whether to ship the material directly from the storage sites to the disposal site or to consolidate the material at designated sites or along planned routes.

b. The fifth section quantifies the risks of spillage associated with the transportation of hazardous materials by barge, rail, and truck. Accident frequency statistics exist for these three modes although there are no statistics compiled for spills occurring as a result of an accident. It is concluded that the accident frequency for trucks is higher than rail, though the risk of a major spill is greater for rail than for truck.

c. The sixth section defines the acceptable modes of transportation for the movement of DDT. Transport by rail and truck are considered the most acceptable based on the risks, public safety, and environmental considerations discussed in previous sections. Following is a list of mitigating measures that are to be taken to ensure the safe transport of DDT. These additional restrictions include requirements for transporters to carry cleanup equipment in the transport vehicle, an escort or communication system plan, and a spill contingency plan.

d. Finally, a breakdown of the costs of transporting the DDT is provided. The costs were estimated by using two transportation schemes in order to provide a range of the transportation-related costs.

2. Public Safety and Environmental Considerations

a. The movement of hazardous materials from one location to another increases the potential for incidents hazardous to the public and to the environment. Once it has been decided that the general public and the environment are better served by disposing hazardous materials at an acceptable disposal site than by leaving them stockpiled around the country, it is imperative that all potential transport related incidents be identified and that steps be taken to minimize these dangers. The following areas have been identified as potential problem areas requiring careful attention.

(1) Load Size. The larger the load being transported, the greater will be the probable amount of material released in the event of a spill. Smaller shipments, however, require more transfers, which would increase the likelihood of a spill.

(2) Material Transfers. The more times a material is transferred from one container to another, from one location to another, etc., the greater the chance of a spill. Likewise, if that transfer is made in a public or populated area, the greater will be the potential present and/or future exposure of the public to the material in the event of a spill unless the cleanup operation is thorough. Likewise, the method of transfer (liquid pump, forklift, drum rolling, etc.) may affect the potential for a spill.

(3) Operations Personnel. The reliability, education, supervision, training, and familiarity of the operations personnel with hazardous materials and appropriate handling procedures will affect the risk of spills and the action taken in the event of a spill.

(4) Project Sponsors. The credibility, dedication, public awareness, and environmental responsibility of the project sponsors are very important in providing assurance that all critical aspects of the transportation operation have been well considered.

(5) Modal Accident Risk. Depending upon the transport mode (plane, barge, truck, or train) there are historical accident records that should be considered in evaluating transport options. However, it is difficult to obtain accurate records of actual hazardous waste spills, rates of spills, spills from specialized transport vehicles, escorted vehicles, etc., since they are not differentiated in most statistical collections.

(6) Vehicle Risk. Within a given transport mode, there are also varying risks associated with different vehicles, such as the risk of a tank truck incident vs. that of a flatbed truck incident. Such refined statistics are also very difficult to come by, especially as they depend upon the age of the vehicle, the training and experience of the driver, etc. Suffice it to say that a fairly new vehicle with design features contributing to the safe handling of hazardous materials would be preferable.

(7) Transportation Route. The routes taken by transport vehicles can determine what quantities of hazardous material traverse populous areas or major waterways, which in turn can affect the public or environmental impact of any spill. A written plan, to be submitted by each bidding contractor for approval, will outline steps to be taken to avoid transporting DDT within close proximity of major waterways whenever possible and to ensure safe transport when this is not possible.

(8) Material Packaging. The integrity of the containers presently holding hazardous materials, as well as the extent of the proposed repackaging operations and the characteristics of new containers used, will influence releases from any containers that may be dropped or otherwise violently disturbed. All containers planned for shipment will be inspected to determine whether repackaging in accordance with USDOT regulations is necessary. The criteria used in this determination is discussed in Section III.A.

(9) Physical Nature of Material. The nature of materials transported dictates in part the seriousness of an incident, as hazardous material in liquid form could remain highly concentrated on the ground and a powder could blow in the wind. Aerosol cans would present little danger unless there were a fire.

(10) Emergency Response Team. The availability and technical expertise of an emergency team charged with responding rapidly to significant spills could have a considerable impact on the public or environmental threat posed by an incident.

(11) Procedural Adequacy. The USDOT and USEPA regulations and procedures that apply to the transportation of hazardous materials may be supplemented in the case of selected transport firms by additional conditions and restrictions that have shown or can be expected to show a decrease in the risk of the occurrence of hazardous spills, or a decrease in the impact of a given spill. Examples would be a special manifest system or communication procedure.

b. The interrelationships between areas outlined above will become apparent in the following discussion, where it can be seen that in order to minimize risks in one area it may be necessary to accept additional risks in another area. Tradeoffs must sometimes be made in order to arrive at the most environmentally sound transportation concept.

3. Regulatory Requirements

a. In the federal regulatory environment, transportation of hazardous waste is subject to the regulations of the U.S. Department of Transportation (USDOT), the U.S. Environmental Protection Agency (USEPA), and the U.S. Occupational Safety and Health Administration (OSHA). Within the USDOT are subagencies that regulate particular modes of transportation: the Federal Aviation Administration (FAA), the Federal Railroad Administration (FRA), the National Highway Traffic Safety Administration (NHTSA), and the U.S. Coast Guard.

b. USDOT regulations contain requirements for the classification of materials into hazard classes, use of shipping papers, marking and placarding of vehicles, handling for different modes, hours of service, reporting of incidents, and other requirements.

c. USEPA authority has been put into force within recently promulgated regulations pursuant to the Resource Conservation and Recovery Act (RCRA) and the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) regulations.

d. OSHA has issued regulations that apply to workers' exposure to hazardous materials and the storage of flammable and combustible materials.

e. Some of the transportation regulations of these agencies are discussed in detail in Appendix D.

4. Alternative Means of Transportation

a. Transport Modes

(1) The four transport modes normally considered for the movement of hazardous materials are truck, train, barge, and plane. There are several areas in which the four can be compared:

(a) Load Size. A plane will normally carry the smallest load, a truck somewhat larger, a train larger still, and a barge the largest under anticipated collection assumptions. Therefore, if an accident occurred, the barge would probably have the largest release of hazardous material and the plane the smallest, though if the accident were severe, the plane could be assumed to have a complete fiery release while a truck would probably only have a partial release.

Therefore, the impact of the plane spill might well be worse than that of the truck. Additionally, air carriers often put such restrictions upon cargo size and shape that drums would be shipped lying down or in some cases refused.

(b) Spill Locale. A barge spill would almost certainly be in a major waterway and therefore be more severe environmentally than spills from the other three modes.

(c) Material Transfers. Spills during transfer of hazardous materials from one container to another, from one part of a storage site to another, from one vehicle to another, or during vehicle loading and unloading operations are normally small. Truck transport would require the fewest material transfers, followed by train, barge, and plane, in order to reach the final disposal site. Barge transfer spills could be the most environmentally hazardous since they are carried out near the water.

(d) Material Storage. Depending upon the size of the load to be carried, hazardous material may have to be stored while enough accumulates for a full shipment. Trucks would require virtually no interim storage, while planes, trains, and barges would certainly require some storage, during which time an incident could occur that might well be serious if storage were close to areas of environmental sensitivity.

(e) Accident Risk. Risk is discussed in more detail in Section III.B.5. Although it is generally concluded that the accident frequency for trucks is higher than for trains, the risk of a major spill by train is greater than that by truck. Statistics such as these make direct risk comparison between truck and rail impossible, although trucks can obviously be made significantly less risky by assigning escorts of one type or another.

(f) Repackaging Requirements. Shipment by plane and barge require the most repackaging of DDT stocks since these transport modes are not well-prepared to move bulk tank-type vessels.

(g) Availability of Carriers. It is rather difficult to find barge and airline companies interested in transporting DDT, while rail and trucking companies are fairly common carriers.

(2) It is apparent that regardless of the transport mode(s) selected, significant amounts of trucking would be necessary to carry the DDT to and from airports, barge docks, and rail sidings.

b. Dedicated vs. Common Carriers

(1) The question of whether a dedicated or a common carrier be assigned all DDT transport is complex. The dedicated carrier normally specializes in the transport of specific materials and has drivers trained in the characteristics and handling of those materials. The common carrier may have long experience in the handling of bulk chemicals, etc., has better availability of transport vehicles, and is generally able to carry higher levels of insurance due to its greater asset value, higher income, and broader scope of operations.

(2) Since training in the characteristics of one hazardous substance may vary somewhat from that required for the care and handling of another substance, there is no guarantee that previous driver training would be entirely transferable. However, the dedicated carrier's specialization and past driver training could be expected to give some advantage over the common carrier with regard to protection of the public and the environment.

(3) It is most important that whatever type of carrier is used, there should be someone in the transport vehicle who has been specially trained in the characteristics and handling of DDT and response to various DDT spills, unless:

(a) the transport vehicle is accompanied by an escort vehicle

(b) the shipment is small, i.e., no greater than ten drums or the equivalent

c. Ground Transport Vehicles

(1) There are various vehicles in which DDT may be shipped from one location to another:

(a) Bulk Shipment

i. Tank trucks, which have good access to DDT storage locations and low risk of spillage during transfer of liquid DDT from storage drums to tank truck, can be used. These trucks could make several stops to accumulate a full load (5,000-6,500 gallons), although the first stop should provide at least 1,000 gallons to ensure sufficient stability for the partially filled truck. Specialized tank trucks would not have low-level valves, and they could include vacuum suction and discharge units, a sludge pump, special internal lining, insulation, placarding, etc.

ii. Railway tank cars would hold 10,000-11,000 gallons and in most instances would require transfer of liquids to them by truck. They would sometimes require storage of liquids temporarily while awaiting arrival of a freight train. Specially outfitted tank cars for carrying hazardous materials are also available.

iii. Piggyback transport of liquids would involve placing the trailers of tank trucks directly on railroad flat-cars for transport to the disposal site. This combination would minimize material transfers, handling, and storage prior to rail shipment and decrease the likelihood of hazardous spills during transport.

(b) Containerized Shipment

i. Containers of liquids, powders, aerosols, etc., carried on a flatbed truck would not normally be stacked, but should be arranged in such a way as to allow periodic inspection. The truck should be equipped to contain any liquid leakage on the bed of the truck. In case of an accident, a flatbed would allow greater dispersal of materials than would a van-type truck.

ii. Containers shipped in a large van would probably not be stacked either. Loading and unloading operations would provide a greater chance for a minor spill than if a flatbed were used since the van floor is normally higher from the ground. A van is also somewhat less stable than a flatbed due to its higher center of gravity. In case of an accident, the concentration of spilled materials would be desirable.

iii. Small vans or pickup trucks would often be used to carry small quantities of materials to central locations for shipment on larger vehicles. These loads would be small enough that a serious spill need not be anticipated.

d. Transportation Options

(1) Several consolidation sites have been identified in the United States as locations to which regional stocks of DDT may be brought for consolidation into full truck or tank car loads. These consolidation points are listed in Section III.A.7.

(a) Regional Consolidation (Option I). This method would include the transport of all DDT stocks from storage sites to consolidation sites before any of them are taken to the disposal site. The procedure would allow all materials to be sorted into homogeneous groups before arrival at the disposal site and would permit considerable utilization of rail transport. However, it would require more material transfers and perhaps more transport miles than would otherwise be necessary.

(b) Partial Consolidation (Option II). This method would include the sequential shipment of large stocks of DDT (i.e., liquids at sites with more than 500 gallons) from storage sites directly to the disposal site, and smaller stocks (i.e., liquids at sites with less than 500 gallons and all powders) going to the disposal site. If most shipments were handled exclusively by truck, fewer material transfers and transport miles would be required than for regional consolidation. However, if trucks were used only to transfer liquids to rail, coordination of shipments would become rather complex.

(c) Direct Collection (Option III). This alternative would include shipment of all DDT stocks directly from storage sites to the disposal site. Again, coordination could be complicated for any rail transport. More truck loads and fewer material transfers would be required than for partial consolidation.

(2) It is clear that each consolidation scheme has its advantages and disadvantages depending upon whether truck or rail transportation is favored. For example, if rail transportation is selected, something resembling the regional consolidation scheme will probably be adopted.

e. Escort/Tracking Alternatives for Truck Transport

(1) Various methods are used for providing additional safeguards to vehicles transporting hazardous materials, depending upon the potential hazard. The primary methods are the following:

(a) Van Escort

i. A van escort normally carries two persons and a variety of safety, health, and clean-up equipment in case of a truck accident and/or spill. Such a van can maintain low visibility, which is normally desirable; there is no reason to generate unjustified public concern with regard to a movement of hazardous material unless that publicity will contribute to public safety. A vehicular escort will decrease any risk of a transport vehicle accident by anticipating or observing many potential problems (mechanical failure, fatigue, etc.), and providing a moderating influence (speed, recklessness, etc.).

ii. Unfortunately, major spills take so many different forms it is quite possible that the van escort may not be equipped to handle a given spill without emergency support. If this is the case, a trained truck driver carrying some basic cleanup equipment (absorbant pillows, plastic bags, etc.) might be as effective as the van escort in his response to small spills, as well as in his immediate response to larger spills.

iii. Whenever a repackaging crew is traveling in tandem with the transport vehicle, it can be expected that the repackaging vehicle will function as the escort van described above.

(b) Military/Police Escort

i. A military escort might carry some basic spill cleanup equipment, while a police escort probably would not. The primary advantages of either would be a decrease of accident risk for the reasons mentioned above, and quick access to local police and fire departments for fast response to any spills.

ii. The primary disadvantage of the military/police escort is the visibility and attendant publicity it would draw, causing concern for individuals who fear that a far more hazardous material is being carried. On the other hand, some may be comforted to know the shipment is being handled with such care.

(c) Radio/Telephone Communications System

i. Currently in use by major hazardous material transporters, a radio or telephone communications system calls for specified points along each transport route where contact must be made with a communications center. This center has experts on call around the clock to give information on any type of spill, as well as on emergency clean-up crews who can be called out on short notice. If such an emergency team is needed, its response time would be as short as if it had been summoned to assist a vehicular escort.

ii. In addition to tracking each transport vehicle, this communications system also provides instant access to local safety officials for crowd control during a major accident or cleanup assistance after a smaller spill.

iii. One of the major obstacles to cleaning up a large spill quickly and properly is transmitting accurate technical information from the spill site to the communications center and vice versa. A well-trained driver, a good manifest system, and a well-conceived communications system can largely overcome this obstacle.

(d) No Escort

i. There are various transport situations for which an escort or communications system would provide no real benefit to the public or the environment. It would be reasonable, for example, not to require an escort arrangement under the following circumstances: (1) when small amounts (no more than ten drums or equivalent) of DDT are transported, (2) when aerosol cans are transported, unless there are significant quantities of other DDT stocks in the same shipment, (3) when empty (but still contaminated) DDT containers are transported.

ii. In summary, a van escort/repackaging team should travel with a loaded transport vehicle whenever schedules can be made to coincide. When such an escort is not practical, a communications system will be required except for vehicles carrying small loads, aerosols, or empty containers. In addition, transport vehicles should travel together whenever they can without seriously disrupting routing schedules. Special escorts may also be called upon for travel through areas that are identified as particularly environmentally sensitive.

5. Risks of Spillage

a. The shipment of hazardous materials is conducted daily via several different modes of transportion: air, rail, truck, and barge. Selection from amongst these alternative modes requires a decision by the shipper relative to the costs and benefits associated with a particular mode of transportation. Implicit in these cost-benefit decisions is a consideration of the expected frequency of accidents that could result in a loss of cargo.

b. This frequency is a measure of the risk associated with the selection of a particular transportation mode, a risk that can be evaluated through the analysis of historical accident statistics. For the purpose of this study, it is anticipated that based on the review of available historical data on accidents, a reasonable estimate of the occurrence of a spill can be made. The results of this analysis may then be applied to compare the relative safety of each mode for the transportation of DDT.

c. Since the probability of an accident during the transportation of a hazardous substance is dependent upon the mode selected, this analysis is developed to evaluate the expected number of accidents for the shipment of hazardous materials and, more importantly, the likelihood of a spill occurring as a result, by transport mode. Three modes of transportation--truck, rail, and barge--are included in this analysis. Air, as mentioned previously, is not being considered because it is extremely expensive and airline companies are reluctant to transport the material in sufficiently large quantities.

(1) Truck

(a) The trucking industry provides for the annual shipment of millions of tons of hazardous chemical cargo across the nation's highways. The frequency of accidents involving hazardous waste transporters is not readily available from any statistics generated by either government agencies or trucking associations. However, data published by the U.S. Department of Transportation (USDOT), U.S. Department of Commerce (USDOC), and Sandia Laboratories, a prime contractor for the Department of Energy, can be combined to develop frequency measures for truck accidents and spills.

(b) The 1977 Census of Transportation published by the USDOC reports the total number of miles by state that trucks traveled carrying hazardous materials. The total miles traveled in all states in 1977 was approximately 117,847,000,000. The number of truck accidents involving hazardous material transporters reported to the USDOT, Office of Hazardous Materials Operations (OHMO) in 1977 was 14,250. Using these figures, the accident frequency would be one accident per 7,379,736 miles traveled.

(c) The types of accidents recorded by the OHMO included incidents that occur during the course of transportation (including loading, unloading, and temporary storage) in which:

i. a person is killed

ii. a person receives injuries requiring hospitalization

iii. estimated carrier or other property damage exceeds $50,000

iv. there is an unintentional release of hazardous materials from a package (including a tank)

v. fire, breakage, spillage, or suspected contamination occurs involving the shipment of a radioactive etiologic agent

(d) From this definition, it is apparent that those accidents reported are not those resulting only in spills. Therefore, it would be erroneous to assume that this accident frequency is indicative of the expected spill frequency.

(e) Sandia Laboratories, in the study Severities of Accidents (Clarke et al., 1976), calculated a truck accident frequency of 2.5 x 10^{-6} (2.5 accidents per million miles). It is apparent from this source that there exists a wide range of reported accident frequencies. One reason for this variation between the rates reported by Sandia Laboratories and OHMO is that Sandia Laboratories' rate is an average of five years of all truck accidents reported to the USDOT, Bureau of Motor Carrier Safety, whereas OHMO accidents are those involving only hazardous waste transporters for one year. Also, the total miles traveled carrying only hazardous material published by the USDOC is not utilized by Sandia Laboratories. These frequencies can be used to represent a high-low range of the expected number of accidents.

(f) Sandia Laboratories (Clarke et al., 1976) used this accident frequency to calculate the probability of an accident by severity category (as shown in Table III.B.5-1). By dividing each of these probabilities by the accident rate of 2.5 x 10^{-6} per mile, it can be shown that for a given number of accidents 97.68% will be minor, 1.83% moderate, 0.29% severe, 0.14% extra severe, and 0.06% extreme.

Table III.B.5-1

PROBABILITY OF SEVERITY CATEGORIES FOR TRUCK ACCIDENTS

Category	Probability
Minor	2.4×10^{6}
Moderate	4.5×10^{8}
Severe	7.2×10^{9}
Extra severe	3.5×10^{9}
Extreme	1.2×10^{9}

* Note: This table refers to the degree of severity of a single accident rather than the frequency of accident occurrence.

Source: Clarke et al., Severities of Accidents, 1976.

(g) The dominant factors in the determination of these severity categories are force, puncture, and fire duration. However, a quantitative definition of these categories that could be used to determine the risk of DDT spillage of a given magnitude does not exist. Agencies and organizations contacted (such as the American Trucking Association, Nuclear Regulatory Commission, and Sandia Laboratories) were unable to provide useful distinctions between these categories. Particularly, no information is available regarding the level of severity at which a loss of cargo occurs. This information is difficult to obtain because when a spill occurs as a result of an accident many variables, in addition to the mode of travel, must be considered. These variables include the type of container the material is packaged in and the type and quality of trucks utilized in transporting the material. Certain containers and trucks are designed to withstand accidents of different intensities.

(h) Despite this lack of a quantitative definition, for the purpose of assessing potential spillage, it is apparent that the likelihood of spill would be relatively low in a minor accident, somewhat greater in a moderate accident, and highly likely in severe, extra severe, and extreme accidents. This conclusion can be supported by the Nuclear Regulatory Commission (NRC), which found in the Final Environmental Statement on the Transportation of Radioactive Material by Air and Other Modes (1977) that minor accidents tend to occur in more densely populated areas where average velocity is relatively low. Table III.B.5-2 shows the distribution of the fractional occurrence of an accident occurring in a given population density zone. Three zones--low, medium, and high--were used in this assessment, and they were characterized by population densities of 15; 1,862; and 10,000 persons per square mile, respectively. The table reflects the increasing severity of accidents in rural areas as average velocity increases. If velocity is low, the force of the accident is less, and therefore the chance of a punctured container is low.

Table III.B.5-2

FRACTIONAL OCCURRENCE OF ACCIDENTS
OCCURRING IN GIVEN POPULATION DENSITY ZONE

Severity Category	Fractional Occurrence According to Population Density Zone		
	Low	Medium	High
Minor	.10	.10	.80
Moderate	.10	.10	.80
Severe	.30	.40	.30
Extra severe	.30	.40	.30
Extreme	.50	.30	.20

Source: U.S. Nuclear Regulatory Commission, Final Environmental Statement on the Transportation of Radioactive Material by Air and Other Modes, 1977.

(i) Based on this information, it can be stated that for trucks there is a low probability of a spill occurring in a minor accident, which account for 97.68% of all accidents. There is a high probability that a spill will occur in the more severe accidents, which occur 0.49% of the time. Severe accidents are more likely to occur in less densely populated areas. It is important to restate that the data in this area are weak, and the actual spill frequency may deviate from the above.

(2) Railroad

(a) The bulk movement of hazardous substances by railroad car provides a satisfactory method for transporting large volumes of material between two locations. As with any mode of transportation, certain risks are associated with the operation of railroad cars. Accident frequencies involving the transport of hazardous materials by rail and, more importantly, spill frequencies are not readily available from any statistics generated by either government agencies or private associations.

(b) The USDOT, Federal Railroad Administration (FRA) and the USDOT, Office of Hazardous Materials Operations (OHMO) both report the number of accidents involving the transportation of hazardous materials by rail. However, neither agency records the miles hazardous materials are carried by rail, so that an estimate of the expected accident frequency cannot be derived.

(c) In 1978, the FRA (USDOT, 1979) reported 1,035 accidents involving hazardous materials transporters, whereas the OHMO (USDOT, 1980) reported 1,191 such accidents. The difference in these totals is a result of the way each of these agencies defines an accident. The FRA has a narrower definition of an accident because it records those accidents that result in any one of the following:

i. more than $2,300 worth of damage

ii. death or injury

iii. impact between railroad on-track equipment and an automobile, bus, truck, pedestrian, or other highway user at a rail-highway grade crossing

(d) The OHMO definition of an accident is documented in the previous section on trucks. OHMO defines accidents in a broader sense because it includes accidents that result in the unintentional release of a hazardous material, whether it occurs during the transport, loading, unloading, or storage phase.

(e) The FRA provides a breakdown of train accidents by type. Of the 1,035 reported accidents in 1978, 79% involved derailment, 15% collision, and 6% other causes (fire, explosions, obstruction, etc.). No information is available on the type of accidents that are most likely to result in a loss of cargo.

(f) Sandia Laboratories (Clarke et al., 1976) calculated a train accident rate of 1.06×10^{-6} car accidents per car mile (1.06 car accidents per million miles). The NRC (1977) used this rate to estimate the probability of a train accident by severity class and by population density zone (Table III.B.5-3).

Table III.B.5-3

PROBABILITY OF SEVERITY CATEGORIES FOR RAIL ACCIDENTS BY POPULATION DENSITY ZONES*

Severity Category	Probability	Fractional Occurrence According to Population Density Zone		
		Low	Medium	High
Minor	.80	.10	.10	.80
Moderate	.195	.30	.40	.30
Severe	.0018	.60	.30	.20
Extra severe	.0002	.90	.05	.05
Extreme	.003	.90	.05	.05

*Note: This table refers to the degree of severity of a single accident rather than the frequency of accident occurrence.

Source: Clarke et al., Severities of Accidents, 1976, and U.S. Nuclear Regulatory Commission, Final Environmental Statement on the Transportation of Radioactive Material by Air and Other Modes, 1977.

(g) Again, no precise quantitative definition of these severity categories exists. More importantly, no information is available on the severity category at which a loss of cargo occurs. As is the case in the previous section on trucks, for the purpose of assessing potential spillage, it is reasonable to assume that the likelihood of a spill is relatively small in a minor accident, somewhat greater in a moderate accident, and highly likely in a severe, extra severe, or extreme accident.

(h) Although the accident frequency rate is higher for trucks (2.5 per million miles) in comparison to rail, the likelihood of a more severe accident occurring is greater for rail. Given an actual accident does take place the combined probability of severe, extra severe, and extreme accidents occurring is 0.70% for rail and 0.50% for truck. The chances of a minor accident occurring is 97.68% for truck and 80% for rail. Moderate accidents, which have an increased likelihood of resulting in a spill, account for 19.5% of all rail accidents and 1.8% of all truck accidents. Based on these statistics, rail cars are the most susceptible to involvement in accidents resulting in a loss of cargo, primarily because of the nature of rail shipments. They typically involve a large number of massive vehicles traveling at high speed in close proximity to each other. Collisions between these units, which have equivalent large masses and velocities, result in the mechanical deformation causing cargo spills. Unlike the tank truck, where collisions would involve the truck and a smaller vehicle, rail collisions generally involve units of equal mass.

(3) Barge

(a) Waterborne commerce comprises one of the principal methods by which commodities are transported throughout the United States. Barges provide relatively reliable low-cost transportation for the movement of liquid bulk, dry bulk, and regulated commodities over thousands of miles of inland and coastal waterways. This analysis evaluates the expected frequency of barge accidents that result in a loss of cargo. A review of the available literature, plus contact with public and private agencies, indicates that no reliable information exists regarding the expected frequency of such occurrences.

(b) The NRC calculated a barge accident frequency rate of 6.0 accidents per million barge kilometers (9.66 per million miles). They also calculated the probability of an accident by severity category and population density zone, as shown in Table III.B.5-4.

Table III.B.5-4

PROBABILITY OF SEVERITY FOR SHIP AND BARGE ACCIDENTS BY POPULATION DENSITY ZONE*

Severity Category	Probability	Fractional Occurrences According to Population Density Zone		
		Low	Medium	High
Minor	.9768	0	.50	.50
Moderate	.01973	0	.90	.10
Severe	.00027	.10	.90	0
Extra severe	.000013	.10	.90	0
Extreme	.000757	.10	.90	0

*Note: This table refers to the degree of severity of a single accident rather than the frequency of accident occurrence.

Source: U.S. Nuclear Regulatory Commission, _Final Environmental Statement on the Transportation of Radioactive Material by Air and Other Modes_, 1977.

(c) In analyzing these data, it is apparent that the chances of a severe accident occurring and resulting in a loss of cargo appear to be very small. Minor accidents are the most likely to occur when an accident takes place, having a probability of 97.68%. A possible reason for these results could be that barges travel only a few miles per hour; therefore, the velocity of impacts in accidents is low. However, because of the large mass of the vehicle and cargo, large forces could be encountered which would account for the remaining 2% of all accidents.

(d) Waterborne traffic includes a very small fraction of its travel time in high density population regions, whereas the high traffic density tends to occur in port areas and, as a result, is associated with lower speed. The NRC found that severe, extra severe, and extreme accidents are more likely to be the result of a lower speed collision in a dock area, either with another vessel or pier. The population density of dock areas in most cities is considered to be representative of a medium population zone. The NRC found that minor and moderate accidents are not likely to involve another vessel; rather, they are generally considered to occur either in open water or while vehicles are securely moored.

(e) Arthur D. Little, Inc. (1974), in a study titled A Modal Economic and Safety Analysis of the Transportation of Hazardous Substances in Bulk, estimated the accident frequency resulting in a loss of cargo to be .417 accidents per million miles. Several theories are offered to explain this finding. First, it was found that the expected number of accidents resulting in a loss of cargo is related to the number of modal units required to transport the cargo. Barge units, because of their larger capacity in comparison to truck or rail, require far fewer units to carry a given quantity and therefore have an expectation for proportionally fewer accidents. Second, the accident rate calculated addresses the probability of an accident being sufficiently severe to cause release of cargo. Such an accident would generally require that large amounts of mechanical energy be expended during the accident.

(f) Information compiled by the U.S. Coast Guard (USDOT, 1980) on the number of accidents involving barge spills of hazardous materials conforms with the findings of the Nuclear Regulatory Commission and Arthur D. Little, Inc. During the seven year period from 1973 to 1979, 321 barge accidents involving the loss of a hazardous material were reported. The number of miles traveled transporting hazardous materials is unavailable so that an estimate of the accident frequency cannot be made using this information. The total amount of material released from these accidents was approximately 3,655,000 gallons. Using these data, the average number of accidents that can be expected per year is 46 and the average amount of material released per accident is 11,400 gallons. No comparable data exist for rail or truck on the average quantity released given an accident, so this amount appears to be large.

(g) Although the risks of a spill appear to be small, it is necessary to consider the environmental impacts if one were to occur. The environmental impacts of a spill by barge would be more severe than the impacts of a spill by overland transport because a barge spill is more likely to present a water pollution hazard.

6. Acceptable Means of Transportation

a. Truck and rail are the preferred means of transportation and it is proposed to allow these in the specifications given the restrictions outlined below. The primary reasons follow:

(1) Risk of Spill. Under the restrictions outlined below, this risk is acceptable for both truck and rail transport. For reasons detailed in Section III.B.5, it is difficult to determine whether the risk of DDT transport by truck is greater or less than transport by rail. Therefore, both transport modes are recommended.

(2) Material Transfers. Truck and rail transport require the fewest DDT transfers and provide the safest methods and locations of transfer of the four primary transport modes.

(3) Potential Environmental Impacts of Spills. Given the characteristics of the DDT to be transported, any spill should pose little public or environmental danger unless it enters a major waterway. Steps will be taken to avoid the occurrence to the greatest extent possible. Reference should also be made to Section V.A.2.

(4) Operations Personnel. The personnel accompanying truck and rail shipments are the easiest to identify, train, and evaluate.

(5) Transportation Routes. Truck and rail transport routes will be chosen to avoid major waterways and any other environmentally sensitive areas that are identified.

(6) Availability. Truck and rail transport vehicles and transport companies are more readily available than other carriers to handle hazardous materials. Consequently, more truck and rail companies have experience in handling hazardous materials.

(7) Utilization. In order of preference, large quantities of liquid DDT should be carried by tank truck, piggyback arrangements (as described in III.B.4.), or rail tank car. Flatbeds and small trucks should be used to carry containerized liquids usually collected at sites with less than 500 gallons liquid DDT. Vans and small trucks should be used to carry powders, aerosols, and empty DDT drums.

b. Air transport is not acceptable for large quantities of DDT for reasons outlined below. However, when ground transport is not feasible, aircraft will be permitted to move small quantities of DDT. The availability of aircraft to carry hazardous materials is limited. Varying carrier and cargo area restrictions require limited loads, repackaging of hazardous material containers, shipment of drums lying on their sides, etc. Many additional transfer operations are required to truck DDT to and from airports, and airport storage of materials (after permits for temporary storage under RCRA Section 3004 are acquired) is necessary following arrival of DDT at its airport destination and preceding departing flights. Smaller average loads require considerably more flights, complicating logistics and tracking of shipments. Also planes do not carry bulk liquids, which would mean additional containerization and repackaging.

c. Transport of DDT by barge is not acceptable for the following reasons. First, most transfer spills are in dock areas, so the chance of a transfer spill or accident spill going into the water is very great. Second, minimum loads are quite large and therefore require extensive DDT trucking and storage (for which a "permit for temporary storage at a loading point" is required under RCRA Section 3004) near docks while full loads accumulate. Third, transfer operations are required from truck to storehouse, storehouse to barge, and vice versa at the destination. Fourth, all DDT must be containerized, requiring additional repackaging. Fifth, availability of acceptable and experienced hazardous material carriers is low. Finally, many DDT storage sites are far from navigable waterways.

7. Mitigating Measures

a. In order to ensure that the transport of DDT is handled in as safe a manner as possible, the following additional restrictions and qualifications are proposed:

(1) Transporters will be pre-qualified to bid on DDT transport.

(2) All shipments (including rail) in excess of 10 drums (or equivalent) will be accompanied by an individual trained in the handling of DDT and proper responses to various DDT spills.

(3) A written plan will be submitted by each bidding contractor for approval, outlining steps to be taken to avoid transport of DDT within hazardous proximity of major waterways whenever possible and to ensure safe transport when not possible.

(4) A written vehicle tracking or escort plan will be submitted by each bidding contractor, including the following minimum requirements:

(a) a communications center

(b) 24-hour on-call availability of at least one expert in hazardous material spill containment and cleanup

(c) citizens-band radios in all transport trucks

(d) shipment tracking by required point-to-point call-in by individuals accompanying DDT loads

(e) action plan for locating DDT transport vehicle in case accompanying individual fails to call in within prescribed period of time

(5) First aid and basic spill cleanup equipment will be required on every transport vehicle.

(6) On each transport vehicle there will be a manifest meeting RCRA Section 3002 regulations; each manifest will include telephone numbers for: the communications center identified above and two emergency spill control centers (including the EPA Emergency Response Team).

(7) The transporter will have a spill contingency plan in accordance with 40CFR Parts 112 and 1510 identifying procedure, for containment, cleanup, mitigation, and disposal of spilled materials, as well as manpower, equipment, and material resources to be committed in the event of a hazardous material spill. Documentation must also be kept concerning:

(a) cause of spill
(b) location of spill
(c) estimated volume spilled
(d) bodies of water threatened
(e) response action taken
(f) any further action proposed
(g) measures taken to avoid similar future spill.

b. It is felt that fewer restrictions than those detailed above do not provide adequate protection to the environment nor to the public, especially in light of the particular sensitivity of the American public to the environmental hazards posed by DDT.

c. It is likewise felt that more restrictions than those outlined above mean further increases in transportation costs without meaningful increases in the protection provided to the public and to the environment.

8. Transportation Costs

a. A range of transportation-related costs was estimated by taking two hypothetical transportation schemes:

(1) Regional Consolidation (Option I). In this scheme, all DDT stores are trucked to regional consolidation sites and then moved from the consolidation sites to a single disposal site within the continental U.S.

(2) Direct Collection (Option III). In this scheme all DDT stores are trucked from storage sites directly to a single disposal site within the continental U.S.

b. For comparative purposes, it is assumed that all transport is by truck. Those portions of the transportation cycle that could be efficiently changed to rail would be somewhat, though not significantly, cheaper than indicated in Table III.B.8-1 if rail transport were used.

c. The following items are included in Table III.B.8-1:

(1) Basic Transport (U.S. Stores). This category covers all transport costs of moving DDT liquids and powders from U.S. storage sites to the disposal site.

(2) Basic Transport (Overseas Stocks). This category assumes that all worldwide DDT stores have been landed in U.S. ports and covers costs of transporting them from these ports to the disposal site.

(3) Other Transport-Related Costs. This category includes:

(a) truck cleaning costs

(b) transport of aerosols, mixed substances, and empty containers

(c) vehicle demurrage charges

(d) additional vacuum truck charges, pump charges, stainless steel fitting rental, sludge unit charges, weighing charges, trailer surcharges, etc.

(4) Repackaging Crew. This category includes salaries, per diems, and overtime for the repackaging crew, including travel time, but not including charges for time spent actually decanting liquid from drums, which is included in collection costs. Also included are special repackaging vehicle operating costs and holding charges.

(5) Escort. This category covers additional costs incurred assuming the use of a communications type of escort arrangement as described in Section III.B.6.a.

d. Transportation costs will vary considerably depending upon the transport strategy chosen.

Table III.B.8-1

TRANSPORTATION-RELATED COSTS

	Regional Consolidation	Direct Collection
1. Basic transport (U.S. stores)	$200,000	$320,000
2. Basic transport (Overseas stocks)	20,000	15,000
3. Other transport-related costs	65,000	65,000
Subtotal	$285,000	$400,000
4. Repackaging crew	130,000	130,000
5. Escort (communications)	70,000	70,000
TOTAL	$485,000	$600,000

C. DISPOSAL

1. Introduction

a. Preface

(1) Possible actions for the disposal or other handling of the U.S. Government owned DDT stocks are assessed within this section. Disposal options considered in detail are ocean incineration, land based incineration, and secure landfill. A non-disposal option considered in detail is to return portions of the DDT stocks to a manufacturer. For all of the above options, an assessment of regulatory requirements, mitigating measures, costs, and other relevant factors is presented.

(2) A summary of the options is presented in Table III.C.1-1, which provides a simplified overview. The preferred options are ocean incineration and land incineration. Ocean incineration is the most desirable, but can only handle liquid formulations, whereas land based incinerators, with some additional equipment for aerosal cans and pressurized cylinders, can handle all types of materials. Return of some powder formulations to a manufacture of DDT is considered an acceptable alternative. Secure landfill is acceptable for empty, rinsed containers. It is considered a less desirable alternative for powders, should it not be possible to incinerate them.

(3) All the above options will be allowed by the proposed specifications subject to specific restrictions. Other options considered but rejected as technically unfeasible are physical/chemical treatment, reprocessing and deep well injection.

(4) While all the options to be included in the specifications are feasible, it is possible that in the present political climate the commercial firms involved might not wish or be able to bid for the work. The restrictions included are considered to be the minimum necessary to protect public health and the environment. The "no action" alternative of keeping the DDT in storage is a viable option in those cases in which no bid conforming to the specifications is received. This is also a viable option to landfilling powders. Stocks may be consolidated to improve their storage conditions and decrease the risk of seepage.

(5) All the options considered are discussed in more detail in the following sections.

Table III.C.1-1

SUMMARY OF DISPOSAL ALTERNATIVES

ALTERNATIVE	DESCRIPTION	SUITABILITY	AVAILABILITY	REGULATORY REQUIREMENTS	SPECIAL RESTRICTIONS TO BE DETAILED IN SPECIFICATIONS	COST	REMARKS
Ocean Incineration	Incineration on M/T Vulcanus at Gulf Designated Site	Most desirable but for liquids only	M/T Vulcanus based in Netherlands Gulf only site designated by USEPA	USEPA Ocean Incineration Permit USEPA permit for loading point		DDT only[1] $1,240,000 Combined with another burn $477,630	Requires special procedure for consolidation, transportation & loading of ship
On Land Incineration	Commercial land based high temperature waste incinerators	All materials	Ensco, El Dorado, AK Rollins, Bridgeport, NJ Rollins, Deer Park, TX all subject to issuance of USEPA PCB permit	State permit where required	PCB incineration permit required. 99.999% destruction efficiency	Option I (powders burned as slurry)[2] $911,500 Option II (powders burned in rotary kiln $401,200	Issuance of PCB license expected in fall of 1980
Landfill	Secure landfill in Western U.S.	Least desirable for powders Suitable for rinsed containers	A number of suitable sites available	State permit where required	Rainfall less than 15 inches Evaporation exceeds precipitation by 20 inch minimum Natural low permeability	Powders $30,495 Containers $10,560	Only to be considered if incineration is not feasible
Return to Manufacturer	Return to Montrose Chemical Corp. for reprocessing	Certain powder formulations only	Montrose indicated acceptance of 69,000 lbs of powder	USEPA exemption from pesticide registration		$3,500 for 69,000 lbs	
Special Disposal Techniques	Special techniques for handling aerosol cans and pressurized cylinders	Aerosol cans & pressurized cylinders	Requires disposer to install special equipment		Propellant gases must be collected and incinerated	$72,000 (excludes special equipment)	
Physical/ Chemical Treatment	Various treatments to change DDT into non-toxic substance	Not feasible					
Reprocessing	Re-use as raw material in chemical process	Not feasible					
Deep Well Injection	Injection into deep isolated aquifer	Not acceptable Not feasible					
No Action	Continued storage at military bases	Not desirable				$210,000 per annum	To be considered for powders if incineration is not feasible Option to consolidate at high grade warehouse

Notes:
1 - Liquids only
2 - Liquids, Powders & Mixed Materials

b. General Disposal Regulations

(1) This section provides an overview of the various federal laws and regulations applicable to the disposal of DDT. The major statutes governing are the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and the Resource Conservation and Recovery Act of 1976 (RCRA). The RCRA regulations concerning the transport and storage of hazardous wastes have recently been published. The regulations covering acceptable technical standards for waste disposal facilities will not be published until the fall of 1980. Other major legislation, such as the Clean Air Act and Clean Water Act, which have to be considered in relation to certain aspects of the disposal, are also discussed. Specific regulatory requirements of different options are considered in the individual sections.

(2) FIFRA regulations contain "recommended procedures for the disposal of pesticides" in 40CFR165.8. In 40CFR165.8, USEPA expresses a preference for incineration as a method for disposal of pesticides, followed by landfill. It must be stressed that these are recommendations within the regulations and not binding requirements. 40CFR162.5 requires approval of the USEPA Administrator for actions that do not result in disposal, such as return of DDT to a manufacturer. These require registration exemptions.

(3) Proposed RCRA regulations issued on December 18, 1978 require all disposal facilities to meet general standards. Sites are required to be located away from active fault zones and floodplains and in conformance with wetlands protection measures, the Clean Water Act, the Endangered Species Act, and the Safe Drinking Water Act (subject to certain exceptions). Active portions of facilities must be within a minimum of 200 feet from the property line of the facility. 40CFR250.43-1 (proposed).

(4) Contingency plans must be developed for each facility so as to prevent or minimize human health or environmental damage in the event of a discharge or release of hazardous waste. The plan is designed to alert entities that might be needed to provide emergency services and is structured to educate these emergency service entities (police, fire department, etc.) as well as the employees of the facility. Persons responsible for handling emergencies must be identified and trained to take necessary and appropriate measures. 40CFR250.43-3 (proposed).

(5) Training of employees in contingency procedures is required and must be updated periodically. 40CFR250.43-4 (proposed). Comprehensive recordkeeping, reporting, and compliance within the USEPA manifest system must be practiced. 40CFR250.43-5 (proposed). Daily visual inspections of many parts of the facility will be required unless the owner/operator can prove that fewer inspections are necessary. 40CFR250.43-6(proposed).

(6) Some of the other requirements under proposed RCRA regulations include site closure and post-closure rules, groundwater and leachate monitoring, financial requirements, standards for storage, storage tanks and containers, and standards for treatment/disposal. 40CFR250-43-7, 250.43-8, 250.43-9, 250.44, 250-44-1, 250.44-2, 250.45(proposed).

(7) Under regulations promulgated in the Clean Air Act and subsequent amendments, disposal facilities to be constructed for modifying the discharge of effluents into the atmosphere must obtain approval from either the state of site location or USEPA if the state does not have an approved air program. 40CFR61.

(8) Under regulations promulgated in the Clean Water Act, facility discharges to water require either a state or USEPA permit under the National Pollution Discharge Elimination System (NPDES). 40CFR122. The facility must meet specific criteria and standards to obtain the NPDES permit. Detailed criteria are given for DDT processing. 40CFR125, 40CFR129.101.

(9) USEPA controls dumping of materials into ocean waters through regulations promulgated under the Marine Protection, Research and Sanctuaries Act of 1972 and its subset, the Ocean Dumping Act. The impact of this legislation on the DDT disposal is discussed at length in Section C.2.

2. Ocean Incineration

a. Description

(1) The problem of how to dispose of unwanted pesticides, herbicides, and organochlorine wastes has been recognized for some time. Prior to the passage of the Marine Protection, Research, and Sanctuaries Act (MPRSA) in 1972, these substances as well as others were commonly dumped directly into the sea at approved ocean disposal sites. With the prohibition of such practices by the MPRSA and later by international agreement (Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, adopted 1975) alternative technologies had to be employed. In the U.S. during the early 1970s,

disposal methods primarily included direct ocean disposal, land based incineration, deep-well injection, and landfill. The additional technology of ocean incineration, however, was being developed in Europe. Initial efforts in 1969 by a German company using the Matthias I, a small tanker fitted with an incinerator, showed the technical feasibility of ocean incineration of organochlorine wastes.

(2) In compliance with USEPA requirements, Shell Chemical Company's Deer Park, Texas facility suspended conventional ocean dumping of organochlorine wastes when their permit, which expired in November 1973, was not renewed. The search for environmentally acceptable methods of disposing of their waste led Shell Chemical Company to ocean incineration, which had been used by European industry and had been evaluated and endorsed by European regulatory bodies and the scientific community. On October 4, 1974, a public hearing was held in Houston, Texas in response to Shell Chemical Company's application for a permit to incinerate organochlorine waste in the Gulf of Mexico. As a result of the hearing, Shell Chemical Company was granted a research permit for ocean incineration of 4,200 metric tons (one ship load) of their organochlorine wastes.

(3) The first ocean incineration operations conducted in U. S. waters were performed aboard the M/T Vulcanus in the Gulf of Mexico between October 1974 and January 1975. The first two burns (4,200 metric tons each) were conducted under USEPA Research Permits; the second two burns (4,200 metric tons each) were conducted under USEPA Special Permits. The wastes, which had resulted from the production of glycerin, vinyl chloride, epichlorohydrin, and epoxy resins, were a mixture of organochlorines with trichloropropane, trichloroethane, and dichloroethane predominating. Combustion efficiencies (i.e., the percentage of hydrocarbons combusted) ranged between 99.92% and 99.98%. In accordance with permit conditions, a substantial monitoring effort was undertaken. Following a review of the results, USEPA concluded that the incineration resulted in no significant adverse impact on the environment (Wastler et al., 1975).

(4) Monitoring of this event, as well as other U.S. incinerations that have occurred to date, provides the technical basis for concluding that ocean incineration is a viable alternative to other means of disposal. Based upon its belief that ocean incineration is an acceptable means of ocean disposal of certain types of unwanted materials, USEPA has designated one ocean disposal site in the Gulf of Mexico for ocean incineration and is presently in the process of

designating additional sites outside the Gulf. International acceptance of the feasibility of ocean incineration is exemplified by the fact that recently adopted amendments to the Ocean Dumping Convention regulations specifically permit ocean incineration of certain types of materials that had previously been banned from ocean disposal.

(5) The second ocean incineration operation occurred between March and April 1977. Under a USEPA Special Permit, approximately 16,800 metric tons (four ship loads) of Shell Chemical Company's wastes were burned aboard the M/T Vulcanus in the Gulf of Mexico. Waste material was similar to that incinerated during the first Shell burns. Combustion efficiency was 99.95%. Again, monitoring studies concluded that there was no significant adverse impact on the environment (Clausen et al., 1977; TerEco, 1978).

(6) The third ocean incineration consisted of three ship loads (approximately 10,400 metric tons) of U.S. Air Force-owned Herbicide Orange. The incineration was carried out during July-September 1977 by the M/T Vulcanus at a designated area in the Pacific approximately 200 miles west of Johnston Atoll. The first burn was carried out under a USEPA Research Permit and the remaining two were under a Special Permit. The Herbicide Orange consisted of an approximate 50-50 mixture by volume of the n-butyl esters of 2,4dichlorophenoxyacetic acid (2,4-D) and 2,4,5-trichlorophenoxyacetic acid (2,4,5-T). Certain lots of the herbicide contained the contaminant 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). The TCDD concentration in the entire stock of herbicide averaged 1.9 ppm and ranged from 0 to 47 ppm. Because of the extremely high toxicity of TCDD, special precautions were placed in effect during all loading and operating procedures on the ship. Results showed destruction efficiencies for 2,4-D and 2,4,5-T were greater than 99.999%, and the destruction efficiency of TCDD was greater than 99.93%. All requirements of the USEPA Permits were complied with (Ackerman et al., 1978).

b. Suitability of DDT for Incineration

(1) Incineration of DDT yields the same major combustion products (CO, CO_2, H_2O, HCl) as did Shell Chemical Company's organochlorine wastes and the U.S. Air Force's Herbicide Orange. The main difference in the DDT incineration in this particular case is that kerosene will be used as a combustion carrier with the resultant waste feed containing an approximate average 18% DDT (stock concentrations range from 5% to 25%).

(2) Several pilot studies have been conducted to determine the combustion characteristics of DDT (CCI, 1974; Ferguson et al., 1975; Riley, 1975; USEPA, 1976; Carnes and Oberacker, 1976; Wilkinson et al., 1978; and Whaley et al., 1970). Incineration of DDT in a kerosene carrier has been studied by Whaley et al. (1970) at the Canadian Combustion Research Laboratories in Ottawa. Their work showed that a DDT-kerosene formulation can be efficiently destroyed and provided the design data from which the Canadian Department of National Defense built and operated a special incineration system to destroy 107,000 gallons of DDT-kerosene formulation.

(3) Additional studies reported by Wilkinson et al. (1978) concluded that DDT can be destroyed by incineration at a temperature of 1000°C with a combustion efficiency of greater than 99.99%. Thus the regulation that ocean incineration be carried out at a minimum temperature of 1250°C includes a safety margin of 250°C.

(4) An example of acceptance of the suitability of DDT for ocean incineration is found in recent changes that have been made in the Ocean Dumping Convention. The Convention is designed to control dumping of wastes in the oceans and specifies that contracting nations will regulate disposal in their jurisdiction. Certain materials such as organohalogens and their compounds were prohibited except as trace contaminants, and other materials such as pesticides required special care. Recent amendments to Annexes I and II of the Convention regulations specifically remove disposal restrictions on organohalogens and pesticides if disposal is by ocean incineration (U.S. Department of State and USEPA, 1979).

c. Proposed Action

(1) It is proposed to include ocean incineration as an acceptable method of disposal for the liquid formulations of DDT only. As explained below it is not presently feasible to incinerate powders at sea. Kerosene will be used as a solvent in rinsing empty containers amounting to about 10% of the volume of DDT. The total amount of liquids would amount to 240,662 gallons of DDT plus 10%, or approximately 265,000 gallons in total.

(2) The liquid formulations will be collected from existing repositories, consolidated, combined with container rinse, and shipped to a port for loading onto the incinerator ship. The "waste" will be pumped directly into tanks aboard the incinerator ship. Once loaded, the incinerator ship will proceed to the designated Gulf of Mexico incineration site, following a route chosen to avoid transiting areas of unique

ecological importance, e.g., the east and west Flower Garden Banks. Upon arrival at the incineration site the incinerators will be brought to the required temperature using an auxiliary fuel. When temperatures sufficient to ensure complete destruction are reached (1250°C) the DDT kerosene mixture is fed into the incinerators. All incineration will take place within the designated incineration site, and an effective wind speed of 10 knots will be maintained over the stacks to enhance disposal of the emissions.

(3) The coordinates of the designated Gulf ocean incineration site, as revised in the Federal Register, Volume 43, No. 4, January 6, 1968, are 26°20' to 27°00'N latitude and 93°20' to 94°00'W longitude.

(4) At present there is only one ship capable of incinerating wastes at a level of destruction efficiency acceptable to the USEPA. The M/T Vulcanus, owned by Ocean Combustion Services BV of Rotterdam the Netherlands, has been used for previous ocean incinerations in the U.S. and is envisioned as a possible incinerator for the liquid DDT formulations. Specifications of the M/T Vulcanus are presented in Table III.C.2-1.

(5) This ship is currently equipped to burn liquids only. Consideration was given to dissolving the DDT in the powder formulation in kerosene. However, since the solubility of DDT is low in kerosene (approximately 8-10%) large amounts of solvent would be required. Furthermore, this would require filtering out the talc powder and other inerts contained in the powder formulations, leaving a DDT and kerosene contaminated sludge to be disposed of in a landfill. Based both on cost and environmental considerations, this option was rejected. The M/T Vulcanus has a tank capacity of 3,503 cubic meters or approximately 925,000 gallons. Thus, the liquid formulations of DDT represent about only one-quarter the shipload capacity of the Vulcanus. From discussions with the Vulcanus owners it is estimated that an incineration rate of approximately 10 metric tons (2,640 gallons, assuming a density of 1) per hour would be an appropriate rate to maintain the 99.9+% destruction efficiency. Higher feed rates would raise the temperature significantly higher, thereby risking damage to the incinerator without appreciably increasing the destruction efficiency. Thus, for the liquid formulations of DDT only a single burn of a partial shipload is required. At 10 metric tons per hour approximately four days would be required to incinerate all of the liquid DDT.

Table III.C.2-1

SPECIFICATIONS OF THE M/T VULCANUS

Length	101.95 meters
Breadth	14.40 meters
Draft, maximum	7.40 meters
Deadweight (DWT)	4,768 metric tons
Speed	10-13 knots
Tank capacity	3,503 cubic meters (cu m)
Number of tanks	15, ranging in size from 115 cu m to 574 cu m
Tank coating	No coating in tanks, pipes, pumps, etc. All equipment consists of low carbon steel
Loading equipment	Not available, but can be placed on board, if required
Hose connection	10.2, 15.2, and 20.3 centimeters (4, 6, 8 inches) in diameter
Safety equipment	Specially designed for this task and in accordance with latest regulations of IMCO, Scheepvaart-Inspectie (The Hague)
Waste to be processed	Must be liquid and pumpable. May contain solid substances in pieces up to 5 centimeters in size. Must not attack mild steel
Incinerators	2
Per incinerator:	
Overall height	10.45 m
Combustion chamber	
OD	5.5 m
ID	4.8 m

Table III.C.2-1 (continued)

Stack (top)	
OD	3.8 m
ID	3.4 m
Waste feed (max)	12.5 metric tons/hour
Combustion air (max)	90,000 m^3/hour
Burners (Vortex type)	3
Volume	120 m^3
Residence	1.0 sec at 1500°C (calculated) time

d. Loading for Ocean Incineration

(1) The overall plan for the disposal of DDT is based on the collection of liquid DDT in rail tank cars. These tank cars would transport the liquid DDT to a consolidation point near the loading port.

(2) Collection of liquid waste from 79 domestic and five foreign sites will require a period of time, estimated to be three months.

(3) Direct transfer of liquid DDT to the ship cannot be considered. It is doubtful the ship would be made available for the time necessary to collect and transport the DDT from different locations. The cost of holding the ship at dock for this period is considered economically prohibitive, even if it is available. For these reasons, it is considered essential to transfer the liquid from trucks to holding facilities. The liquid DDT can then be held for later loading onto the ship.

(4) There are currently no commercial facilities available for loading the _Vulcanus_ in the U.S. The ship in previous burns had been loaded directly at the waste generator facility. For the Agent Orange burn, the herbicide was loaded into rail tank cars at the U.S. Navy Seabee Base at Gulfport, Mississippi, taken to a commercial pier at Gulfport, and pumped directly to the _Vulcanus_.

(5) For the DDT, unless an appropriate commercial loading facility fully meeting RCRA requirements has been established by the time the contract for disposal has been let, it is proposed to bulk load the liquid DDT onto military tank cars at the consolidation points listed in Sections III.A and B. The tank cars will then be marshaled at the consolidation point nearest the loading point. At the time the _Vulcanus_ berths, the tank cars will be taken to the dockside for immediate loading onto the ship. In this way the DDT will be assembled at a military storage area under supervision of DPDS and will only be situated in the dock area for the time required for loading. Twenty to thirty cars will be involved.

(6) The loading will be at a military pier with a rail siding. The pier will be permitted as an interim storage area under RCRA. A similar system will be used as was in loading Agent Orange. That is, pumps will be set in an area enclosed by sandbags and covered with an impervious plastic sheet to contain any spillage. The DDT will be pumped directly to the _Vulcanus_ as the rail cars are brought to the dock.

(7) All appropriate requirements for collection and transportation indicated in Sections III.A and B will apply to the consolidation, transport, and loading the DDT aboard the Vulcanus. In addition, special measures will be required to contain any leakage or spillage at the marshaling point. All modifications necessary for the safe storage and transport of the DDT will be made to rail tank cars. Contingency plans will be prepared to handle possible spillages at the marshaling point or dockside, and the contractor will be required to have trained personnel and equipment available to effect those plans.

e. Regulatory Requirement

(1) Conceptually, ocean disposal of waste materials allows basically three options. The first, direct dumping into the ocean, is the most widespread practice and most easily accomplished. Incineration of wastes at sea aboard specially designed ships, herein referred to as ocean incineration, is the second viable option; it has been in practice since 1969. The third technological option is incineration at sea on a fixed platform utilizing an incinerator similar in design to land based incinerators capable of handling hazardous wastes. The fixed-platform incinerator currently is only in the feasibility study-preliminary design phase. Even if the environmental studies leading to its designation as a disposal site and the engineering studies are successful, this option is several years away from being an operational reality. For this reason, as well as its offering no environmental advantage over ocean incineration, platform incineration is dismissed from further consideration as a disposal option.

(2) Under Title I of the Marine Protection, Research, and Sanctuaries Act of 1972, responsibility for regulation of ocean disposal activities rests with the USEPA. Published regulations setting forth the procedures to be followed and the criteria to be applied in reviewing applications to dispose of materials in the ocean, inclusive of direct dumping and incineration, are found in the Ocean Dumping Final Revision of Regulations and Criteria (Federal Register Part IV, Tuesday, Jan. 11, 1979).

(a) Ocean Dumping

In the past a great variety of waste materials has been dumped directly into the ocean. However, Section 227.6 of the regulations and criteria prohibits the ocean dumping or transportation of materials containing organohalogens in concentrations above trace amounts. Clearly, then, the direct dumping of DDT into the ocean is prohibited.

(b) Ocean Incineration

i. Applicable exclusions to Section 227.6 are the basis for permitting ocean incineration. Paragraph h of Section 227.6 excludes the prohibition of organohalogens for the purpose of incineration at sea if the stack emissions consist of substances which are rapidly rendered harmless by chemical, physical, or biological processes in the sea. Combustion products resulting from the incineration of DDT are carbon dioxide, hydrochloric acid, chlorides, and trace amounts of unburned organohalogens, which may include DDT and its by-products DDD (1,1-dichloro-2,2-bis (p-chlorophenyl) ethane) and DDE (1,1-dichloro-2,2-bis (p-chlorophenyl) ethylene).

ii. From these limitations and prohibitions, ocean incineration appears to be the only viable ocean disposal alternative for DDT disposal. Therefore, Section V.A.3.b considers the environmental impacts resultant from ocean incineration of suitable DDT formulations on a special incinerator ship at the designated ocean incineration site in the Gulf of Mexico.

f. Mitigating Measures to Reduce Environmental Impact

The general mitigating measures to reduce environmental impact from ocean incineration of DDT are encompassed under three major headings: Permit conditions, requirements in incinerator, and proper site selection.

(a) Permit Conditions. Permit conditions or restrictions cannot be specifically addressed at this time; however, in the past, incineration permits have contained or addressed some or all of the following items:

i. description of waste allowed for incineration
ii. amount of material authorized for incineration
iii. port of departure
iv. loading conditions and restrictions
v. location of incineration site
vi. location of amenities and the minimum distance the loaded ship is allowed to approach them
vii. minimum destruction efficiency
viii. location of incinerator vessel with respect to other ships
ix. position and speed of incinerator ship relative to wind during incineration.
x. requirements for stack, marine, and atmospheric monitoring

(b) Requirements of Incinerator Ship. As with any process involving mechanical equipment, incineration operations are subject to malfunction and, therefore, require adequate safeguards to protect the environment and provide safety of personnel. The necessary shipboard safeguards that will be enforced during incineration are discussed below:

i. The ship must be constructed to comply with Type II ship requirements of the IMCO Code and must meet current U.S. Coast Guard requirements regarding loading and the carrying of hazardous liquid cargoes.

ii. The ship should be so designed that once loaded, shipboard pumps are only capable of discharging the liquid wastes directly into the combustion chambers. However, international regulations require that if the safety of the ship or crew is threatened, there must be some means of discharging the cargo directly into the sea. This could be effected by a separate pumping system or gravity release valves that would be officially sealed under normal circumstances.

iii. The incineration system should include the following failsafe items 1) The incinerators should be automatically shut down if one of the following conditions fall below preset (USEPA permit requirement) levels: incineration temperature, excess air feed, or waste feed rate. 2) Operational controls and monitoring should be manned at all times by a person whose sole responsibility is operating and maintaining the incinerator system at the desired combustion parameters.

iv. Tank washings should be incinerated at sea in accordance with the guidelines of the Ocean Dumping Convention and its amendments, or discharged in port facilities after consultation with relevant authorities.

(c) Site Selection. Since most materials that are candidates for ocean incineration are considered hazardous or toxic, the site chosen for their incineration should be one where environmental damage would be minimal if an accident occurred. One would have to concede that the Gulf of Mexico incineration site is close to ideal. As stated by USEPA (1976), it meets or exceeds all the criteria of site selection contained in Paragraphs 228.5 and 228.6 of the Final Revision of Regulations and Criteria on Ocean Dumping (Federal Register, Jan. 11, 1977). For example, the site is over 300 kilometers from the nearest coast, which assures there will be no effect on beaches or populated areas. In addition, the site has been referred to as a biological desert; thus important Gulf fishes are not affected. Secondly, careful and extensive monitoring of previous ocean incinerations at this site showed no significant degradation of the site's air or water quality during or following incinerations of organochlorine wastes generated during manufacture of vinyl chloride.

g. Ocean Incinerator Costs

(1) Ocean incineration costs are calculated on two bases. First, that the *Vulcanus* has to be chartered especially to incinerate the DDT, and second, that the burn is coordinated with that of some other waste. In the first case, the ship would have to be chartered from Rotterdam, Netherlands and returned to Rotterdam. In the second case, a per ton fee would be charged. In each case an additional cost for consolidating the liquids into rail cars and loading the *Vulcanus* has been included.

(2) DDT incineration alone:

Time charter	
Transatlantic travel	$ 763,215*
Incineration	661,215*
Loading	288,000
	$1,712.430

DDT burn coordinated with other wastes:

Incineration	$ 394,995*
Loading	288,000
	$ 682,995

*Based on a rate of exchange of 1 Dutch florin = $0.51.

3. On Land Incineration

a. Description

(1) Incineration is a proven method of destroying organic waste without posing a threat to the environment. Recent USEPA studies have determined that DDT can be almost totally destroyed when incinerated properly.

(2) On land incinerators, which would be used to dispose of the wastes in this project, would require a scrubber to clean the exhaust gases. Most incinerator installations use a "Venturi" type scrubber, which sprays a fine mist of water across the gas stream to remove particulates. The scrubber would also be used to neutralize hydrochloric acid, which would be formed during combustion.

b. Regulatory Requirements

(1) Incineration of hazardous wastes on land will be greatly influenced by the promulgation of RCRA regulations, as either the individual states or USEPA will be enforcing strict standards for these facilities. RCRA regulations referenced here are from proposed regulations issued December 18, 1978. FR58946-59028. In the event that final RCRA regulations differ from these proposed regulations, the DDT disposal project will comply with any RCRA regulations enacted.

(2) Trial burns must be conducted for each hazardous waste that is significantly different in physical and chemical characteristics from any previously demonstrated under equivalent conditions. Results of burns must satisfy specifications for the incineration of hazardous waste. These specifications include standards for residence time, combustion temperature, excess air, combustion efficiency, scrubber efficiency, and automatic feed cutoffs. Essentially, 99.99% of hazardous material offered for incineration must be destroyed. 40CFR250.43 (proposed).

(3) Three states--Arkansas, New Jersey, and Texas--have incinerators that are expected to meet criteria to burn DDT and associated wastes as specified in Section III.C.3.c. of this document. The state of Arkansas has passed Acts 406 and 1098 of 1979, which deal with the disposal of hazardous wastes. Regulations under the first two Acts are in hearings and have not been promulgated. The final impact of these regulations upon incineration of the DDT and associated wastes in the state is unknown at this time. The states of New Jersey and Texas grant permits for the operation of hazardous waste incineration facilities. It is not expected that special state permission would be necessary for incineration of the DDT and associated wastes. Regulations for the incineration of hazardous wastes for other states are included in the list of state legislation and regulations in Appendix F.

c. Acceptable Standards

(1) Introduction

The most realistic and practical procedure for the removal of pesticides in concentrated solutions (less than 1% by weight) and in powdered form is by destruction through incineration. This has been done on a commercial scale for over twenty years; numerous investigations to improve the efficiency of the process have been made, as reported in the literature.

(2) Destruction of DDT

(a) Laboratory investigations, on the thermal destruction of DDT (Duvall et al., 1976) indicate that p,p-DDT, the most common form of that pesticide, is converted to p,p-DDE, and that at 900°C (1652°F.) the DDT and DDE compounds are completely destroyed. A 50% destruction of DDT is reported at 350°C (662°F.) in one second. DDE is less toxic than DDT.

(b) Based on investigations performed with pilot-sized incinerators, Riley (1975) reports that Class IV halogen-contained pesticides (including DDT, aldrin, chlordane, dieldrin, lindane, Herbicide Orange, toxaphene, 2, 4, 5-T) were successfully combusted in different types of equipment under conditions ranging from two-tenths of a second retention time and approximately 1093°C (2000°F.) combustion temperature to 704°C (1300°F.) at eight to ten seconds retention time. Mention was made of the fact that it was difficult to extrapolate the data to those that might be obtainable from other combustion equipment because of the tremendous differences in the operating characteristics of the combustion devices. It should be added that 2,3,7,8 tetrachloro dibenzyl p-dioxin (known commonly as dioxin or TCDD) and tetrachloro biphenyl, also known as PCB, are included in Class IV.

(c) The literature (Ross, 1979) reports 99.991% average combustion efficiency for Herbicide Orange for a one-second dwell time in the furnace at a flame temperature of 1500°C (2732°F.), and 99.994% average combustion efficiency (Clausen et al., 1977) for a one-second dwell time at a flame temperature of 1535°C (2795°F.), when burning other organochlorine compounds in commercial incinerators onboard ship. The furnace wall temperature was in both cases approximately 1200°C (2192°F.). Controls to terminate the burn were set at 1200°C (2192°F.).

(d) Average combustion efficiencies of 99.999% have been reported on the burning of PCB and nitrochlorobenzene waste in a commercial incinerator operated on land. The flame temperature was approximately 1300°C (2372°F.). The residence or dwell time for the PCB test was approximately three seconds (Duvall et al., 1976).

(e) The review of these rules within the scope of the Resources Conservaion and Recovery Act (RCRA) will not be completed by the USEPA until the fall of 1980. These requirements are also used in this report as standards for the combustion of DDT because PCB has a similar molecular structure to DDT, similar thermal decomposition characteristics, and the requirements for PCB incineration have been defined by USEPA.

(f) According to another reference (Kennedy et al., 1969) percent losses on combustion are reported for chlorine containing pesticides as follows:

	600°C	700°C	800°C	900°C	1000°C
2,4,5-T	99.9	99.9	99.9	99.9	99.9
Dieldrin	99.1	99.4	99.5	99.5	99.5
DDT	99.2	99.3	99.7	99.9	100.
2,4-D	99.8	99.9	99.9	99.9	99.9

(g) Combustion or destruction efficiency may also be calculated on the basis of hydrocarbon removal or DDT removal. Apparently the percentage losses were determined by weighing the residues, which explains why the losses above are reported only to the first decimal place. The tests were made on a laboratory scale in controlled temperature chambers in the presence of adequate oxygen. Commercial formulations of pesticides were burned. There was no information on the dwell time, but it is believed that it was the same for all substances tested. Thus, the data can be used for comparison purposes only. They show that all of the pesticides are substantially decomposed at 1000°C. Apparently DDT decomposes more rapidly than the other tabulated pesticides plus fourteen more listed by Kennedy et al. (1969) with the exception of one, Paraquat.

(h) It is noted that the final rules of the USEPA on liquid polychlorinated biphenyls (PCBs), as of the issue of the <u>Federal Register</u> published on May 31, 1979, are as follows:

(i) Maintenance of the introduced liquids for a two-second dwell time at 1200°C (2192°F.) and 3% excess oxygen in the stack gas.

(ii) Maintenance of the introduced liquids at one and one-half second dwell time at 1600°C (±100°C) (2912°F. ±180°F.) and 2% excess oxygen in the stack gas.

(iii) Combustion efficiency of at least 99.9% computed as follows:

Combustion efficiency = $[C_{CO_2} / (C_{CO_2} + C_{CO})]\ 100$

where C_{CO_2} = concentration of carbon dioxide

C_{CO} = concentration of carbon monoxide

(i) If percentage burn or combustion efficiency is converted either to mg/m^3 of air or to ppm by volume in the incinerator emission, the following concentrations of DDT should be found in the gaseous emission from the burning of DDT alone, including the dilution due to air and to the byproducts of combustion:

% efficiency	mg/m^3	ppm
99.9	192.	10.6
99.99	19.2	1.06
99.999	1.92	0.106
99.9999	0.192	0.011

(j) The calculations are based on the use of 15% excess air, a dwell or residence time in the furnace of at least two seconds at a minimum of 1300°C.

(3) Types of Incinerators Used For Destruction of Hazardous Wastes

(a) Among the thermal destruction units used by industry are (Scurlock et al., 1975):

i. rotary kiln

ii. multiple hearth

iii. liquid injection

iv. fluidized bed

v. molten salt

vi. wet oxidation (Zimmerman Process)

vii. plasma destruction

viii. multiple chamber

ix. gas combustion

(b) Although incinerators described under Items i, ii, iii, iv, vi, and viii have been used in a number of applications, those described under Items i, ii, and viii or a combination of those common configurations have been used for the destruction of chlorinated organic compounds, which include many of the pesticides.

(c) An incineration system for combustion of solids and liquids may include the following major pieces of equipment in the sequence listed below:

i. rotary kiln

ii. liquid injection chamber

iii. afterburner in secondary combustion chamber

iv. venturi-type liquid scrubber

v. absorption tower

vi. stack

(d) The Venturi scrubber and absorption tower would be part of the gas scrubbing and cooling system. This system would remove only those constituents such as hydrogen chloride that are soluble in water. Carbon dioxide is only slightly soluble in water.

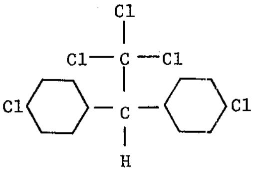
(e) The absorption of hydrogen chloride in water is rapid. Because the vapor pressure of a 10% solution of hydrogen chloride in water is very low even at 40°C (0.0282 mm Hg), it is possible to remove almost 100% of the acid with relatively small volumes of water. Although sodium hydroxide would increase the capacity of the absorption system, it is not advantageous to use this reagent because it would be wasted in the removal of carbon dioxide. The less expensive hydrated lime is used for neutralization of the scrubber water blowdown.

(f) In most cases the neutralized spent scrubbing water is temporarily stored and gradually discharged to a stream. This is probably acceptable because DDT and many of the pesticides are practically insoluble in water and would not be absorbed in the scrubbing operation.

(4) Expected Quality of the Emissions

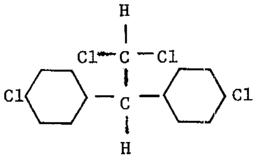
(a) Among the products in the emission from a good burn, in addition to carbon dioxide and hydrogen chloride, there could be traces of carbon monoxide, DDT, or DDE. Phosgene ($COCl_2$) has been suggested as a possible byproduct, but has never been found (Ackerman et al., 1977; Clausen et al., 1977) The dissimilarity of the molecular structure between DDT and 2,3,7,8 TCDD (dioxin) is such that it would take a much more organized reaction than that possible in an incinerator to produce dioxin (Figure III.C.3-1). Furthermore, the dioxin would be destroyed in the incineration process.

DDT



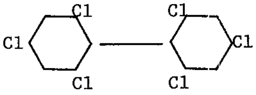
1,1,1-trichloro-2,2
-bis(p-chlorophenyl) ethane

DDE



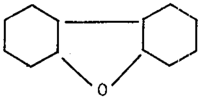
1,1-dichloro-2,2-bis
(p-chlorophenyl ethane)

PCB



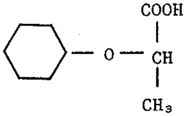
hexachlorobiphenyl

Dibenzofuran



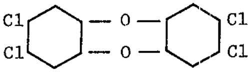
phenylene oxide

Silvex



2(2,4,5-trichloro phenoxy)
propisnic acid

Dioxin



2,3,7,8 tetrachloro
dibenzyl p-dioxine

Phosgene

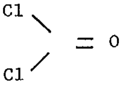


Figure III.C.3-1

Chemical Structures of Some Compounds Discussed in This Report

(b) It is believed that the very minute traces of TCDD noted during the testing of the emissions from the Herbicide Orange burn on the *Vulcanus* may have been due to interference in the instrumentation (Ackerman et al., 1978). The TCDD found on the ship was due to spillage of the Herbicide Orange solution containing TCDD, which had not been incinerated.

(c) Mention has been made by one of the public interest groups contacted that dibenzofuran ($C_6H_4OC_6H_4$) might form in the burning of DDT. No reference to this occurrence has been found in the literature. Again, it should be stated that the likelihood of dibenzofuran being formed in the incinerator is remote (Figure III.C.3-1). Furthermore, this too would be thermally decomposed.

(d) Particulate matter would also be found in the gaseous emission. It would be due primarily to the inert materials found in the powder. These would almost be completely removed in the scrubbing operation, as evidenced from data in the literature and the fact that removal of micron and even submicron-size particles is possible and feasible in a Venturi-type scrubber.

(e) It is estimated that a suitably designed incinerator with auxiliary equipment, operating with a flame temperature of 1400° to 1500°C, a furnace wall temperature of 1200°C, a dwell time of one second, without scrubbing facilities (based on a 99.99% combustion efficiency for 8% by weight of DDT in kerosene, and 15% excess air) will produce an emission containing:

	mg/m^3		ppm
DDT	0.59	or	0.041
HCl	18.0		1,112
CO_2	199,000		111,000
CO	15		13.1

With scrubbing facilities:

	mg/m^3		ppm
DDT	0.59	or	0.041
HCL	2		1.3
CO_2	198,000		110,000
CO	14		12

(f) With a dwell time of two seconds in the firing area and the same conditions as described above, it is estimated that the emissions would have the following characteristics (based on a 99.999% combustion efficiency and 15% excess air).

For 8% by weight DDT in kerosene, without scrubbing facilities:

	mg/m^3		ppm
DDT	0.06	or	0.004
HCl	1,810		1,112
CO_2	199,000		111,000
CO	2		1.7

With scrubbing facilities:

	mg/m^3		ppm
DDT	0.06	or	0.004
HCl	2.0		1.3
CO_2	198,000		110,000
CO	2		1.7

For 15% by weight DDT in kerosene, without scrubbing facilities:

	mg/m^3		ppm
DDT	0.115	or	0.008
HCl	5,411		3,624
CO_2	203,000		113,000
CO	2		1.7

With scrubbing facilities:

DDT	0.115	or	0.008
HCl	2.0		1.3
CO_2	202,000		112,000
CO	2		1.7

(g) The compositions of the gas emissions resulting from the combustion of liquid mixtures containing from 8 to 15% DDT in kerosene will vary within the aforementioned limits. A straight-line interpolation may be used to approximate the concentrations of DDT, HCl and CO_2 within that percentage range and a straight-line extrapolation between 15% and 20%. For additional information the reader is referred to Appendix C.

(5) Specifications For Burning of DDT in Liquid Emulsions or in Powder Form as Well as Other Pesticides That May Be Present

(a) There are two possible ways of incinerating the DDT-rich mixtures:

i. By dissolving the DDT and slurrying the insoluble powder in the existing liquid formulations and by adding whatever solvent is required to solubilize any residual DDT powder. The resulting liquid mixture may be injected into the furnace.

ii. By separately burning the solids in a kiln and the liquid in a liquid injection furnace.

(b) The first option is believed to be preferable from the standpoint of control of the burn. The second option is believed to be less expensive but less desirable from the standpoint of control of combustion of the powder.

(c) The contractor operating the incineration facility will receive:

i. 240,500 gallons of solvents containing 10% by weight DDT compounded from liquids with 5% to 25% DDT.

ii. 210,000 pounds of powder containing about 59% DDT, 0.25% of other pesticides (containing Lindane in the majority), and the remainder consisting of inert materials.

iii. 22,000 aerosol containers and 17,000 1-pound pressurized cylinders (see information on special disposal techniques - Section III.C.6).

(d) All powdered formulations under Option No. 1 shall be slurried in either kerosene or another suitable nonchlorinated petroleum solvent derivative at the incinerator site. These solvents would be used for background fuel. The powder delivered in drums shall be added to the solvent or vice-versa. Any fugitive dust shall be vented through a scrubber utilizing kerosene as an absorbing medium, thence through a granular activated carbon bed to remove kerosene vapors. Use of the activated carbon bed might be waived. The contractor operating the incineration facility may submit another method of venting.

(e) The resulting slurries shall be stored in agitated tanks under a curtain of nitrogen throughout the duration of the burn.

(f) The intent of these specifications is to secure 99.999% removal of DDT by incineration. To achieve that goal the incinerator shall be operated for a two-second dwell time at a minimum of 1200°C and 5% excess oxygen in the stack gas.

(g) Should the contractor choose to burn the powders in the kiln without dissolving the DDT in auxiliary solvent (Option No. 2), he shall describe the operating procedure to be followed in meeting the 99.999% DDT removal requirement.

(h) Before the burn, the background fuel shall be fed to the burners. Other fuels may be used; however, they will have to be submitted by the contractor for approval before use. In any event, background fuel shall be used for one-half hour before the burn of DDT.

(i) The feed system for the DDT waste shall consist of piping connected to the storage tanks and to the background fuel tanks, bleed off and drainage valves, valved bypasses for the control valve, and a manually operated control valve with indicating and recording or totalizing flowmeter for the waste. An automatic shutoff valve shall be located downstream from the manual control valve. This shall be shut off by a temperature sensor when the exit combustion temperature drops below 1150°C (2101°F.) and/or when the continuously recorded oxygen level in the stack gas is below 5%. At the end of a burn and in the event that a burn is interrupted either by desire or accidentally, background fuel shall be automatically injected for one-half hour.

(j) The following parameters shall be continuously monitored:

i. Firing zone wall temperature

ii. Hot duct temperature

iii. Oxygen and carbon monoxide in stack gases

iv. Waste feed flow

v. Background fuel flow

(k) The following parameters shall be measured intermittently in the gas:

i. Carbon dioxide, carbon monoxide, and oxygen by Orsat analysis (once per shift)

ii. Chlorinated organic compounds (once per day)

iii. DDT (once per day)

iv. NO_x (once per day)

v. Hydrogen chloride (once per day)

vi. Particulate matter (once per day)

(l) The following parameters shall be measured intermittently in the liquid:

- i. Acidity (daily composite from sequential sampler)
- ii. Chlorides (daily composite from sequential sampler)
- iii. Chlorinated organic compounds (daily composite from sequential sampler)

(m) The accuracy of all instruments used shall be well within the range of the concentration limits specified for the various parameters.

(n) All sampling and analyses shall be in conformance with federal EPA approved procedures. The contractor shall supply a description of the methods, apparatus, and instrumentation to be used.

(o) The spent scrubber water shall be neutralized to a pH in the 6 to 9 range to comply with the requirements of the federal EPA and the local regulatory agencies. It shall be impounded and analyzed before it is discharged to a surface stream. Should the quality of the water not be acceptable for discharge, the proper measures shall be taken to comply with the requirements of the regulatory agencies.

(p) As indicated previously, DDT is essentially but not completely insoluble in water. Its solubility, according to Hooker Specialty Chemicals Division, Lindane HGI, Form 9368 N-W, Niagara Falls, New York, is less than 0.01 ug/liter or 10 micrograms (ug) per liter. Unless the solubility is considerably less than 10 ug per liter, the resulting solution would be considered toxic in accordance with the following description.

(q) According to Water Quality Criteria: Availability, published by USEPA in the October 1, 1979 issue of the Federal Register p.56649, the following data are available:

i. Freshwater Aquatic Life. The concentration of DDT should not exceed 0.00023 ug/l as a 24-hour average, and 0.41 ug/l at any time.

ii. <u>Saltwater Aquatic Life</u>. The concentration of DDT should not exceed 0.0067 ug/l as a 24-hour average, and 0.021 ug/l at any time.

iii. <u>Human Health</u>. Consideration has been given to the potential carcinogenic effects of exposure to DDT through ingestion of water and contaminated aquatic organisms, with risks ranging from 0 additional risk to 1 in 100,000. On the latter basis the concentration limit should be less than 0.36 ug/l if only water is ingested.

(r) It appears that the concentration of DDT due to its solubility in water could exceed the above-mentioned toxic concentration limits. However, the limits are based on the receiving stream not the effluent quality. Unless the background concentration of DDT in the receiving stream is significant, a many-fold dilution may be possible, which would raise the allowable concentration in the effluent to well above the acceptable limits for stream quality.

(s) In the case of an incinerator operating at a 99.999% combustion efficiency and 99.999% removal of DDT it is likely that the concentration of DDT will be within the approved limits. However, at the lower combustion efficiencies the additional DDT present could cause the concentration limits to exceed those imposed by the regulatory agencies.

(t) Should the combustion and/or destruction efficiency decrease at any time, the CO_2 and CO analyzer will register that change and can cause a diversion valve to discharge the flow to a separate pond for the duration of the problem. The wastewater can be analyzed for DDT. If the concentration is in excess of the limits for discharge to a stream and if the water is not handled on a closed loop basis, the contractor shall remove the DDT by either biological and/or activated carbon treatment. The contractor shall submit a description of the diversion and treatment scheme proposed.

(u) It is expected that a minimum of 86,000 pounds of inert material will accumulate as a residue in the incinerator. The contractor operating the incineration facility shall test representative samples of the residue for DDT and organochlorine compounds in accordance with ASTM Standard E 122, Recommended Practice for Choice of Sample Size to Estimate the Average Quality of a Lot or Process or similar procedures. The analyses shall be performed in accordance with USEPA approved procedures.

(v) The contractor shall dispose of the solid residue either on its own property or on an approved secure land storage (landfill) operation in accordance with the latest and most stringent requirements of either the USEPA or of the local regulatory agency, whichever is the most severe. If the residual concentration of toxic constituents is greater than allowable for secure land storage, the residue shall be incinerated again until it passes the test for approved land storage.

(6) Fail-Safe Provisions in the Event of Total Power Failure

(a) All feed systems (i.e., fuel, solid waste, liquid waste, and air) shall stop in the event of total power failure. Provisions shall be made for sealing the gas exhaust piping system such as by introducing water into the low point of the piping system. This would prevent the escape of unburned gases or particulates. There may be other procedures that are satisfactory. The contractor shall submit a description of those procedures and steps to be taken to prevent the escape of unburned gases.

d. Incinerators in Operation

(1) There are currently four commercial industrial waste incinerators in operation accepting hazardous wastes from outside sources.

Ensco, El Dorado, Arkansas
Rollins Environmental Services, Baton Rouge, Louisiana
Rollins Environmental Services, Bridgeport, New Jersey
Rollins Environmental Services, Deer Park, Texas

(2) The Rollins facility at Baton Rouge is equipped with a less efficient caustic spray scrubber in place of the venturi scrubbers at the other facilities. On this basis it would not be acceptable for the incineration of DDT. Installation of a wet wall electrostatic precipitator is planned in 1981. This addition would be acceptable.

(3) The other two Rollins' facilities as well as the Ensco facility have applied for permits to burn PCBs. All have completed test burns, the results of which are currently being evaluated by USEPA. Test permits are expected to be issued in the fall of 1980.

(4) Both Ensco and Rollins indicated that they could meet the required destruction efficiency of 99.999%.

e. Mitigating Measures

Mitigation for possible land incineration activity is not necessary beyond the "Acceptable Standards" established for incinerator facilities in Section III.C.2. These standards are in excess of proposed federal RCRA standards and will provide an extra measure of protection for the public.

f. Estimated Cost of Incineration

(1) The costs of incineration are based on two procedures: dissolving solids in kerosene prior to incineration and burning solids in a commercial rotary kiln on a controlled basis. A disadvantage of the first procedure is that inert solids would have to be separated by a filter unless the incinerator burn could pass the soluble particulate solids. In other words, Option I involves the dissolution of powder in kerosene whereas Option II does not.

(2) Option I

150 tons of DDT @ $660	$ 99,000	
1,587 tons of fuel* @ $300	476,100	
	$575,100	$575,100
232,000 gallons of auxiliary fuel (kerosene) @ $1.00		232,000
Dissolution of solids in solvent 232,000 gallons @ $0.20		46,400
Field testing, laboratory analyses (3 weeks)		
Field technologists (4) 84 days @ $350	29,400	
Expenses 84 days @ $75	6,300	
Laboratory analyses	6,250	
Shipping samples	1,000	
Overhead and profit @ 35%	15,032	
	$ 57,982	57,982
		$911,482
	use	$912,000

*Including 232,000 gallons (394 tons) of kerosene

(3) Option II

150 tons of DDT @ $660	$ 99,000	
814 tons of fuel @ $300	244,200	
	$343,200	$343,200
Field testing, laboratory analyses		58,000
		$401,200

(4) The preceding tabulation shows that the cost of burning the solids (Option No. 2) without first dissolving them in additional solvents is approximately 56% less than Option No. 1 which involves dissolution of the solids. It should also be added that under Option No. 2 the heat required to vaporize the DDT prior to combustion is obtained by burning portions of the liquid formulations of DDT.

4. Secure Landfill

a. Description

(1) Placement of wastes in a secure landfill is an operation in which burial in earth is used to hold substances in place and away from areas in the environment where harmful impacts might occur. These disposed materials must be isolated from ground and surface water. This is accomplished by proper siting, controlling and diverting surface runoff, prohibiting placement of excessively wet waste, and using cover materials such as soil and vegetation. Additional protection is provided by using impermeable liners. Any water that does come into contact with the waste material must be collected, tested, and treated if contaminated.

(2) Standards for landfill operations have varied considerably in the past, and serious long-term problems have occurred where unsafe practices have been employed. The promulgation of regulations under portions the Resource Conservation and Recovery Act (RCRA) is a comprehensive effort "to require that landfills be designed, constructed, and operated so that discharges are minimized or do not occur."

(3) Any secure landfill utilized for disposal of wastes from DDT stocks will meet federal standards plus requirements specified later in this section that seek to add an extra measure of protection against future releases of toxic substances into the environment.

(4) Liquid DDT should not be deposited in secure landfills and state regulations and proposed RCRA criteria will prevent this because it is an environmentally unsafe practice. If the criteria to be stated in the following section on regulatory requirements and acceptable standards are met, powder DDT materials may be placed in secure landfills. In addition to powders, empty containers, crushed and shredded aerosol cans, and sheared and cut pressurized cylinders, which have all been triple rinsed, may be deposited in a secure landfill. The total amounts of these items are estimated at approximately 140,000 pounds (70,000 pounds as DDT) and approximately 88 tons of triple rinsed containers for a total of approximately 158 tons for disposal.

b. Regulatory Requirements

(1) There are four broad criteria categories that influence site selection: engineering, environmental, legal, and economic. Some criteria are fixed, while others are flexible. Fixed criteria indicate fatal flaws that absolutely eliminate sites. Flexible criteria can be applied more loosely and are used to rank alternative sites. Fixed siting criteria specified in RCRA proposed regulations Sections 250.43-1 and 250.45-2 which are used to eliminate potential sites are:

(a) inactive fault zones

(b) within the 100-year flood plain

(c) within the coastal high hazard area

(d) within a 500-year flood plain

(e) within wetlands

(f) in critical habitats

(g) in the recharge zone of a sole-source aquifer

(h) within 200 feet of the property line of the facility

(i) within 500 feet of any functioning public, private, or livestock water supply

(j) in direct contact with navigable waters

(k) within 5 feet of the historical high-water table

(2) The proposed regulations also include other siting considerations. Section 250.45-2(b)(19), for example, requires that soils of less than 1×10^{-4} centimeter per second permeability be located under the landfill.

(3) Two categories of landfill design are defined by the proposed RCRA regulations. The first category is for sites with extensive homogeneous clay deposits and where the evaporation rate exceeds the precipitation rate by at least 20 inches per year. In these sites, the landfill design must include a liner of 10 feet of natural inplace soil with a permeability of less than 1×10^{-7} centimeter per second. This percolation rate is generally considered nearly impervious because the rate represents a migration of about 1.25 inches per year. Leachate collection is usually unnecessary from these sites. Leachate is defined by RCRA as "the liquid that has percolated through or drained from hazarous waste or other man emplaced materials and contains soluble, partially soluble, or miscible components removed from such waste." 40CFR250.41(47)(proposed). Leachate collection would be necessary if a "bathtub" situation could occur, where liquids accumulate in areas causing surface overflow or leaks into groundwater. 40CFR250.45-2(11), (12)(proposed).

(4) Two alternate designs are suggested for the second category, where the geology and climate of the site location do not meet the requirements of the first category. Design I requires a leachate collection and removal system on top of a soil liner or natural soil and mantle barrier greater than or equal to 5 feet thick with permeability not greater than 10^{-7} centimeters per second. 40CFR250.45-1 (13)(proposed).

(5) Design II requires a double liner of soil and a membrane liner. The soil liner would be a minimum of 3 feet thick with a permeability of less than 10^{-7} centimeters per second, and the synthetic membrane must be greater than or equal to 20 milliliters thick with a permeability of less than or equal to 10^{-7} centimeters per second. Both soils and liner material used must also meet specified minimum standards. Design II requires two leachate detection and removal systems on top of the soil liner and beneath the synthetic bottom liner. 40CFR250.45-1(13)(proposed).

(6) As a minimum, groundwater monitoring should include sampling and analysis of water from the monitoring wells, the runoff system, and the leachate collection system. Groundwater and leachate monitoring are by far the most important. As noted previously, the proposed RCRA regulations require monitoring in (a) the aeration zone (leachate monitoring), drawing samples from the leachate collection system under the landfill, and (b) the saturated zone (groundwater monitoring),

drawing samples from the groundwater adjacent to the fill. 40CFR250.43-8 (proposed).

(7) The simplest groundwater monitoring network required by RCRA is a group of four wells, one hydraulically up-gradient and three down-gradient of the landfill in a line perpendicular to the direction of groundwater flow. Well spacing and depth should be determined by local conditions. Additional wells may be necessary as the landfill is developed. Standards for time between sampling and what types of substances should be tested for presence in the samples are also included. 40CFR250.43-8 (proposed).

(8) Closure and postclosure requirements are mandated in the proposed regulations. On closure, the landfill must be graded to maximize runoff and minimize erosion. The upper surface must be sealed with a 6-inch impermeable cap of clay of no greater than 10^{-7} centimeters per second permeability and then covered with 18 inches of natural soil revegetated with shallow-rooted plants. Three feet of soil cover are required for deep-rooted vegetation. 40CFR250.45-2(c)(d)(proposed). The postclosure period continues twenty years after closure, during which time the owner is required to maintain and monitor the site. 40CFR.45(d)(proposed).

(9) Many states regulate secure landfills through minimum standards and the issuance of permits. A summary of state legislation and regulations is included in Appendix F.

c. Acceptable Standards

(1) Considerable concern has been expressed during the public participation program at the long-term risks inherent in the burying of a non-degradable toxic substance such as DDT. This concern is shared by DPDS. To be acceptable it is felt that factors dependent on human control of the operation of landfill or its proper maintenance after closure should be minimized. It is therefore proposed to require that any landfill used for the disposal of DDT be in a climatic zone where water does not percolate the soil and the geology of the site reduces the risk of contamination of groundwater to neglible proportions.

(2) In order to add this extra measure of safety to the deposit of any DDT powders in a secure landfill, it is proposed that the following restrictions will be required for selection of these sites in addition to proposed RCRA regulation requirements cited in Section III.C.4.b.:

(a) Rainfall does not exceed 15 inches a year and evaporation exceeds precipitation by 20 inches or more. Maps showing annual percipitation and evaporation are included in Figures III.C.4-1 and III.C.4-2.

(b) Natural soil of low permeability on the order of at least 5 x 10^{-7} centimeters per second shall be at least several hundred feet deep and be above an interbed aquifer by at least 40 feet.

(c) Perched water tables if they exist shall be at least 130 feet below the surface and not show signs of continuous water movement.

(3) These restrictions will not apply to the disposal of rinsed containers.

d. Available Landfills

(1) To fulfill the climatic requirements indicated above, landfills will generally have to be situated in areas west of the Rockies (see Figures III.C.4-1 and III.C.4-2).

(2) A number of secure landfills were visited during the preparation of the EIS. Three were located west of the Rockies in isolated areas considerable distances from population centers. All three, subject to final evaluation of data supplied by their operators, would meet the climatic and geological criteria mentioned above.

(3) One operator would only accept wastes generated in the region where his facility is located. This policy was adopted to ease public conerns that his facility might become the dumping ground for the nation's toxic wastes, and particularily those from a neighboring state with strict controls on the disposal of hazardous materials. The operator of the other facilities did not express any such concern.

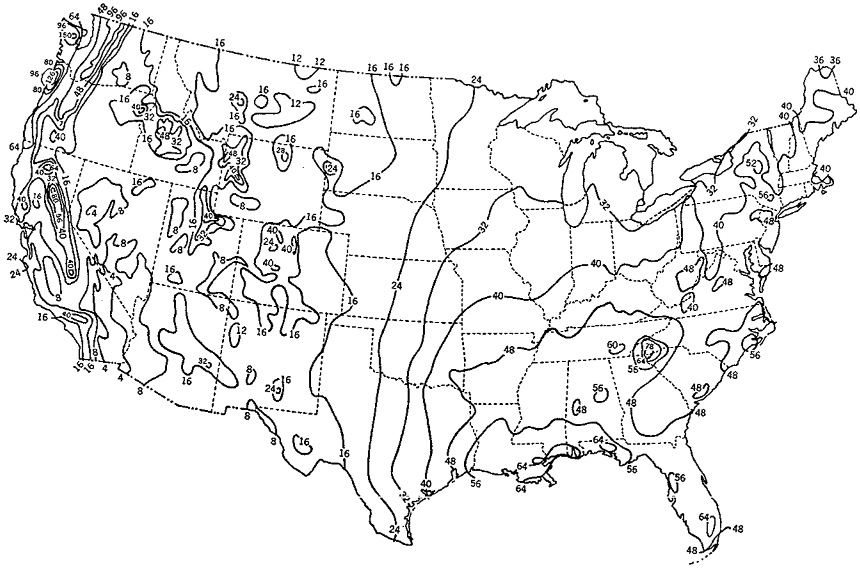
(4) There are a number of other known secure landfills in the west. Most are probably capable of meeting the specified climatic and geographical criteria.

e. Mitigating Measures.

Mitigation for possible burial in secure landfills is not necessary beyond the "Acceptable Standards" established for secure landfills in Section III.C.4.c. These are more restrictive than the proposed federal RCRA standards.

Figure III.C.4-1

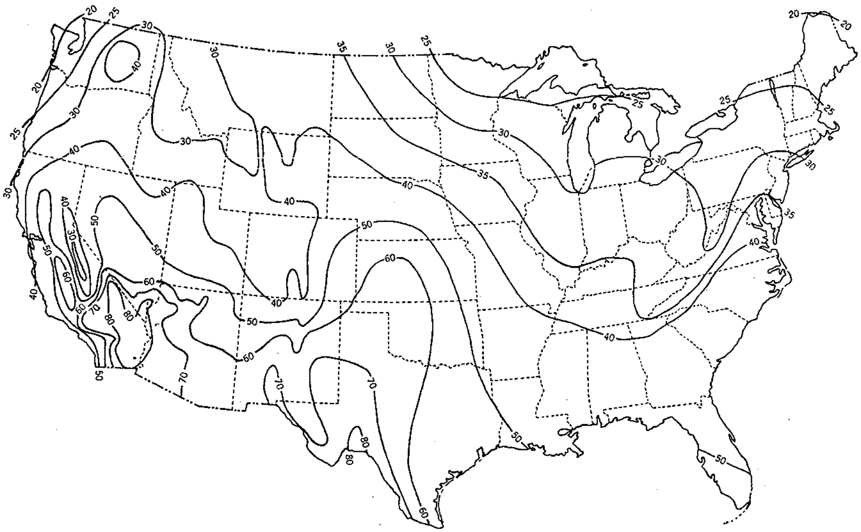
AVERAGE ANNUAL PRECIPITATION IN THE UNITED STATES



(U.S. Weather Bureau.)

Figure III.C.4-2

AVERAGE ANNUAL LAKE EVAPORATION, IN INCHES



(U.S. Weather Bureau.)

f. Costs.

The cost of disposal of 210,000 pounds of powder (123,000 pounds of DDT) is estimated at approximately $30,495 in a secure landfill. Container disposal is estimated at $10,560 for 88 tons of triple rinsed containers for a total secure landfill cost of approximately $41,055, assuming that powders are disposed in a secure landfill. Secure landfill would be the second choice option for the disposal of DDT powders after other alternatives are exhausted and/or if the comparatively small quantity of the powder inventory does not lend itself to economical destruction by a commercial incinerator, if the liquid inventory is incinerated at sea.

5. Return to Manufacturer

a. Description

(1) There is currently one manufacturer of DDT in the U.S., the Montrose Chemical Corporation of California. This firm currently manufactures DDT for special applications as allowed by the USEPA in the U.S., for export to other countries, as well as for use as an intermediate in the manufacture of other chemicals.

(2) Montrose has indicated interest in accepting only certain powder formulations for reprocessing. The DDT would not be used in its existing conditions because it has deteriorated during its lengthy shelf life. Instead, it would be reprocessed to an acceptable quality for reuse. In particular, Montrose has offered to accept approximately 69,000 pounds of a 75% DDT formulation currently stored in Stockton, California for $3,500 to cover handling, reprocessing, and proper disposal of the containers. This method would be less costly than any other acceptable method of disposal. Public interest groups participating in the project are opposed to this alternative because it would allow the export to foreign countries of a pesticide banned in the U.S.

(3) The export of hazardous materials banned or strictly controlled in the U.S. is a concern of national policy. It is argued that less developed foreign countries are accepting U.S. manufactured hazardous and toxic substances without the benefits of the sophisticated regulations and controls that exist in the U.S. As a result, their populations and environments are subject to detrimental impacts. It is further argued that in some cases these impacts could be international in scale. On the other hand, each country has the sovereign right to determine how to control the use of hazardous and

toxic materials within its borders and to decide that in certain cases the benefits of using a particular substance banned in the U.S. outweighs its costs.

(4) These are issues beyond the jurisdiction of DPDS. Montrose has stated that the returned DDT would replace virgin DDT in their existing line of products with a consequent saving of scarce petroleum-derived raw materials required for the manufacture of virgin DDT. It will not, therefore, increase the amount of DDT exported. The shipping of DoD DDT stocks to Montrose does not indicate any position by DPDS or DoD in the overall question of the export of DDT. There is no direct connection between the shipping of DoD DDT stocks to Montrose and the quantity of DDT manufactured for U.S. consumption, export, or use in the manufacture of other chemicals. Therefore, the return of these stocks will not affect the use of DDT for any of these purposes.

b. Materials Involved

(1) Montrose has expressed interest in accepting the following DDT powder formulations:

Stock No.	% of DDT
6840-290-5056	10
6840-290-6274	100
6840-00-551-8824	100
6840-00-576-5008	100
6840-00-576-5009	100
6840-00-598-7313	75
6840-252-3002	90
6840-00-264-6692	75
6840-00-058-1934	75
6840-00-079-4689	10
6840-00-240-2540	10
6840-242-4221	100
6840-00-242-4222	100

(2) The quantities, description, and location of these formulations are shown in Appendix B. The total stocks of these formulations amount to approximately 170,000 pounds.

c. Regulatory Requirements

(1) Under USEPA regulations, shipment of any portion of the DDT stocks to Montrose Chemical Company would require a USEPA exemption from pesticide registration. This exemption requires the determination of the USEPA Administrator or official appointed by the Administrator that the requirements of FIFRA do not mandate registration for the purposes of this transfer. 40CFR162.5(b)(6).

(2) An alternative course of action would be to register DDT for the purpose of this shipment. However, USEPA has confirmed that applying for an exemption is the preferable course of action in light of the structure of the regulations.

(3) Exemption requests are made to the Director of the Pesticides and Toxic Substances Enforcement Division, USEPA, Washington, D.C. The request should detail the types of waste to be transported, quantities, modes(s) of transport, labeling, purpose, and the approximate time period when the shipment(s) will occur. USEPA will respond with a determination of whether or not an exemption would be granted and place any conditions necessary for the transfer in addition to the measures stated in the request.

d. Acceptability

(1) It is recognized that the offer of DDT to the Montrose Chemical Corporation is a controversial issue. In a determination of whether to recommend this alternative in the Final EIS, note will be taken of comments on the draft.

(2) At this time, it would appear that this alternative offers equally few net risks to the environment or public safety as the other preferred alternative, incineration. It offers fewer risks than landfill. Furthermore, it is to be expected that it will save some resources in terms of material and energy inputs to manufacture the DDT it replaces. As such, this alternative is considered to be acceptable and it is proposed that it be allowed by the specifications.

e. Costs

Montrose has offered to accept approximately 69,000 pounds of 75% DDT currently stored at Stockton, California delivered to their plant at Torrance, California for $3,500 to cover unpacking, handling, and disposal of containers.

6. Special Disposal Techniques

a. Introduction

Two types of DDT containers will require special treatment prior to disposal: aerosol cans and pressurized cylinders. The aerosol containers are either 2-ounce or 12-ounce low pressure containers containing DDT, a solvent, and a propellant, which is a fluorocarbon gas. The pressurized cylinders are 1-pound refillable cylinders approximately 4 inches in diameter by 8-1/2 inches long with an 1/8-inch valve on one end and on the other a fusable plug that melts at 208°F. Methods of emptying these containers and their final disposal are discussed in the following paragraphs.

b. Low Pressure Aerosol Cans

(1) A special survey of the marketers and manufacturers of aerosol containers was conducted by the magazine *Aerosol Age*. It was determined that 59% of the companies surveyed use landfills to dispose of aerosol cans, 48% puncture the cans, and 22% crush the cans. Most companies had developed their own method of puncturing the defective cans; most devices were "home-made" and unsophisticated.

(2) Most recently, the Revlon Company developed a process for crushing cans with a stone crusher. The crusher, with some modifications and safety devices, has been successful in crushing cans that are filled with hydrocarbons by the Phillips Petroleum Company. The gases are vented to the atmosphere and the liquids are caught in an underground tank. This method has not been used on cans containing hazardous wastes, but is thought to be the latest technology in aerosol can destruction. Further modifications to such a system would have to be made for hazardous waste containers.

(3) Requirements for emptying hazardous wastes from aerosols should be given further consideration. The aerosol containers will be emptied so that the contents, including the propellants, are exhausted into an incinerator and the aerosol is discharged until the pressure is exhausted. After the gas has been discharged into the incinerator with the contents, as carried by the propellant, the aerosol cans will be punctured and/or crushed and shredded into pieces such that rinsing with kerosene can be effected. The criteria for disposal of aerosol cans will be as follows:

(a) All cans will be vented of pressure into ducting under negative pressure leading to an incinerator.

(b) After pressure release, all cans will be punctured and crushed and/or shredded such that they can be rinsed with kerosene.

(c) The punctured and crushed/shredded containers will be rinsed with 10% of the volume of the original containers using kerosene as a triple rinse.

(d) The rinsed, punctured, and crushed/shredded containers will be taken to a secure landfill, meeting criteria as cited under Section III.C.4.

(e) The rinsate from the rinsing procedure will be incinerated by an incinerator capable of destroying DDT to a destruction efficiency of 99.999%.

(4) A rinsing efficiency of 90% or greater for the removal of DDT in the crushed and shredded containers will be required or equal to the USEPA rinse procedure (three rinses, each with 10% of container capacity). Achieving this rinse efficiency will render the containers safe for final disposal.

(5) The residual DDT will be rinsed with kerosene and the rinsate incinerated. It is estimated that for 68 cubic feet of aerosol containers a rinse volume of 154 gallons kerosene will be required. It is estimated that a 90% rinsing efficiency on a container 90% empty will leave approximately 0.6 pounds of residual DDT on the containers distributed over a surface area of approximately 1,112 square feet, or about 0.00054 pounds per square feet of container surface.

c. Pressurized Cylinders

(1) In addition to the aerosol cans, special emptying and disposal techniques will have to be employed for the 1-pound refillable cylinders. These containers are approximately 4 inches in diameter by 8-1/2 inches long and are rated as pressure containers. The 1-pound refillable cylinder contains, besides DDT and solvent, the propellant dichlorodifluoromethane, which has a vapor pressure of 70.2 psig at 70°F. Therefore, the container is designed for at least 70 psig, but probably has a vapor pressure of about 100 to 150 psig.

(2) Pressurized cylinders cannot be readily crushed and disposed of in the same manner as the aerosol cans. Special venting and emptying of such containers would have to be devised. One of the techniques used for emptying unwanted contents from pressurized cylinders practiced by compressed gas manufacturers is that of venting into a scrubber using a closed system. That is, a direct connection via tubing and ducting to the disposal apparatus is required such that the contents are drawn into the equipment from the container. The disposal equipment in the case of the DDT cylinders would be an incinerator. The incinerator would destruct the DDT and also the propellant gas, dichlorodifluoromethane. The handling of the 17,000 units on an individual basis is not feasible except over a period of time. A mass discharging station to do the job would entail an engineering design and set-up that would not be warranted on a short-term project unless the system could be used by the disposer for other projects. However, it is estimated that for such a project 200 to 300 cylinders could

be discharged per day, which would take 85 to 90 days at a cost of approximately $36,000. The empty containers would then be cut or sheared and taken to a landfill for disposal.

(3) Another method for disposing of unwanted hazardous waste cylinders that has been used is concrete encasement. Several cylinders are placed in a basket within a 55-gallon drum and concrete is poured in the drum to encase the cylinders. The drums are then taken to a secure landfill. The cost of disposal excluding transportation is estimated at $400 per drum. For 17,000 units or 50 units per drum, a requirement of 340 drums is necessary, which amounts to approximately $136,000.

(4) The criteria for disposal of pressurized cylinders will be as follows:

(a) All pressurized cylinders will be vented of pressure into ducting under negative pressure to an incinerator.

(b) After pressure release, all cylinders will be cut or sheared such that the sheared cans may be rinsed with kerosene.

(c) The sheared cylinders will be rinsed with 10% of the volume of the original cylinders using kerosene as a triple rinse.

(d) Sheared cylinders will be taken to a secure landfill, meeting criteria as cited under Section III.C.4.c.

(e) The rinsate from the rinsing procedure will be incinerated by an incinerator capable of destroying DDT to a destruction efficiency of 99.999%.

(5) A rinsing efficiency of 90% or greater for the removal of DDT in the sheared cylinders will be required or equal to the USEPA triple rinse procedure (three rinses, each with 10% of container capacity). Achieving this rinse efficiency will render the cylinders safe for final disposal.

(6) The residual DDT will be rinsed with kerosene and the rinsate incinerated. It is estimated that for 567 cubic feet of pressurized cylinders a rinse volume of 1,285 gallons of kerosene will be required. It is estimated that a 90% rinsing efficiency on a cylinder 90% empty will leave approximately 10.0 pounds of residual DDT on the cylinders distributed over a surface area of approximately 7,784 square feet, or about 0.0013 pounds per square feet of container surface.

7. Unacceptable Alternatives

a. Introduction

(1) A number of alternatives have been considered for the disposal of DDT that are not acceptable or have become second or third choice alternatives, at best. If for any unforeseen reason, alternatives such as incineration are not feasible, further consideration should be given those alternatives that now seem unattractive and are now rejected. This section describes those alternatives.

(2) Physical/chemical treatment methods are described involving either dehydrochlorination, oxidation or reduction. Each of these methods has disadvantages in that 100% destruction is not achieved and byproducts are formed which are as toxic as DDT. Dilute solutions are more readily treated by physical chemical methods than concentrated solutions, but such methods do not apply to bulk concentrated quantities. Bulk concentrated quantities are more easily identified with reprocessing techniques.

b. Physical/Chemical Treatment

(1) Chemical degradation techniques investigated for the disposal of concentrated solutions of DDT include reaction with a base, chemical oxidation, and reduction (Lawless et al., 1975).

(a) Reaction with Base. In alkaline solutions and with organic bases such as amines, DDT undergoes a dehydrochlorination reaction. The dehydrochlorination reaction results in the production of DDE, which is persistent, subject to biomagnification, and adversely affects non-target species. Reaction with a base is, therefore, not a suitable disposal method.

(b) Chemical Oxidation. DDT is quite resistant to oxidation by potassium permanganate or chlorine. Ozone does remove DDT from dilute solutions, but large and impractical dosages of ozone are required and the by-products are unknown.

(c) Reduction. DDT can be reduced in the presence of heavy metals. Investigations have been made using liquid ammonia with metallic sodium or lithium. The degradation products, however, are unknown and the reagents are dangerous to use. The use of zinc powder in a mildly acidic solution also decomposes the DDT. The principal degradation product is bis (p-chlorophenyl) ethane. This product has some insecticidal properties and thus detoxification with this process is incomplete.

(2) Adsorption with either powdered activated carbon or granular activated carbon beds, alkaline hydrolysis, coagulation-filtration, anaerobic degradation, chemical oxidation, and froth flotation are a few of the physical/chemical processes that have been applied to the disposal of dilute solutions of DDT (Ottinger et al., 1973). Dilute solutions of DDT are those generated in the waste waters of the manufacturers' formulators or in solutions used to rinse empty containers. Generally, methods such as oxidation and hydrolysis convert DDT to less toxic compounds. On the other hand, methods such as coagulation-filtration, adsorption, and froth flotation do not detoxify but rather remove the DDT.

(a) Adsorption with Activated Carbon. Activated carbon beds are recommended over the use of powdered activated carbon. The spent activated carbon would be thermally regenerated at temperatures in excess of 871°C under a controlled atmosphere.

(b) Alkaline Hydrolysis. With alkaline hydrolysis, DDT would be dechlorinated at a pH of 11 in less than twenty-four hours. The resulting DDD would also be dechlorinated, but at a slower rate to form 2,2-bis-(p-chlorophenyl)-1-chloroethylene.

(c) Coagulation-Filtration. Coagulation-filtration is useful for removing insoluble DDT, but not for soluble or finely divided solutions. For soluble or finely divided suspensions, the coagulation-filtration should be followed by activated carbon adsorption. Coagulation with alum, ferric chloride, or ferric sulfate followed by filtration has removed 80% to 90% of DDT.

(d) Anaerobic Degradation. Anaerobic degradation of DDT is far more rapid than aerobic degradation. Anaerobically, DDT is almost immediately converted to DDD. DDD, with a half-life of less than one week, degrades gradually but steadily. Anaerobic degradation is not favored because of the low effluent concentrations required.

(e) Froth Flotation. Froth flotation processes can remove 90% of DDT from waste waters.

(f) Oxidation. Oxidants are not particularly effective in removing DDT from water.

(3) Ottinger et al. (1973) recommended activated carbon beds and alkaline hydrolysis as the best methods for treating dilute DDT wastes. However, chemical methods are not generally

adequate for disposing of DDT for the following reasons (Shih et al., 1975):

(a) the extent of chemical degradation is unknown or incomplete

(b) the identity of the degradation products is unknown

(c) the environmental hazards of the degradation products are unknown

(d) the chemical reagents involved are expensive and hazardous

(e) the chemical degradation products are unknown

c. Reprocessing

(1) Reprocessing techniques require sophisticated processing equipment and expertise usually found in a chemical processing facility. Facilities of those companies, such as Montrose Chemical and Boots Hercules, are interested only in a selected portion of the total stocks, usually the technical grade 100% or 75% powder, and furthermore, in quantities of several thousand pounds packaged in not smaller than 50 to 250 pound lots. This limits the amount available for reprocessing.

(2) The ideal solution to the hazardous wastes problem is to change industrial processes so that hazardous byproducts are not produced or, if that is not feasible, to extract hazardous materials from the waste streams and use them as raw materials. In the past, the cost of recovery of such materials has generally been much greater than the cost of new materials, and this option has been little used. The increased costs of disposal mandated by RCRA, though, provide a strong incentive to reduce the waste load and recover as much of the wastes as possible.

(3) In general, recovery techniques are both process- and material-specific. The most common technique for chemical recovery and treatment is pH adjustment or neutralization and oxidation or reduction reactions. These methods are appropriate for many inorganic reactions and serve to render many chemicals harmless or to change their state so that concentrates are further recovered and recycled.

(4) Further treatments commonly practiced are evaporation, distillation, adsorption, and ion exchange, among others. Usually, recovery and/or reprocessing is a multi-step process

and will involve several steps of unit operation and process to achieve a product recovery. These steps are especially necessary for a complex organic chemical such as DDT, which has a number of isomers and impurities.

(5) The recovery and/or reprocessing is further complicated in that several of the chemical processing companies that were formerly in the business of manufacture of DDT no longer make or have the facilities to process the material. They are, therefore, not interested in reprocessing a material that they no longer sell.

(6) Although recycling and chemical treatment are the least controversial and most acceptable methods for disposal of hazardous wastes, their primary advantage is that the waste material is either used or destroyed, so there is no further need for containment or monitoring. This latter statement should be qualified to emphasize that recycling and/or reprocessing assumes that a process for recovery is economically feasible, is available, and creates no other byproduct as harmful or more harmful than the one being processed.

(7) Montrose Chemical Company has expressed an interest in accepting shipment of DDT in specific formulations for reprocessing and sale. Montrose is the only firm in the U.S. permitted to manufacture DDT. Details of this alternative are given in Section III.C.5, Return to Manufacturer.

d. Deepwell Injection

(1) Deepwell injection would only be considered as a last resort in disposal of DDT. The complications of disposal of solids bearing material into deep wells entail considerable pretreatment such as filtering, aside from the unknown factors of long-term storage on the effect of a deep well system even if it is isolated and the disposal zones are of no utility value.

(2) The primary concern in the planning, construction, and operation of a deepwell disposal system is the complete protection of underground potable water, which includes water with up to 10,000 ppm total dissolved solids (TDS), according to USEPA definition. Of secondary concern is the protection of oil, gas, and valuable minerals.

(3) A deepwell disposal system consists of a disposal zone, well, and surface facility for pretreating the waste liquids. The disposal zone must be located below potable-water

aquifers and isolated from them by thick, relatively impermeable and fracture-resistant strata, such as shale, limestone, or dolomite. The zone must totally contain the waste liquids and have no other utility value. Deepwell disposal-zone depths vary from a few hundred to several thousand feet.

(4) The key to a successful deepwell system is compatibility of the waste liquids with materials of construction, formation fluid, and the formation itself.

(5) Basically, an industrial waste stream is deepwell injected only after all reasonable alternative disposal methods have been evaluated and found less desirable in terms of environmental protection and dependability.

(a) Preinjection Treatment Required

(i) The purpose of pretreatment is to prevent plugging of the disposal zone formation and damage to equipment. Unless the zone is cavernous, it is highly desirable to remove by filtration and/or clarification all solids greater than one micron from the waste liquid because accumulation of solids can plug the formation. In many cases, dissolved waste constituents will react with formation fluid, causing precipitates that will eventually plug the formation and reduce disposal zone capacity. Disposal of DDT in deepwell formations is not recommended due to the high solids content in some of the DDT formulations. In addition, solids and sludges result from decomposition of various DDT formulations.

(ii) The feasibility of a well site within an acceptable area may be determined by using as disposal zone guidelines the following 10 criteria: (1) uniformity, (2) large areal extent, (3) substantial thickness, (4) high porosity and permeability, (5) low pressure, (6) saline aquifer, (7) separation from potable-water horizons, 8) adequate overlying and underlying aquicludes, 9) no poorly plugged wells nearby, and (10) compatibility between the mineralogy and fluids of the reservoir and the injected wastes.

(b) Permits

i. Selection of a well site will usually be within the confines of the existing plant property. As a general rule, a well will not be permitted if there are other ways of treating the waste(s). Economics are not considered in the making of this decision. In most states, the essential components of the permit application include:

(a) a complete hydrologic assessment of the potable water (including mapping) within a minimum 2.5 mile radius

(b) a complete geologic assessment of the chosen disposal zone, including isopach and structure maps, E-W and N-S cross-sections, and a map of surface features

(c) a detailed engineering design of the well construction, including appropriate drawings

(d) a complete chemical analysis of each waste stream, including volumes

(e) a description of the process(es) from which the waste(s) are generated (trade secrets may be protected)

(f) a design of the surface facility for preconditioning the waste fluids before subsurface injection

(g) an identification of every wellbore ever drilled within 2.5 miles of the proposed disposal well location, an establishment of each well's present condition, and a determination as to whether the well might serve as an access from the disposal zone to the potable zones; all wells that present a possible danger must be properly corrected before a permit will be issued

(h) disposal-zone calculations that forecast fluid and pressure frontal movement away from the disposal wellbore with respect to time and cumulative volume injected

ii. The permit application is completed and submitted to the appropriate state regulatory agency, which will examine it in detail and evaluate it with respect to any and all activities ongoing or planned in the area of interest.

iii. Assuming everything is found in order, a public hearing will be set, at which time all interested parties may give testimony or comment on the merits of the proposed project.

8. No Action

a. Description

(1) The no action alternative involves the continued storage of DDT stocks at existing military depots. The stocks would continue to be inspected on a regular basis.

(2) The team preparing the EIS visited stocks at depots located in wide-ranging climatic zones throughout the U.S. At all locations with the exception of Fort Lewis, Washington the stocks were stored in well maintained, dry warehouses with concrete floors (except for a small amount at Hill Air Force Base, Utah). Any leakage at these warehouses would probably be contained within the warehouse. At Fort Lewis the warehouse roof leaked and the area is subject to heavy precipitation. At Hill Air Force Base 119 gallons were stocked out of doors in a Conex Box (small shipping container), which appeared to be weather proof and presented little concern in view of the local dry climate.

(3) The containers were generally in good condition. There were a few signs of leakage (stains on the outside of canisters), a few bulged heads (indicating internal pressure), and a few signs of corrosion from either internal or external sources. At Fort Gillam, Georgia 55-gallon drums containing DDT formulation 253-3892 had developed leaks through internal corrosion. They had been overpacked, but overpacks had developed pin-hole leaks. The manufacturer of the overpacks is investigating the cause of the corrosion to determine a method of preventing corrosion.

(4) Stocks are inspected at intervals and repacked as and where necessary. However, the responsiblity for inspection and repacking varied with the military branch. At some bases the Defense Property Officer was not responsible for inspection and repackaging.

In general, liquids present a greater risk than powders. Liquids are more corrosive and flow more easily. There was very little sign of deterioration of primary containers of powders except where they had obviously been stored out of doors at sometime. Aerosol cans and pressurized cylinders are also in good condition.

(5) On this basis it is believed that the no action alternative presents a minor risk of leakage if storage of stocks continues on the present basis. If liquids are disposed of, but powders, aerosols, and pressurized cylinders are kept in storage, the risk would be neglible.

b. Mitigating Measures

(1) The following measures could be undertaken to prevent leakage:

(a) Move all stocks into well maintained weather proof stores.

(b) Make the D.P.O. responsible for inspection and repackaging with inspection scheduled at regular intervals.

(c) Assign more stringent criteria for determining repackaging needs.

(2) The application of these measures could reduce the risk of leakage of DDT to neglible levels.

c. Costs

(1) In calculating costs it is assumed that containers of liquids and powders would be repackaged or overpacked every two years at overall costs of $423,000 including new containers/overpacks, labor and a contingency of 10%. This rate of repackaging, which is higher than the current rate, would allow the implementation of mitigation measures (b) and (c) above. No storage costs have been allocated.

(2) At this rate the annual cost of the no action alternative would be approximately $210,000.

IV. AFFECTED ENVIRONMENT

A. COLLECTION

1. The affected environments are the military warehouse and storage areas where the DDT is currently stored. These facilities, which are normally in large military complexes, are similar to their civilian counterparts, which are located in areas where the natural environment has been disturbed by man's activities. The military facilities are usually outside urban areas, as opposed to their civilian counterparts.

2. Most warehouses are well constructed and maintained buildings, weatherproofed, with concrete floors having no internal drains, and with excellent facilities for the loading of trucks or rail cars. However, some DDT is stocked outside or in substandard or leaking buildings.

B. TRANSPORTATION

The affected environment includes the major highway and rail arteries of the U.S. and immediately adjacent areas. Truck routes will be planned along major highways to the maximum extent possible. The specifications will also require trucks to avoid urban areas and proximity to waterways to the maximum extent feasible. The environment that could be affected by a spill will therefore largely be the rural areas alongside major highways where truck transport is conducted. In that there is less flexibility in rail routing, the potentially affected environments will probably include a greater share of urban areas and waterways if this option is selected.

C. DISPOSAL

1. Ocean Incineration

A full technical description of the environment at the Gulf incineration site is provided in Appendix G, which is included as supporting documentation for an ocean incineration permit application.

a. Physical Setting

The Gulf of Mexico is a semi-enclosed sea with an approximate surface area of over 1,600,000 square kilometers and a maximum depth of about 3,840 meters. Most of the oceanic input is from the Caribbean Sea via the Yucatan Strait with outflow primarily through the Florida Straits. Both of these connections with the parent Atlantic are confined to the southeastern sector and runoff from approximately two-thirds of the U.S. and more than half of Mexico empties into the basin. These factors contribute significantly to the characteristics of the Gulf in general and the western Gulf in particular.

b. Location

The location of the incineration site is centered 355 kilometers east-northeast of the Texas-Mexico border, 315 kilometers south-southeast of Galveston, Texas, and 350 kilometers south of Cameron, Louisiana (see Figure IV.C.1-1). The site occupies an area of approximately 3,900 square kilometers in the western terrigenous province of the Gulf. Water depths within the perimeter of the site range from nearly 1,100 meters to more than 1,835 meters, and the seafloor gradient for this portion of the outer continental slope is uniform and gradual. The site is seaward of Gealy's "hummocky zone" in an area of relatively low relief where the surface is cut by steep-sided troughs that extend downslope. Alaminos Canyon and Ida Greene Canyon, probable extreme components of the trough zone, flank the area of the incineration site on the west and the east, respectively.

c. Meteorologic Aspects

(1) Winds. In the region of the Gulf incineration site, winds prevail from the east throughout the year with strong northern components in evidence from November through February. They are historically calmest during July and August when they average 7-10 knots. Speeds increase somewhat during September to October but are highest in November to February when they average 13 to 15 knots. Thereafter, a subsidence is noted within the period from March through June. Abnormally high speed winds may occur at the incineration site during winter (as northers) or late summer (as tropical storms or hurricanes).

(2) Storms. A norther is a strong cold wind from the northern quadrant that generally lasts for about a day and a half. Severe storms may endure for three or four days and gust across the Gulf within a short period of time, creating very adverse weather conditions. From one to six northers are likely to be severe over the Gulf during individual years. Tropical storms (winds of 35 to 63 knots) and hurricanes (winds of 64 or more knots) are active in the Gulf during the months of August and September. The majority of those storms in the area of the incineration site move sporadically from the

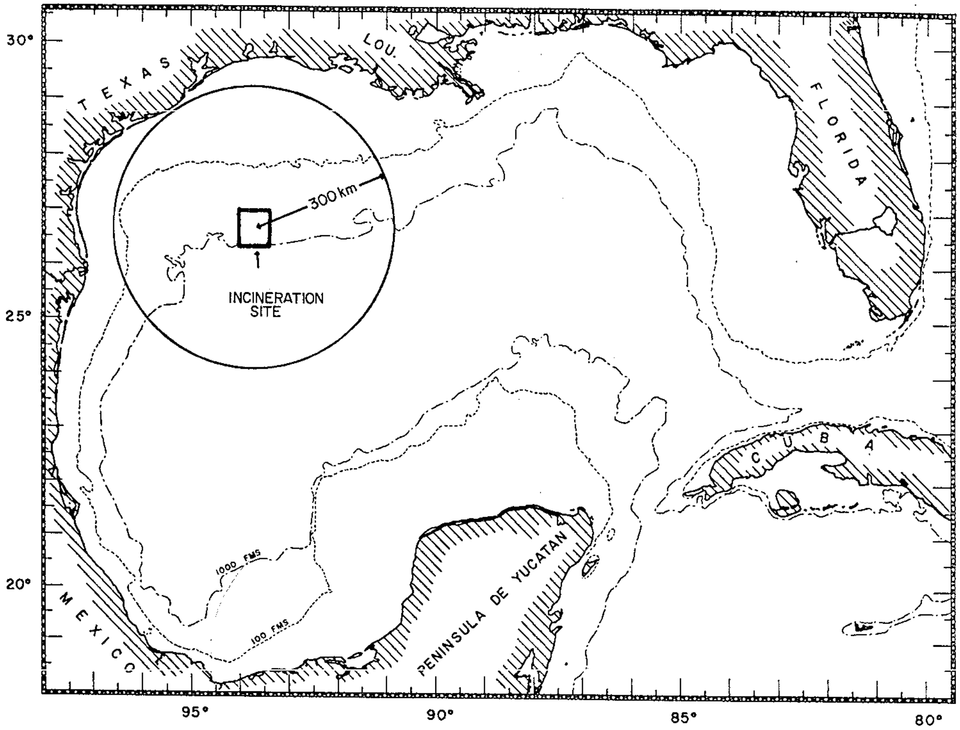


Figure IV.C.1-1: Location of the Gulf Incineration Site. This site is bounded by 26°20'-27°00'N latitude and 93°20'-94°00'W longitude. From the center of the site to closest land, the distance is about 305 km.

southeast at a mean speed of approximately 10 knots. A summary of available data indicates that forty-three tropical storms and twenty-six hurricanes can be expected to occur within or very near the site during a 100-year period.

(3) Visibility. According to information from the National Climatic Center, the subject area has a very low frequency of poor visibility.

d. The Water Column

(1) Description. The incineration site is located in oceanic water and the physical-chemical parameters of that water are typical of the west central Gulf.

(2) Salinity. At the site, salinity of the surface water is generally within the range of 36.0 to 36.4 ppt.

(3) Dissolved Oxygen. In the Surface Mixed Layer, dissolved oxygen concentration is fairly uniform and tends to be at saturation values.

(4) Currents. The flow of surface water over the incineration site varies only a small amount seasonally and the prevailing current is to the west or northwest.

(5) Wave Action. Wave direction at the incineration site corresponds closely to wind direction; during April to September waves come mainly from the southeast quadrant with influence from the northeastern quadrant being noted within the October to March period. Wave heights in the vicinity of the site are generally greater during December to February when heights ≥ 5 feet occur 50% of the time and those ≥ 8 feet occur 10% of the time. An overall low period (June to July) shows waves ≥ 5 feet in height occurring 15% of the time and those ≥ 8 feet as almost nonexistent.

(6) Pelagic Biota. The data available for the incineration site show that it is not within as productive an area as either the adjacent continental shelf or upper continental slope regions.

e. The Sea Floor

(1) In general, the benthic environment is defined and affected by the same factors that influence the waters above the bottom. Other factors to be considered for the sea bottom alone are: topographic expression; nature of sediment; and, sub-bottom temperature, salinity, oxygen, and pH.

(2) Topography. Other than for microtopographic features, the sea floor underlying the incineration site is uniform and shows little relief. The northernmost boundary of the site, adjacent to the upper slope's hummocky topography, could be somewhat irregular, but the vast majority of the study area's sea floor shows to be a somewhat smooth and gradual slope, i.e., one part declivity per 100 parts distance. No prominent banks or topographic highs (features characteristic of the shelf break in the northwest Gulf) are known to exist within this region.

(3) Surficial Sediments. Bottom sediments are predominantly fine-grained, post-glacial alluvial silts and clays in the deep-water portion of the Gulf of Mexico, while complex patterns and mixtures of grain sizes characterize the upper slopes and shelves.

(4) Benthic Biota. Whereas the plankton biota of the surface waters over the site may be viewed primarily as transitional between that of the shelf and that of the deep Gulf, such is probably not the case with the benthic fauna. Most of the benthic inhabitants of the slope are not found elsewhere, and together they constitute a complex, true slope fauna.

f. Endangered and Threatened Species

(1) Several federally designated endangered species occur, either on a permanent or on a transitional basis, within the area encompassed by this study. A definitive portrayal of geographic range has not been accurately identified for many of the species, but because it is possible that motile forms such as whales and sea turtles traverse the incineration site, a brief description for these species follows:

(a) Whales - Six species of whales known to inhabit the Gulf are considered endangered. The population status and migratory patterns of these species are unknown.

(b) Sea turtles - Five species of sea turtles are considered endangered. However, the areas of concern are the high energy beaches that the turtles utilize for nesting.

(2) Because of the distance between the incineration site and the critical habitat of the various species or the transitory occurrence of marine species near the site, the endangered and threatened species should suffer no ill

effect from incineration activities. Accidental spillage, resulting in a localized kill of marine life, would be the only possible impact of significance and such an occurrence is considered remote.

g. Human Amenities

When viewed from a cultural or economic standpoint an amenity, by definition, is a feature of quality, attractiveness, and/or value. Human amenities can be grouped into three categories (biologic, economic, and recreational) for the northwestern Gulf region. There are no areas of biologic or cultural concern in the area of the incineration site. The intensively studied Flower Garden Banks (northernmost thriving tropical shallow water coral reef on the eastern coast of North America) is located 133 kilometers north of the site. From an economic standpoint, the site is at least 75 kilometers from the nearest shipping fairway and far seaward of the continental shelf and its associated commercial fisheries. Since the incineration site is over 300 kilometers offshore, it is highly unlikely that any but an occasional fishing or sailing vessel for recreation would ever occur in the area. The majority of sport fishing occurs within 25 miles of the shoreline.

2. Land Incineration

The affected environment of this disposal alternative is the area surrounding the land incinerator. Hazardous waste incinerators are generally located in industrial areas close to other sources of air pollution, such as oil refineries and chemical plants. However, in analyzing the impacts of disposal at any suitable incinerator that meets certain criteria contained in the proposed specifications, it must be assumed that such an incinerator might be located close to residential and other sensitive areas, that background pollutant concentrations are low, and that meteorological conditions are the worst possible in terms of concentrating pollutants at sensitive receptors.

3. Landfill

a. The secure landfills to be considered would have to be in relatively arid sections of the U.S., those generally lying west of the Rockies. As such, they are likely to be located in remote areas with low intensity agricultural land use. They are likely to be underlain with impervious clays or rocks, and the water table will lie at a considerable depth.

b. However, in the worst case assumption, proximity of intense agricultural areas (for example, irrigated farmland, residences, and other potentially sensitive areas) must be considered. Nevertheless, as a minimum, they must meet the meteorological and geological conditions described in Section III.C.3, which will be included in the proposed regulations.

4. Return to Manufacturer

The affected environment would be the Montrose Chemical Corporation plant at Torrance, California. This is a major chemical plant.

5. Special Disposal Techniques

The disposal of aerosol cans and pressurized cylinders covered by these techniques will be at land based incinerators. The affected environment was described in Section IV.C.2.

6. Unacceptable Alternatives

Because plants or facilities capable of disposing of the DDT by unacceptable means (that is, physical/chemical treatment, reprocessing, and deep well injection) have not been identified, their affected environments cannot be discussed.

7. No Action

a. The DDT is currently stored at 79 military installations located in 34 states throughout the U.S. (see Figure I.1-1) as well as Puerto Rico, Guam, and three foreign countries. Ten of these storage areas were visited by team members, and following is a generic description of the environmental conditions at these sites.

b. The 79 military installations are located in a wide variety of locations from deep rural areas to major cities. They are in themselves major developments employing many people. They usually cover large areas, which are necessary for military exercises, airfields, and housing for employees and their dependents. Some stores, however, are in military warehousing complexes or naval bases within constrained areas.

c. Most stores are in warehouses or warehouse complexes similar to those that may be found in the waterfront area of major ports. They are areas disturbed by man's activities. Although most are distant from residential areas, some are located in developed areas.

d. None of the stores were located close to sensitive environmental areas such as wetlands or streams. No assessment of groundwater resources or quality under the store was made. It must be assumed, however, that productive or potentially productive aquifiers exist under some storage areas.

V. ENVIRONMENTAL CONSEQUENCES

A. PROBABLE ADVERSE EFFECTS THAT CANNOT BE AVOIDED

1. Collection

a. In the unlikely event that significant quantities of DDT escape during collection adverse environmental impacts could result. Whether for bulk shipment or shipment in containers, the disposer will be required to take all measures to minimize the risk of spills while handling the DDT. In the event of spillage, it is likely the DDT will escape in a warehouse storage facility typically having concrete floors without drains. This type of impervious construction should facilitate containment and clean-up. Should DDT be released to the soil, it is likely to be at a storage area in a large military complex, away from drinking water supplies and other sensitive areas. The disposer will be required to have a spill contingency plan to handle such spills safely. In addition, each military storage area (DPDO) is required to have a spill contingency plan.

b. Disposers will be required to use personnel trained in the handling of hazardous wastes and to use all necessary protective clothing and equipment to protect their people and others involved in the collection. In this manner, workers will be exposed to minimal health and safety risks.

c. Empty containers will be triple rinsed to remove all but trace amounts of DDT. The rinsed containers will then be disposed of in a secure landfill, remelted as scrap (destroying any traces of DDT), or reused for handling hazardous materials. None of the container disposal alternatives presents any significant environmental or health risks.

d. In conclusion, the collection of DDT stocks does not represent any significant environmental impact.

2. Transportation

a. Introduction

(1) Any and all of the materials covered in this study could be involved in a spill incident since they all must be transported from their existing location to a final disposal site. These materials include: powders between 10% and 100% DDT, liquids between 5% and 25% DDT, and aerosol cans with 2% to 3% DDT.

(2) The amounts and types of material involved in a spill would depend upon the collection option being utilized, the type of vehicle, and the severity of the accident. If the DDT is being transported without repackaging, a spill would result from the rupture of one or several of the existing containers. These containers range from 2 ounce cans of 10% DDT powder to a 100 pound drum of 100% DDT powder or a 55 gallon drum of 25% DDT liquid.

(3) If the liquid DDT is collected in a tank truck for shipment to a disposal site, an accident could result in the spill of 5,000 gallons of a mixture of 5% to 25% DDT. It is probable that if the tank truck were ruptured, the entire contents would be lost.

(4) If the DDT is collected and packed into rail box cars or tankers, the magnitude of a spill would probably be much greater since there would be larger quantities of DDT concentrated in a single container.

(5) The rest of this discussion will assume an accident involving a full tank truck that is ruptured and loses 5,000 gallons of 15% DDT. In an accident with a truck or box car of solid or aerosol materials, it is probable that most of the separate containers would not be ruptured and so the release of DDT to the environment would be much less than from a tank truck. An accident with a truckload of 55 gallon drums of liquid would be very similar to that of a tank truck, only the impact would be proportionally smaller. A rail tanker accident would have a proportionally larger impact. A spill of 5,000 gallons of 15% DDT would contain 6,750 pounds of DDT in an oily medium. One 55 gallon drum would release about 75 pounds of DDT.

(6) The first action after any spill would be to secure the area and limit access to authorized persons. This procedure is to make cleanup easier and to prevent any spreading of the material. There is no danger of explosion, there would be no poisonous gases, and the DDT is not toxic to humans at the low concentrations that would be present.

(7) The second step would be to contain in place as much DDT as feasible to prevent the DDT from being dispersed into the environment and to make it possible to recover most of the spilled material. If the material is spread out on the roadway, it should not be washed off unless necessary. Drainage swales or intermittent streams can be temporarily blocked with earth or straw bales. The top several inches of ground cover can then be collected and disposed of in the same

manner that is used for the other solid materials. DDT on road surfaces can be washed off, collected, and disposed of with the other liquids. These cleanup efforts would not be significantly affected by surrounding land uses. If the spill occurs in a heavily populated area or traveled roadway, there would be some inconvenience due to the requirement to limit access to the spill site for cleanup purposes.

(8) The amount of DDT remaining in the environment after cleanup is difficult to forecast. Assuming that the spill is contained on the ground, it should be possible to recover about 95% of the DDT. Approximately 340 pounds would be left in the environment from a tank truck spill. Only 4 pounds would be left from a single 55 gallon drum spill. Most of this quantity would remain in the soil. Orgill et al. (1976) estimated resuspension rates for aerial sprayed DDT at only 10^{-8} fraction per second. Therefore, it is unlikely that any of the spill would evaporate. The fate of DDT in the soil is discussed later.

(9) If the spill occurred on a bridge or adjacent to a stream, most of the DDT would be washed into the water. It would be very difficult to recover any of the spill. The impact of DDT on the aquatic environment will be described later.

(10) There is little reason to try to establish particular shipping routes in order to minimize the impact of a spill. Routes should be chosen that would avoid locations of high accident probability. Spills on the ground will be confined to the immediate area of the accident and should not have any other adverse impacts. Spills into water courses cannot be easily recovered. However, any transportation route will cross bridges and there is little reason to attempt to avoid specific rivers.

b. DDT in Soils

(1) DDT left in or on the ground will not remain there indefinitely. A number of degradation mechanisms have been identified, although there seems to be a wide divergence of opinion concerning the rate at which the DDT will be broken down. Woodwell et al. (1967) estimated a mean half-life of DDT in soils to be about 5.3 years. Metcalf and Pitts (1969) indicated a half-life of 2 to 4 years and Menzie (1972) reported a half-life of 3 to 10 years. Lichtenstein (1971) found that loam soils contained 10.6% of the DDT applied 15 years earlier. Edwards (1966) reported figures of 4 to 30 years for the time to remove 95% of applied DDT from soil areas. Based on work in the Pacific Coast region, Freed (1970)

stated that DDT disappearance from the surface of warm moist agricultural soil will be rapid with a half-life of less than one year.

(2) The problem in comparing these studies and applying their findings to determine the impacts of a spill is the number of factors involved. Soil type, soil moisture, climate, use of the land, and many other variables will significantly affect the rate at which DDT is decomposed. Not knowing where a spill could occur makes it impossible to identify particular studies with similar conditions. The only conclusion that can be made is that some of the DDT will persist in the environment for a long period of time. It will be degraded by photo decompo-sition and chemical and microbial activity at a rate so that 50% of it is destroyed every 2 to 10 years. What remains will circulate in the ecosystem along with the other background quantities.

c. DDT in H_2O

(1) DDT spilled into a water body will eventually end up in the sediments. Powder is not readily soluble in water and would probably adhere to suspended sediment particles and settle to the bottom. The mechanism for the liquid forms is less clear. The liquid DDT is mixed with kerosene or other oily substances that would tend to float on the surface of a body of water. There is no information in the literature on this occurrence. However, the weight of evidence is so strong that DDT in the aquatic environment collects in the sediments that it must be assumed a liquid spill would ultimately show up in the sediment.

(2) The severity of an aquatic spill would depend primarily on the magnitude of the loss. One or two 55-gallon drums would not be of great consequence since they contain only a small amount of DDT that would be diluted in an aquatic environment. There is little reason to attempt any cleanup because it would be nearly impossible to recover any of the spilled material.

(3) If a tank truck or rail tanker were damaged and spilled into a water body, it would be more severe. It might be possible to utilize oil spill cleanup techniques to contain and recover some or most of the spill. Regardless, the area should be closed to body contact recreation, water supply, and fishing. Sediment samples should be collected and tested for DDT concentration. It is not possible to state what could happen next since that would be determined by specific conditions, such as the type of water body, flow rate, normal

usage, type of sediments, etc. It may be preferable to dredge, remove, and dispose of the sediments containing more than a specified threshold concentration of DDT. On the other hand, dredging could stir up and disperse the DDT contaminated sediment and make the situation worse. Cleanup options for a spill of this magnitude cannot be established ahead of time. It would require special study to determine a course of action.

(4) It should be noted, however, how a large spill would compare with the Triana incident (discussed in Section C.1). The amount of DDT to be disposed of is several hundred tons, all of which would not be involved in a single spill. In Triana, over several thousand tons were disposed of in the water. A spill of this material would be immediately known and cleanup measures could be instituted within a short time. In Triana, some of the pesticides were in the water unnoticed for over thirty years and all of the waste for at least eight years. The worst possible spill would be many orders of magnitude less than the Triana problem.

(5) A DDT spill into a water body would probably cause the water quality criteria proposed by USEPA to be exceeded. The amount of water polluted would depend upon the size of the spill and the body of water. Because of the low solubility of DDT in water and the fact that most of the DDT is mixed with kerosene, it is expected that the majority of DDT would not dissolve into the water. It should be noted that the USEPA criteria are based upon long-term exposure, and any spill would be a one-time event so that the water body could be returned to all previous uses as the dilution occurs and a cleanup, if necessary, is carried out.

3. Disposal

a. General Environmental Impact Considerations

(1) The following section provides general background information for the environmental evaluation of disposal options. Much of the information concerns the levels of DDT found in the environment, which is to be related to the levels of emissions and releases of DDT connected with the different disposal options considered.

(2) Implementation of any disposal alternative may cause the eventual presence of small amounts of DDT residues in different types of ecosystems. The first two parts of this section consider the general impacts of the presence of DDT in terrestrial and aquatic ecosystems, where transport, incineration, and landfill activities have potential impacts in

both the short and long term. Following is a discussion of DDT and its impact upon public health. The last part is a discussion of the "ultimate fate" of DDT in the environment. A specific discussion of the impacts of DDT residues from incineration activity is included within the Ocean Incineration and On Land Incineration sections.

(a) Terrestrial Ecosystems

i. As a result of this disposal project, DDT could end up in the terrestrial ecosystem from a spill or through precipitation or dry deposition of incinerator emissions. Woodwell et al. (1971) estimated an average DDT content in agricultural soils to be 0.168 g/m^2 and in non-agricultural soils to be about 0.00045 g/m^2. Soil concentrations around an incinerator are predicted to be on the order of 0.002 pounds/acre (0.0002 g/m^2); concentrations from a spill could be much higher.

ii. The USEPA monitored most agricultural areas of the U.S. for pesticide residues from 1968 to 1973. In 1969 they also initiated sampling of urban soils. Table V.A.3-1 presents the average DDT concentrations in agricultural soils over the life of the USEPA study. However, the USEPA studies generally found higher levels of DDT in urban rather than rural soils, which is in contradiction with the Woodwell et al. conclusions and with previous values of DDT concentrations measured in air.

Table V.A.3-1

TOTAL DDT RESIDUES
(ppm dry weight)

Year	% Positive Detections	Geometric Mean
1968	28.9	0.015
1969	23.8	0.013
1971	23.7	0.013
1972	21.3	0.010
1973	21.5	0.007

Source: Carey, A.E., "Monitoring Pesticides in Agricultural & Urban Soils of the U.S.," Pesticides Monitoring Journal, Vol. 13, No. 1, 1979.

iii. Data on the concentration of DDT in organisms are numerous, although only a few examples will be cited here. Causey et al. (1972) measured DDT concentrations (as shown in Table V.A.3-2) and attempted to differentiate between areas with no previous DDT applications and those exposed to DDT. These results would support the conclusion that DDT concentration in organisms reflects the concentration in the surrounding environment. However, Table V.A.3-3 shows DDT concentrations in Big Bend National Park, which is a land area of more than 700,000 acres where no organochlorine pesticide has been used since 1944. The higher concentrations in biota do correspond to the high soil concentration, although the source of this DDT could not be identified.

Table V.A.3-2

DDT CONCENTRATIONS IN SELECTED ANIMALS (ppm)

Animal	Area with No History of DDT Applications	DDT-Treated Soybean Field Area
Deer	not detected - 1.26	0.01 - 18.8 average - 3.0
Rabbit	not detected	0.33 - 18.0 average - 2.5
Quail	0.55 - 3.10	2.07 - 46.6 average - 17.1

Source: Causey et al., "Organochlorine Insecticide Residues in Quail, Rabbits, and Deer from Selected Alabama Soybean Fields," Journal of Agricultural Food Chemistry, Vol. 20, 1972.

Table V.A.3-3

DDT RESIDUES IN BIG BEND NATIONAL PARK (ppm)

Camp Site	Soil	Vegetation	Rodents	Lizards	Birds
Boquillas	2.80	3.02	3.52	2.54	7.24
Castolon	1.91	2.78	3.66	1.47	0.42
Chisos Basin	3.86	2.57	4.52	1.94	0.17
Lajitas	27.06	7.24	11.56	4.51	28.08

Source: Applegate, H.G. "Insecticides in the Big Bend National Park," Pesticide Monitoring Journal, Vol. 14, 1970.

iv. Many more examples of DDT concentration in organisms could be given, although the value of most of them is small because there was no attempt to correlate the concentrations to the surrounding environment. It can be concluded that higher concentrations of DDT in the environment will induce higher concentrations in organisms. However, the data do not exist to estimate the size of this relationship.

(b) Aquatic Ecosystems

i. The solubility of DDT in water under the most ideal conditions has been reported to be 1.2 ppb (1.2 ug/l) or less at 25°C (Bowman et al., 1960), but as noted by Gunther et al. (1968), natural waters--fresh or marine--will contain salts, collodial material, and suspended particulate matter, which may increase the apparent solubility of the chemical. Kenaga (1972) gives some typical values of residues of DDT and its metabolites found in various types of water:

rain water	0.0002 ppm
fresh water	0.00001 ppm
sea water	0.000001 ppm

ii. DDT does tend to adhere to particulate and colloidal matter in the aquatic environment, and the largest concentrations are usually found in sediments. Bottom sediment in Clear Lake, California contains 31 ppb in the top 6 inches, 19 ppb in the next 6 inches, and 1.0 ppb 12 to 18 inches deep (Rudd, 1972). Values measured in Lake Ontario were similar, ranging from below detection limits in older sediments to 25 ppb in the top layers (Frank et al., 1979).

iii. However, even more problems exist than in terrestrial ecosystems when trying to relate concentrations in biota to ambient concentrations. There is a large body of data on DDT concentrations in organisms, but very little analytical work explaining how it got there. Bevenue (1976) agreed with the Woodwell et al. (1967) conclusion that recorded pesticide residues in waters have limited meaning when evaluating the effects of DDT on animal populations, yet such residues must contribute to concentration mechanisms elsewhere in the ecosystem.

iv. USEPA has proposed water quality criteria for DDT (44FR56649) for the protection of aquatic life and human health. These criteria have not been finalized, but when they are final they may become the basis for enforceable standards. The criteria proposed for fresh water aquatic life is 0.00023 ug/l with a 24 hour average of 0.41 ug/l not to be exceeded at any time. For the protection of human health, the USEPA is considering concentrations of 0.98 ng/l, 0.098 ng/l, and 0.0098 ng/l. These criteria would protect human health from potential carcinogenic effects of exposure to DDT through ingestion of water and contaminated aquatic organisms.

(c) Marine Ecosystems

i. Description

(a) Like other chemicals, DDT has a toxicity level for various species of plants and animals. Toxicity may be acute, killing an organism relatively quickly, or chronic, gradually affecting activity, feeding, reproduction, and general physiology. DDT has been found to inhibit photosynthesis in some marine phytoplankton (Skeletonema costatum, a diatom; Coccolithus huxleyi, a coccolithophore; Pyraminoas sp., a green algae; and Peridinium trochoideum, a dinoflagellate) and affect growth rates and cell divison of other phytoplankton species. Fiddler crabs fed natural detritus containing DDT residues of 10 ppm over eleven days exhibited behavior modification associated with a tripling of residue in the muscle tissues of the large claw (Odum et al., 1969). In the

Eastern oysters, DDT concentrations of 0.1. ppm have been reported to halt growth, and concentrations as low as 0.0001 ppm significantly reduced growth; those containing 151 ppm concentrations required approximately three months in clean water to eliminate 95% of their accumulated residue burden, but after only ten days of flushing, growth returned to normal (Butler, 1966 a, b).

(b) DDT is one of the most commonly found residues in fish and has been implicated in the mortality and reproductive failure of fish in some lakes and streams. The amount of persistent insecticide found in fish appears to be remarkably constant in a given system; fewer residues are found in marine than freshwater fish. Non-polar contaminants such as DDT tend to accumulate in fish eggs, leading to the mortality of embryos and larvae at the yolk absorption stage.

(c) Pesticides in general, and DDT in particular, are, upon entering the aquatic system, rapidly absorbed by bottom sediments, plankton, algae, aquatic invertebrates, vegetation, and fish. Some organisms may accumulate pesticides directly from the water or indirectly through their food. Direct uptake from the water is a more important route for pesticides to be taken into the bodies of fish than is feeding on contaminated invertebrates (Edwards, 1970; Jarvineu et al., 1977; Macek et al., 1979).

(d) Sub-lethal effects of various concentrations of DDT and its metabolites, DDD and DDE, include lowered resistance to disease, degeneration of reproduction, thickening of gill membranes, lack of osmoregulation, depressed blood counts, reduction in body weights, and brain damage. Behavioral changes such as depressed feeding rates, changes in temperature selection, and varying salinity preference are often associated with an altered functioning of the central nervous system (Edwards, 1970; Livingston, 1977). There is no single mode of action by DDT on biological systems since reactions appear to be species specific.

ii. Bioaccumulation

(a) Bioaccumulation, the ability of living organisms to accumulate relatively high concentrations of lipid-soluble organic compounds from relatively low levels present in their environment, is well documented; it varies directly with the lipid solubility characteristics, inversely with the water solubility of the compound, and variously with the physiological peculiarities of a given species. Bioaccumulation can involve ingestion of contaminated food, uptake from water passing across gill membranes, cuticular fusion, or direct absorption from the sediments. Biological magnification, the stepwise concentration of pesticides from one trophic level to the next, has been confirmed in the laboratory as well as the field (Metcalf, 1977; Livingston, 1977).

(b) Of various chemicals (chlorinated hydrocarbons in particular), Macek et al. (1979) found that DDT exhibited the greatest biomagnification potential as related to its extremely low water solubility, high lipid solubility, and long depuration rate (time required to flush pesticide residues from an organism after being removed from a contaminating environment). Of the chemicals studied, DDT was the only one that could be increased by bioaccumulation through the food chain over those levels achieved solely by absorption directly from the water (Macek et al., 1979; Jarvineu et al., 1977).

iii. Levels

(a) Evidence suggests that organic pesticides, primarily chlorinated hydrocarbons (e.g., DDT), are in residence in the aquatic environment. Almost all chlorinated hydrocarbon levels have been found to be less than the proposed water quality criteria for potable water or for fish and other wildlife inhabitants of natural surface waters. Maximum concentrations for DDT (0.316 ug/liter), DDE (0.050 ug/liter), and DDD (0.84 ug/liter) fall well below the criteria of 50.0 ug/liter for each of the compounds (WQC, 1972; Faust, 1977).

(b) The San Joaquin River has been estimated to contribute 1,900 kg/year total pesticides into San Francisco Bay in California, while the Mississippi River is estimated to contribute 10,000 kg/year into the Gulf of Mexico. Considering the time span and probable dilution encountered, even these apparently large amounts would contribute very small concentrations at any one time and place. Pesticides disappear rapidly from waters. Some may be absorbed directly by organisms, yet the bulk seems to be trapped in the sediments. After 6 hours exposure of DDT contaminated water over previously uncontaminated sediment, 56% of the DDT had been transferred to the sediment, and after 24 hours, a total of 78% had transferred into the sediment.

(c) Concentrations of DDT and its metabolities, DDD and DDE, were measured in Monterey Bay, California, and again approximately three years later (Phillips et al., 1975).

	Concentrations (ppb)				Persistence (yrs)	
	Initial		3 yrs. later		Residence Time	Life
	Mean	Maximum	Mean	Maximum		
DDT	3.1	19.3	15.5	83.1	11	29
DDD	2.3	8.7	2.3	11.4	7	44
DDE	5.4	20.5	5.4	17.5	8	39

These figures indicate that while the concentrations of DDT in the water column are quickly depleted, the concentrations within the sediments are persistent.

iv. Sources

(a) The marine environment with various points of input is believed to be the ultimate sink for persistent pesticides such as DDT and its metabolities DDD and DDE. Pesticide transport is determined by several factors: type of pesticide; area, method, and time of application; meteorological conditions; physical nature of the drainage system; and specific biological activity. The principal routes of DDT transport into the marine environment from the target area are through soil runoff (the DDT is absorbed to organic components of the soil) and through industrial waste disposal. Factors contributing to the removal of DDT from the soil are: volatilization, codistillation, leaching, oxidation, hydrolysis, and microbial activity, the latter presumed to be the most important.

(b) Pesticides reach streams, rivers, lakes, and oceans in many different ways, runoff and drainage from agricultural and forest lands being the main source of gradual pollution. Direct application to water and the discharge of effluents or waste chemicals cause more serious, but localized and usually temporary, contamination. Precipitation can remove pesticides from the air either directly or subsequently, by runoff or drainage into water. Most pesticides that enter the atmosphere are redeposited locally with relatively little long-distance, wind-driven transport.

(c) Ionic flocculation and siltation contribute to the deposition of pesticides into marine sediments, which can then potentially serve as a reservoir for those compounds. Chlorinated hydrocarbons (especially DDT) are relatively insoluble in water and seldom appear in solution, but are usually absorbed to particulate matter in suspension or in sediments (Livingston, 1977; Edwards, 1970).

(d) Pesticide monitoring in the Mississippi River Delta showed much larger quantities of chlorinated hydrocarbons in the mud and sediment than in the water. Past surveys indicate that the mud in many rivers of the United States is heavily contaminated with pesticides and will continue to be a reservoir for periodic future contamination of the water (Edwards, 1970).

v. Persistency

(a) The exact persistency of DDT is still a subject of contention between the public, industry, and researchers. In his article in the October 1969 issue of Reader's Digest, Dr. Charles Wurster stated that DDT persists in the environment for a decade, and perhaps much longer. It has been reported that DDT retained 75% to 100% of its activity in soil for four years, and 39% retention after 17 years.

(b) Miscus et al. (1956) report that DDT in Clear Lake, California, water with phytoplankton can be degraded 95% in 7 days to DDD. Others have shown that the breakdown of DDT occurs between a week or two to perhaps thirty months with a general average of less than a year.

(c) Dr. White-Stevens (1970) stated that DDT and other organochlorines have half lives measured in days, weeks, months, and in a few special cases, years. Their rate of decay is subject to many environmental factors, including moisture, temperature, light, and the presence of organic matter and microflora. Decay results from microflora and microfauna attack. In sandy, dry soils in mild climates DDT and its derivatives have been found in some cases to persist with a half-life of up to ten years. DDT degrades rapidly to either DDD or DDE, both substantially less toxic (about one-tenth and one-half, respectively) than DDT to all kinds of vertebrate life. Wilson and Forester (1970) reported a 93% loss of DDT and its metabolites in sea water in about forty days; 90% completely degraded in thirty-eight days.

(d) The transport and fate of pesticides in the aquatic environment are affected by at least three main factors: concentration, dilution, and degradation. Bioconcentration is two sided, concentrating pesticide within an organism while lessening the concentration in the environment. As mentioned previously, concentration may occur by direct absorption form the water or by transfer through successively higher trophic levels of the food web. Concentration also occurs when pesticides are absorbed onto particulates and deposited into the sediments.

(e) Dilution may occur as a result of dispersion of pesticides through the water from a point source by biogeochemical reactions. Pelagic organisms can accumulate and transport pesticides from one area to another; currents can disperse soluble and particle adherent pesticides for great distances.

(f) Degradation or transformations occur due to photochemical reaction, chemical reaction, biological action, or a combination of these. The original chemical is altered and the resultant may be either more or less compatible with the environment than the original.

(d) Public Health

i. The relationship of DDT to the human population, primarily from the health standpoint, has been seriously considered from the time DDT was introduced for commercial usage. Accumulated data on the subject have been acquired through planned studies with human subjects (Hayes et al., 1971), accidental or acute poisoning cases, and epidemiological reports.

ii. The most recent case study occurred in 1979 in Triana, Alabama (Kriess et al., 1980). From 1947 until 1971, DDT was manufactured in a plant 10 kilometers from the town. Several thousand tons of DDT industrial waste accumulated in the sediments of a nearby tributary of Indian Creek. Residents in the town hauled household water from Indian Creek until 1967, when a well and distribution system were constructed. Fish caught locally had DDT concentrations up to 100 times the tolerance of 5 ppm set by the Food and Drug Administration. Before the problem was publicized in December 1978, residents consumed 4.3 fish meals per month. The arithmetic mean DDT level in Triana residents was 159.4 ppb. The geometric mean was 76.2 ppb with a range from 0.6 to 2820.5 ppb. The most striking result from the Triana study was the steady increase in DDT levels with increase in age. Past studies of DDT levels in the human population have stressed a steady state concept in which excretion matches intake. If an equilibrium were reached, DDT levels in adipose tissue and serum should reach a plateau and not increase with age. The Triana study has shown a persistent age-related increase despite control of fish consumption, agricultural experience, and years of local residence. There are other possible explanations for the DDT residue increase with age, but this result does cast doubt upon the conclusions of past research. The researchers found no alarming health effects from the levels of DDT found in the Triana residents.

iii. Other studies have found average DDT residues in the blood of the general population ranging from 7 to 42 ppb. Occupationally exposed individuals were found to have concentrations up to 949 ppb. As a general rule, residents of warmer climates have higher concentrations than residents in cooler areas, men have higher levels than women, and blacks higher than whites.

iv. For the general population, Kraybill (1969) estimated that the total annual intake of DDT was 35 mg from the following sources: food - 30 mg; absorbant inhalents and cosmetics - 4.96 mg; water - 0.01 mg; and air - 0.03 mg. Hayes et al. (1971) calculated the daily DDT dosage to be 0.028 mg/man/day (10.2 mg/year). He conducted long-term studies in which volunteers consumed 35 mg per day of DDT for 21.5 months. No specific health effects were identified as a result of this intake of DDT.

v. Mrak (1969) seemed to sum up all the literature when he reached the following conclusion, which still holds true after 10 years of additional research. Residues of DDT have been and are still being acquired by man from all articles of diet and a variety of other environmental sources.

vi. The consequences of these prolonged exposures to human health cannot be fully elucidated at present. Evidence from workers who are subject to vastly greater exposure than the public is reassuring but far from complete. No reliable study has revealed a causal association between the presence of these residues and human disease.

vii. While there is no evidence to indicate that pesticides presently in use actually cause carcinogenic or teratogenic effects in man, nevertheless, the fact that some pesticides cause these effects in experimental mammals incidates cause for concern and careful evaluation.

(e) Ultimate Fate of DDT in the Environment

i. The two most widely known concerns about DDT in the environment are biomagnification and the persistence of DDT in the ecosystem. Although many simplified conclusions have been drawn from the existing data, many questions still exist that cast some doubt on their validity.

ii. Only recently has attention been focused on the presence of PCB residues in the environment, yet they have been widely used since 1930 (USDA, 1972). From the analytical standpoint the PCBs, if present, will confuse or defy interpretation of analytical data obtained for residues assumed to be DDT and/or its metabolites (Fries et al., 1971; Richardson et al., 1971; Zitco 1971; and others). Only the most recent analytical methodology has included procedures, more or less successful, for the isolation of PCB residues and the separation from any DDT and metabolites that may be present in the same biological specimen. Therefore, the question may be raised: How much of the massive amount of residue data acquired during the past 25 years contains an error factor because of the possible presence of PCB residues, and perhaps other interfering contaminants in the sample (Bevenue, 1976).

iii. Although data may seem to indicate that organisms in higher trophic levels have higher concentrations, it is not an obvious result that bioconcentration is occurring. Some of the conclusions of Edwards (1970) summarize the analytical questions.

iv. Organochlorine insecticides may accumulate in "small" amounts in plant tissues, especially root crops; but in all available data there was no instance where the residue in the plant was greater than that in the soil in which it was grown. Chlorinated pesticide residues do concentrate in aquatic plants, probably because the insecticide has a greater affinity for the plant than it has for water.

v. The reasons for large amounts of residues noted in some birds and the significance of these amounts are still not clear. The mechanism of transmission from the physical environment to higher levels of the food chain is somewhat conjectural and subject to various interpretations. The amounts of residues in domestic animals have shown no adverse effects on growth or reproduction; present evidence is insufficient to indicate that organochlorine insecticides are hazardous to wild mammals.

vi. DDT is not a "permanent" substance in the environment with an unlimited lifetime. Edwards (1970) noted that ultra-violet degradation of a pesticide may occur in the atmosphere. There are also numerous examples of pesticides, including DDT, undergoing transformations by nonmetabolic processes (Crosby, 1969, 1970; Kearney and Helling, 1969). By far, the largest body of evidence for the degradation of DDT concerns bacteria and fungi populations (Johnsen, 1976).

vii. Hayes (1972) has noted the speculation that it is the persistence of DDT in the ecosystem that leads to trouble, but DDT is far less stable than lead. DDT is broken down, albeit slowly, by animals and microorganisms to form less toxic compounds; lead remains toxic regardless of its chemical combination.

b. Ocean Incineration

(1) Impacts from Incineration

(a) Impacts on the marine environment resultant from the incineration of 250,000 gallons of DDT in a kerosene base (154,000 kg DDT) are not based on conjecture, but rather draw upon extensive studies of the disposal site and surrounding environs, intensive monitoring during incinerations of similar substances at the same site, and monitoring results of a far more toxic compound at another incineration site. Organochlorine wastes from the manufacture of vinyl chloride were incinerated and monitored at the Gulf incineration site in 1974 and 1977 (Ackerman et al., 1978; Clausen et al., 1977; TerEco 1974, 1975, 1978; Wastler et al., 1975).

(b) The waste was similar to DDT in that both are organochlorenes with a chlorine content of approximately 65%. However, they differ in that eight shiploads of organochlorine wastes were incinerated, whereas the DDT incineration will require only 1/4 shipload. Further, the organochlorine wastes were essentially 100% organochlorines, but the DDT waste is only about 18% DDT in a kerosene base. Thus, the concentration and total amount of the component of greatest concern is far less for the proposed incineration. The incineration of the herbicide Agent Orange, a far more toxic compound than DDT, was conducted and monitored in the Pacific Ocean (Ackerman et al., 1978). Three shiploads were incinerated and monitorings of these incinerations showed that destruction efficiencies as stipulated in the permit were met or exceeded. No significant degradation of the environment was found. In most instances, even short-term, localized perturbations in air and water quality were difficult to discern.

(2) Expected Emissions

(a) For the incineration of DDT in a kerosene solvent, emissions constituents which may be of concern in the marine environment are HCl (hydrogen chloride exhausted from the stacks, which combining with water forms hydrochloric acid) and any DDT not destroyed during incineration. The two emission products vary significantly from each other in their rates of formation and their subsequent effect on the environment. Hydrogen chloride is emitted at approximately 1,043 kilograms per hour, while unburned DDT is estimated in the worst case to be only 1.8 kilograms per hour.

i. Hydrogen Chloride

(a) At a feed rate of 10 metric tons per hour of 18% DDT in kerosene with 150% excess air, it is calculated that 1043 kilograms of HCl will be emitted per hour (2,898 g/sec). By contrast, stoichiometric calculations for the organochlorine waste previously burned in the Gulf estimated that 4,700 g/sec and 3,800 g/sec of HCl would be emitted at feed rates of 25 and 20 metric tons per hour respectively for that waste (USEPA, 1976). Aerial monitoring of these emissions demonstrated the lens of maximum atmospheric concentration of HCl (1-5 ppm) to be at elevations of 120-250 meters above sea level at a downwind distance of 400 to 500 meters. Sea level monitoring showed the downwind HCl concentrations on the order of 1-2 ppm, with a one-time maximum of 7.3 ppm (USEPA, 1976). To place these values in proper perspective, the Department of Labor Standards allow eight hours per day exposure at 5 ppm HCl, and the odor detection limit in humans for HCl as 1 ppm.

(b) Monitoring of surface seawater pH and chlorinity was conducted for the organochlorine waste incinerations (HCl emissions 3,800-4,700 g/sec). No significant changes in pH or chlorinity were observed between upwind and downwind (exposed to plume) areas (USEPA, 1976). Thus, by comparison of HCl emission rates for DDT incineration with those for previously burned organochlorines, no affect on the atmosphere or seawater could reasonably be expected due to HCl emissions.

ii. Unburned DDT

(a) The amount of unburned DDT will be a function of the destruction efficiency of incineration, while the rate of DDT emissions will depend both on the destruction efficiency and the rate of feed into the incinerators. Destruction efficiencies of 99.99+% have been measured for DDT at temperatures of 1000°C and higher (Carnes and Oberacker, 1976). Moreover, *M/T Vulcanus* operators maintain that destruction efficiencies of 99.99+% can easily be met. Permit requirements for previous ocean incinerations have specified a minimum destruction efficiency of 99.9%.

b. While the *Vulcanus* has the capacity for a feed rate of 25 metric tons per hour, operators have indicated that because of the high energy content of the DDT-kerosene mixture a feed rate of approximately 10 metric tons per hour would be sufficient to sustain the temperature required for 99.99% destruction. Higher feed rates would result in temperatures damaging the incinerators. Thus, the following conditions form the basis for estimating DDT emissions to be the environment.

TOTAL DDT/KEROSENE MIX - 250,000 gallons
1.842 x 106 pounds
8.35 x 105 kg

TOTAL DDT - 1.503 x 105 kg
(average 18% of DDT/kerosene Mix)

FEED RATE
TOTAL - 10 metric tons per hour (10,000 kg)
DDT - 18% of 10 mt = 1,800 kg/hour

DESTRUCTION EFFICIENCIES
Worst Case - 99.9%
Probable Case - 99.99%

DDT EMISSIONS

Worst Case - 1.8 kg/hour
Probable Case - .18 kg/hour

TIME REQUIRED FOR INCINERATION -

83.5 hours rounded off to 4 days (96 hours)

(c) From the above calculations and conditions it is estimated that 17.28 kilograms (probable case) to 172.8 kilograms (worst case) of DDT will be released to the environment at the incineration site. The fate, and consequently the effects, of this DDT cannot be precisely defined because of the variability of the controlling factors, e.g., atmospheric dispersion and transport, flux of DDT from the air to the sea, mixing and dilution in seawater, and the rate of scavenging of DDT by particulates in the ocean. In lieu of such an approximation it seems appropriate to consider various worst case scenarios concerning the input of the residual DDT into the marine environment. Similarly, the input of DDT into the atmosphere can be evaluated by comparison to past applications of DDT.

iii. DDT in Seawater

(a) As a worst case scenario consider that all of the DDT emissions are transferred to the seawater via exchange at the surface or through scavenging by rainfall, and for the purpose of calculation assume that the DDT is confined to the boundaries of the incineration site. The incineration site has an area of 49 square kilometers (49 x $10^8 m^2$). Expected DDT concentrations in the water column resultant from the worst and probable destruction efficiencies for three assumed mixing depths are shown below:

Assumes Uniform Mixing From Surface To:	Worst Case 99.9% D.E.	Probable Case 99.99% D.E.
	DDT concentration ng/l*	
1 meter	35.0	3.5
10 meters	3.5	.35
**75 meters	.47	.047

* ng = 10^{-9}g
** approximate depth of surface mixed layer

(b) Even with these most environmentally conservative assumptions (no mixing outside site boundaries, and all emissions absorbed in the sea) the most probable resultant concentration in the short term (0.35 -3.5 ng/l) is quite low. The average DDT concentration for Gulf of Mexico waters (based on 34 samples) is estimated to be 0.6 ng/l (Giam et al., 1976). Thus the theoretical increase at the disposal site only ranges from approximately 1/2 to 6 times the estimated ambient concentration. If further mixing beyond the site bounds and a less than 100% transfer to the sea are acknowledged, then the increase in DDT over ambient levels becomes insignificantly small.

(c) To further elucidate the magnitude of this DDT input into the Gulf of Mexico waters, two other sources are considered: annual flux from the Mississippi River and from the atmosphere. It is estimated that the Mississippi River (DDT concentration 0.5 ng/l) contributes 1.2 x 103 kg of DDT to the Gulf of Mexico annually (Giam et3al., 1968). Similarly the atmospheric concentration (1.7 ng/m) contributes 1.5 x 10^3 kg per year through rainfall (Atlas, 1979). River and rainfall annual contributions being approximately equal are each 8 times greater than the worst case input at 99.9% destruction efficiency and 80 times greater than the probable input at 99.99% destruction efficiency.

iv. DDT in Marine Air

(a) With such a high atmospheric flux relative to the incineration emissions, one might expect that were the emissions to remain in the atmosphere, the incineration would not have a measurable effect on the atmospheric burden of DDT. For the calculation of ambient atmospheric DDT burden, 0.04 ng/m3 is used as the mean concentration for the Gulf (Giam et al., 1976) For the column of air over the incineration site (49 x 108 m) the height of the troposphere is assumed to be 6.5 km.

(b) Thus, the ambient DDT burden in the atmosphere over the incineration site is calculated to be 1.274 kg DDT. Calculation of the same parameter for the entire Gulf of Mexico (area 160 x $10^4 km^2$) shows an atmospheric burden of 416 kilograms. While the probable emission (17.28 kg) is 10 times greater than the instantaneous ambient burden and the worst case exceeds the instantaneous ambient burden over the site by 100 fold, the whole Gulf of Mexico ambient atmospheric burden is 2-1/2 times the worst case emission. While this may seem significant it must be remembered that the flux of DDT is from the atmosphere at sea, and that the residence time for chlorinated hydrocarbons in the atmosphere is on the order of 0.05 - 0.3 year (18-110 days) (Bidleman et al., 1976). Thus, while the atmospheric increase may seem relatively important in the short term, the long-term significance must be in the context elevating the seawater concentration.

(c) In evaluating the significance of this input of DDT to the atmosphere it is necessary to evaluate the significance of this input not only in comparison to ambient concentrations but also in the context of prior uses. DDT spraying from 1945-58 by US Department of Agriculture amounted to approximately 4.3×10^6 kg. As late as 1974 over 45×10^3 kg of DDT were sprayed over northwestern pine forests for tussock moth control (Orgill et at., 1974) and approximately 105×10^6 kg per year are estimated to be used annually worldwide by foreign countries in malaria mosquito and cotton insect control (Goldberg, 1975). By comparison, the incineration emissions of 172.8 kg and 17.28 kg DDT seem quite innocuous.

(3) Physical/Chemical Impacts

(a) The only impacts of a physical or chemical nature expected to occur as a result of the incineration of DDT are those resulting from the emission of HCl and unburned DDT. No change in the physical characteristics of the site (e.g., wind, waves, currents, visibility, bottom topography or composition, etc.) can be expected to occur.

(b) The introduction of HCl to the air and surface waters, as quantified in the previous discussion on emissions, will not have any long-term effect. Moreover, the short-term effects are expected to be so negligible that their detection will be difficult. Dispersion of HCl in the air will dilute concentrations well below the detectible limit far before the emissions reach inhabited areas onshore. HCl additions to seawater will be immediately neutralized by the strong buffering action of seawater.

(c) Similarly, the introduction of DDT residues into the environment are not expected to result in a measurable increase in DDT concentrations beyond the very short term. The expected addition of DDT (less than .18 kilograms per hour) represents only about half the DDT estimated to be present in Gulf of Mexico waters equal in area to the incineration site and extending to a depth of 10 meters. Dilution, both through vertical and horizontal mixing, will rapidly return locally elevated DDT concentrations back to ambient levels. The input of DDT to this area of low productivity is also small in comparison to other DDT inputs to the Gulf. DDT inputs from the Mississippi River and rainfall each are 8 times greater per year than the one time worst case input of DDT from the proposed incineration (assuming only a 99.9% destruction efficiency producing a total 172.8 kg DDT). With respect to probable emissions (99.99% destruction efficiency) these other sources each exceed the incineration input by 80 fold. Thus, the DDT emissions resultant from the at-sea incineration of these liquid DDT stocks may be considered as a negligible input into the Gulf of Mexico ecosystems.

(4) Biological Impacts

(a) With the exception of contaminant accumulation in organisms the biological impacts arising from the ocean incineration of DDT are short-term and will affect a very limited segment of the biota. The potential for adversely affecting the marine avifauna is limited owing to the low resident populations in the area, the great dilution and resultant low concentrations of HCl in the atmosphere, and the infrequent occurrence of migrating species. Although approximately 400 species of birds have been identified over the Gulf of Mexico only the pelagic and migratory species exhibit any potential for being impacted. Pelagic birds enter the Gulf from the Atlantic between breeding seasons, and their movements are largely regulated by weather and availability of food. Only three species (sooty terns, brown noddies, and Wilson's Storm Petrel) regularly occur in large numbers in the Gulf. The low productivity of the incineration site would not favor the abundance of pelagic sea birds in that area and their breeding grounds are far removed from the incineration site.

(b) Trans-Gulf migrations of about seventy-six species of birds occur in the spring (March through May) and fall (August through October) over three western routes. While birds following two of these three routes could pass near the incineration site if they fly on the margins of the route, the altitudes at which they fly, 310 to 1,530 meters, would place them above, or at the very worst in very low concentrations of stack emissions. Furthermore, with an estimated migration time of 24 hours (19 hours under ideal conditions for the shortest route to Yucatan), their exposure time to these low concentrations of emissions would be very short (on the order of minutes). Moreover, scheduling the incineration so as not to coincide with migration periods would avoid the potential for impacting migrating species entirely.

(c) In consideration of the low concentration of contaminants expected, the extensive dilution which will occur in the atmosphere and water column within hours of emission, and the unlikely but at best transient occurence of whales and turtles at the incineration site, no threat to rare or endangered species is foreseen resulting from the proposed incineration.

(d) Biological impacts are most likely to occur, if they occur at all, in the plankton, and in particular in the neuston at the incineration site. The plankton through DDT uptake from the water may provide the initial pathway for DDT accumulation in the food chain. However, as has been discussed, the contribution of DDT to the Gulf waters is small in comparison to ambient levels and other uncontrolled sources. Thus, it would seem that the incineration emissions would not constitute a significant escalation in the accumulation of DDT in the biota.

(e) Though it seems highly unlikely, were the emissions sufficient to cause measurable mortalities among the plankton, even these impacts would be of localized consequence and short duration. The short duration of the incineration and the high regenerative capacities of the plankton components would serve to ensure that plankton populations would be restored to normal levels in a short time (on the order of a few weeks). The fact that plankton are hardly utilized by higher trophic levels when found in low densities characteristic of the incineration site further serves to mitigate the significance of impacts on the plankton. In addition, the small meroplankton component (larval stages of larger organisms) of the site's plankton populations tends to minimize the "downstream effect" on other biotic components, e.g., recruitment to fish stocks. For comparison it should be noted that during monitoring of the organochlorine waste burns (more concentrated emissions over a longer duration than that proposed here) no effects were observed on the plankton as indicated through examination of plume fallout and control areas for changes in relative composition or abundance.

(f) The biological component most likely to experience adverse impact is the neuston. Inhabiting the water at the air/sea interface, the neuston is likely to be subject to the highest concentration of emitted contaminants. The effects may range from exposure to or accumulation of contaminants resulting in a chronic stress to the organism to death of indivdual organisms. In either case the effects are considered to be of short-term consequence, and the populations should return to normal within days after the incineration is completed.

(5) Impact on Resources

(a) Socioeconomic and Cultural Resources

Socioeconomic and cultural resources can generally be grouped into two broad, somewhat overlapping, categories. These are the socioeconomic/cultural and the natural. Impact of incineration activities on socioeconomic and cultural resources would be insignificant.

(b) Mineral and Petroleum Resources

Though the continental shelves off Texas and Louisiana support a giant petroleum industry, exploration and exploitation of the petroleum resources of the western Gulf of Mexico slope and basin are currently not feasible. The distance from shore, as well as depth limitations, generally limit the exploration and recovery of these resources at the incineration site. Similar considerations limit the mining of minerals at or near the site. Since no active exploration of resources of this type is occurring near the incineration site, no impact is expected.

(c) Fishery Resources

i. In terms of fishery production and value, the Gulf of Mexico is second only to the waters off the Peruvian coast on a worldwide basis (Taylor et al., 1973). Juhl (1974) estimated that Gulf of Mexico landings equal 40% of the U.S. total by volume and 30% by value. The leading fisheries in the Gulf are: shrimp, menhaden, red snapper and grouper, oyster, mullet, industrial bottomfish (croaker, sand and spotted seatrout, spot, etc.), Spanish and king mackerel, and blue crab.

ii. It is anticipated that the shellfish fishery of the northeastern Gulf will not be impacted by incineration activities at the site. The oyster fishery is entirely nearshore, and the shrimp and crab industries are centered well shoreward of the 100-fathom contour. This relatively nearshore distribution and the fact that shrimp are basically benthic organisms seldom inhabiting offshore surface waters suggest that the shellfish industry will not be impacted by incineration activities at the site.

iii. Two species of shellfish, the royal red shrimp (*Hymenopenaeus robustus*) and the red crab (*Geryon guinquedans*), represent deepwater species of potential commerical value. Bullis (1956) indicated that royal red shrimp are present throughout the Gulf on all types of bottom in a depth range of 190 to 270 fermium (maximum range of 150 to 400 fermium). Though the royal red shrimp is highly marketable, commercial fisheries for the shrimp presently exist only in the eastern Gulf. This localization, and the fact that these shrimp are benthic, occurring in water less than 500 fermium, suggest that no impact from DDT incineration should occur.

iv. Similarly, Pequenat (1970) reported that the red crab is widely distributed on the continental slope of the northern Gulf in depths from 200 to 800 fermium. Although this species is quite edible and is fished commercially on the east coast, no commerical fishery exists in the Gulf.

v. Finfish fisheries in waters off South Texas are restricted to relatively nearshore waters. The fishery consists of spotted seatrout (*Cynoscion nebulosus*), black drum (*Pogonias cromis*), red drum (*Sciaenops ocellata*), red snapper (*Lutjanus campeschanus*), and flounder (*Paralichthys lethestigma*). For the years 1968-70, a record low catch of about 2.8 million pounds of finfish were harvested from nearshore and bay waters around Corpus Christi (Arthur D. Little, Inc., 1973). Offshore finfish amounted to 866,000 pounds during this same period. As with the shellfish, the proximity to shore of the finfish industry suggests no impact from offshore incineration of DDT.

vi. The deepwater fishes of the Gulf are mainly from the families Macrouridae, Gadidae, Alepisauridae and Myctophidae (Sal'nikov 1965). These deepwater fishes and their commercial significance is still under investigation. At present, no commercial exploitation of deep water fishes occurs in the vicinity of the incineration site.

vii. In addition to the deepwater forms, oceanic and bathypelagic fishes in the Gulf are further represented by the families Thunnidae, Histiophoridae, Xiphidae, Cybildae, Coryphaenidae and Caranyidae. Many of these fishes (see Table G-13 of Appendix G for list) represent a sport or longline fishery. Though the fish may be found as far offshore as the incineration site, sports fisherman rarely fish this far, and longline efforts have not proven successful. Incineration activities would seemingly produce no direct impact to the fishery itself. The likelihood of these fast-swimming fishes being exposed to effects of incineration for any period of time prior to capture and consumption by man is remote.

viii. Though turtles at one time represented a fishery in certain parts of the Gulf, the fishery has nearly been eliminated. Due to the reduced numbers, paucity of nesting sites in the northwestern Gulf (see Nekton-Marine Reptiles, Appendix G), and their transient nature, minimal impact is anticipated to this fishery.

(6) Accidental Spillage

(a) Even though incineration at sea has been found to have no demonstrable deleterious effects upon the upper portion of the water column and its biota (TerEco, 1974; TerEco, 1975; U.S. Department of State and USEPA, 1979), the possibility of environmental damage resulting from an accidental spill does exist. The ocean incinerator ship could experience adverse weather conditions which might jeopardize the safety of the vessel. The ship could, also, be involved in a collision with another which has strayed from the shipping lanes.

(b) The climatological conditions in the vicinity of the Gulf ocean incineration site would rarely hinder the operations of a vessel which would be operating under an USEPA permit to incinerate chemical wastes. Winds are at their highest in NovemberFebruary, averaging 13-15 knots, but pose no problems to sea-going vessels. Tropical storms and hurricanes are expected to occur forty-three and twenty-six times, respectively, within or near the inceration site in a 100 year period, but are predictable far enough in advance to suspend or defer ocean incineration operations. Waves should have little or no effect on the incinerator ship, since the percent frequency of adverse wave conditions is low and sufficiently predictable in advance to suspend or defer ocean incineration operations. Additionally, only vessels which meet all U.S. Coast Guard requirements for the transport of chemicals at sea would be permitted to operate under an USEPA permit to incinerate chemical wastes. The usage of the site is restricted to one incinerator ship at a time, except under extreme emergencies. For the proposed incineration of DDT only one ship at one time is required.

(c) The same U.S. Coast Guard requirements for vessel construction safety, and operation will also ensure the maximum protection against loss of ship or cargo in case of a collision, stranding, or other vessel casualty. As further protection against collisions within the site, the USEPA will request a "Notice to Mariners" to be published by the U.S. Coast Guard prior to each use of the site to warn vessels that the site is in use. As an additional protection the incineration site has been located more than 75 kilometers from the nearest shipping fairway to reduce the likelihood of vessels straying into the site from charted fairways.

(d) The possibility of the vessel's accidental collision, stranding, or sinking while loaded with chemical wastes is of considerable environmental concern. Such an accident could occasion moderate or serious consequences, depending in large measure upon where it occurred. For instance, a major spill near shore affecting an estuary would destroy many organisms (including bottom-living forms) and contaminate the area for a substantial period of time. A spill on the continental shelf could have a significant short-term impact on organisms, however, the wave and current actions would greatly disperse the contaminant and the large volume of water would dilute the contaminant, thus significantly reducing the long-term impacts at the site.

(e) In addition to the possibility of collision and catastrophic marine accidents, spillage may result from improper loading and transfer operations. In order to reduce the potential for such discharges, the U.S. Coast Guard conducts surveillance flights at ports handling over 10 million tons of petroleum products annually and flights are conducted in all coastal waters. Specific coastal surveillance areas are determined by pollution potential expected as a result of vessel density studies and historical spill data. The Federal Water Pollution Control Act requires polluters to report spill, and non-spilling industries and the public are encouraged to report spills to augment this mandate.

(f) During the transfer and transport of Herbicide Orange, special precautions were taken to reduce the potential for spillage. A contingency plan was drawn up by the Air Force, USEPA, and the U.S. Coast Guard. The contingency plan defines precautions to be taken to prevent spills of herbicide and the countermeasures to be taken if a spill occurred during any stages of the disposal operation. Organization of the operation was under the direction of an Air Force project director or his deputy. Preventing spills and taking appropriate measures in the event of a spill were the responsibility of the Air Force On-Scene Coordinator. The contingency plan also listed government agencies and commercial salvages firms that could be called for assistance and government agencies to be notified in the event of a spill or any other accident.

(g) Similar precautions will be taken when loading, transferring and transporting the liquid DDT for incineration at sea.

c. On Land Incineration

(1) Effects of DDT Emissions On Air Quality

(a) There is presently no standard for concentration of DDT or other organochlorine compounds that can be used to judge the level of emissions from incineration. Background levels of DDT in air vary considerably. Stanley et al. (1971) analyzed over 800 samples of air obtained from nine locations representative of rural and urban areas, including southeastern, southwestern, midwestern, and western sections of the U.S. DDT was found in the air at all locations with levels highest in the agricultural areas of the south. In units of mg/m^3, 0.002 was reported in rural Orlando, Florida; 0.00125 in rural Stoneville, Mississippi; 0.000282 in rural Dothan, Alabama; 0.000025 in urban Baltimore, Maryland; 0.000023 in urban Fresno, California; 0.000014 in rural Buffalo, New York; and 0.000008 in rural Iowa City, Iowa.

(b) McClure and Lagrung (1977) studied the deposition of DDT in southern California. They found three orders of magnitude variation between the highest and lowest measured transport fluxes, which they correlated with major wind patterns. They concluded that aerial transport of chlorinated hydrocarbons is a mesoscale (hundreds of kilometers) phenomena. Long distance transportation of dust was proven possible by Cohen and Pinkerton (1966) when they related the characteristics of dustfall in Cincinnati, Ohio to a mammoth dust storm in the southern high plains. Peakall (1976) was able to find a striking example of long-range transport of pesticides when he sampled precipitation in upstate New York for several months following a spraying program in 1974 of timber land in Oregon, Washington, and Idaho. The program was the only large-scale use of these insecticides since the restrictions placed on the use of DDT in North America. He noted a significant increase in DDT concentrations (up to 1.8×10^{-12} g/cm^3) for four months after the spraying followed by a decline to background levels (less than $0.1 \times 10^{-12} \times g/cm^3$).

(c) These results seem to be supported in all of the surveyed literature on air concentrations of DDT. Local use or handling of the chemical will increase background concentrations in the near vicinity. However, DDT concentrations in ambient air can also be significantly increased by events several thousand miles removed.

(d) The worst case instantaneous DDT concentrations at ground level predicted as a result of incineration (0.00014 mg/m^3) are greater than has been observed in some urban and northern parts of the U.S., but they are also less than has been measured in other rural, agricultural areas. However, concentrations of this magnitude could also result from pesticide spraying thousands of miles removed from the incinerator.

(e) Once entrained in the air the DDT does not remain there indefinitely. The pesticide may be degraded by ultra-voilet light, as was noted by Edwards (1970), although this has not been supported by other investigators. DDT will also be removed by precipitation and dry fallout.

(f) Data on the concentration of organochlorines in precipitation are sparse. Besides the previously mentioned study by Peakall (1976), Peace et al. (1978) also measured DDT in rainwater following large-scale spraying operations. They found between 0.06 and 0.11 mg/kg in rainwater, although these measurements do not appear pertinent to this analysis because of the large amounts of DDT that were applied. Other investigators have measured DDT concentrations in precipitation between 3 and 1,000 ng/l (Bevenue, 1976). Woodwell et al. (1971) suggested that rainfall is probably the dominant mechanism for the removal of DDT from the atmosphere. Using the very limited analytical data available, these authors estimated that rainfall would contain an average DDT concentration of 60 parts per trillion and an average precipitation of 1 m/yr annually, which would remove a total of 3 X 10^{10} g/yr of the residue. The mathematical model of the Woodwell group has been challenged by Stewart (1972). It is difficult to draw any conclusions about DDT in rainwater with the limited amount of data available. Some of the DDT that is emitted from an incinerator will end up in precipitation, although it could as easily fall several thousand miles away as it could fall near the stack. The total amount of DDT that could be emitted (about 160,000 g) is so small relative to the quantities that are in the atmosphere that any impact would not be measurable.

(g) In areas with little precipitation, dry deposition of DDT has also been noted as a removal mechanism from the air. The only major study of fallout of DDT was conducted by Young et al. (1976) in the southern California vicinity. They noted deposition rates that range from about 50 to 700 X 10^{-9} g/sq mi/day. However, they also sampled around the Montrose Chemical Company plant (the only remaining manufacturer of DDT in the U.S.), the Rolling Hills landfill (past site of wastes from Montrose), and the Kazarian landfill (present site of waste disposal for Montrose). Deposition rates around the Montrose plant ranged from 6,000 to almost 20,000 x 10^{-9} g/sq m/day. Deposition around the landfills ranged from 900 to over 10,000 X 10^{-9} g/sq mi/day. Deposition was much higher around the old landfill than around the present landfill, although the authors gave no explanation for this fact.

(2) General Impacts of Land Incineration

(a) If the DDT is destroyed in an incinerator, small amounts of the material that are not combusted will be released to the atmosphere. In addition, CO_2, CO, and HCl will be emitted. For this analysis it was assumed that only incinerators meeting and guaranteeing PCB burn standards (99.999% destruction) would be suitable. The amounts of CO_2 and CO that would be released are about the same as if any other substance were burned. Expected concentrations of these elements in the stack gas are shown below:

CO_2	250 g/m^3
CO	2 mg/m^3
DDT	0.116 mg/m^3
HCl	2 mg/m^3

(b) Because this is a generic evaluation, it is not possible to identify site specific environmental impacts. The site characteristics that will influence the impacts are not known. Therefore in order to ensure that the analysis is conservative and can be applied to any site that may be selected, the impacts will be estimated for a "worst case" situation. The worst case analysis will identify environmental impacts for the most severe situation that could occur. The meteorological conditions, temperature, and other parameters used will be those that produce the most severe impact possible. This approach will overestimate the environmental impacts and provide a level of confidence that nothing worse could happen.

(c) Typical characteristics of an industrial waste incinerator that are utilized in this analysis are shown below:

Stack height	30 m
Stack gas temperature	327°K (54°C)

(d) Approximately 5.9 cubic meters of air are required to combust one pound of a 15% DDT, 85% kerosene mixture and have a 15% excess air safety margin. With a typical feed rate of 7,000 pounds/hour the gas flow out of the stock would be 3.03 m^3/second.

(e) The USEPA model PTMAX was used to estimate maximum ground level concentrations. PTMAX is one of several computerized air quality models developed and approved by USEPA for the purpose of predicting air quality impacts resulting from point sources of pollution. The model is a steady-state Gaussian approximation of a plume. It assumes that the source is located on relatively flat ground with no nearby obstructions. Plume rise is calculated after the method suggested by Briggs. The output of the program is the maximum ground level concentration of a conservative pollutant for each stability class and wind speed. These concentrations are expected to last for a ten to sixty minute period since the meterological conditions that coincide to produce the maximum impact will not persist for a long period of time.

(f) The results of the model run are shown in Table V.A.3-4. The worst case concentration that the model found was 2.55 X 10^{-8} g/m^3, which occurred approximately 300 meters downwind from the stack. This occurred under a stability class 1 with a wind speed of 0.5 meters/second. In practice this means a very stable atmosphere (little turbulence) with a minimum wind speed. These are typical characteristics of an "inversion" which is responsible for most of the severe air pollution episodes.

Table V.A.3-4

WORST CASE GROUND LEVEL DDT CONCENTRATIONS

Stablity Class	Wind Speed (m/sec)	Downwind Distance (km)	Maximum DDT Concentration (g/m^3)
1	0.5	0.314	2.55X10^{-8}
2	0.5	0.474	2.33X20^{-8}
3	2.0	0.417	1.61X10^{-8}
4	0.8	1.075	1.70X10^{-8}
5	2.0	1.876	5.67X10^{-9}
6	2.0	3.211	4.90X10^{-9}

(g) Worst case carbon monoxide (CO) and hydrochloric acid (HCl) concentration would be approximately 4 X 10^{-7} g/m^3. The National Ambient Air Quality Standard for CO is 4 X 10^{-2} g/m^3 over a one hour period, so even under the worst case the CO emissions would have a neglible impact. HCl in these small concentrations will also have no impact. Although CO_2 will be emitted in much larger amounts it is considered a natural component of unpolluted air. Background concentrations of CO_2 are about 5.5 X 10^2 mg/m^3. Stack emissions of CO_2 will be quickly diluted to backgound levels and cause no noticable impacts.

(h) DDT emissions from the incinerator were investigated further with the USEPA PTDIS model. PTDIS is part of the same package as PTMAX and is based on the same set of assumptions. For PTDIS the user selects the stability class and the wind speed, and the model calculates ground level concentrations at a series of locations. The output can be used to draw a graph of pollutant isopleths.

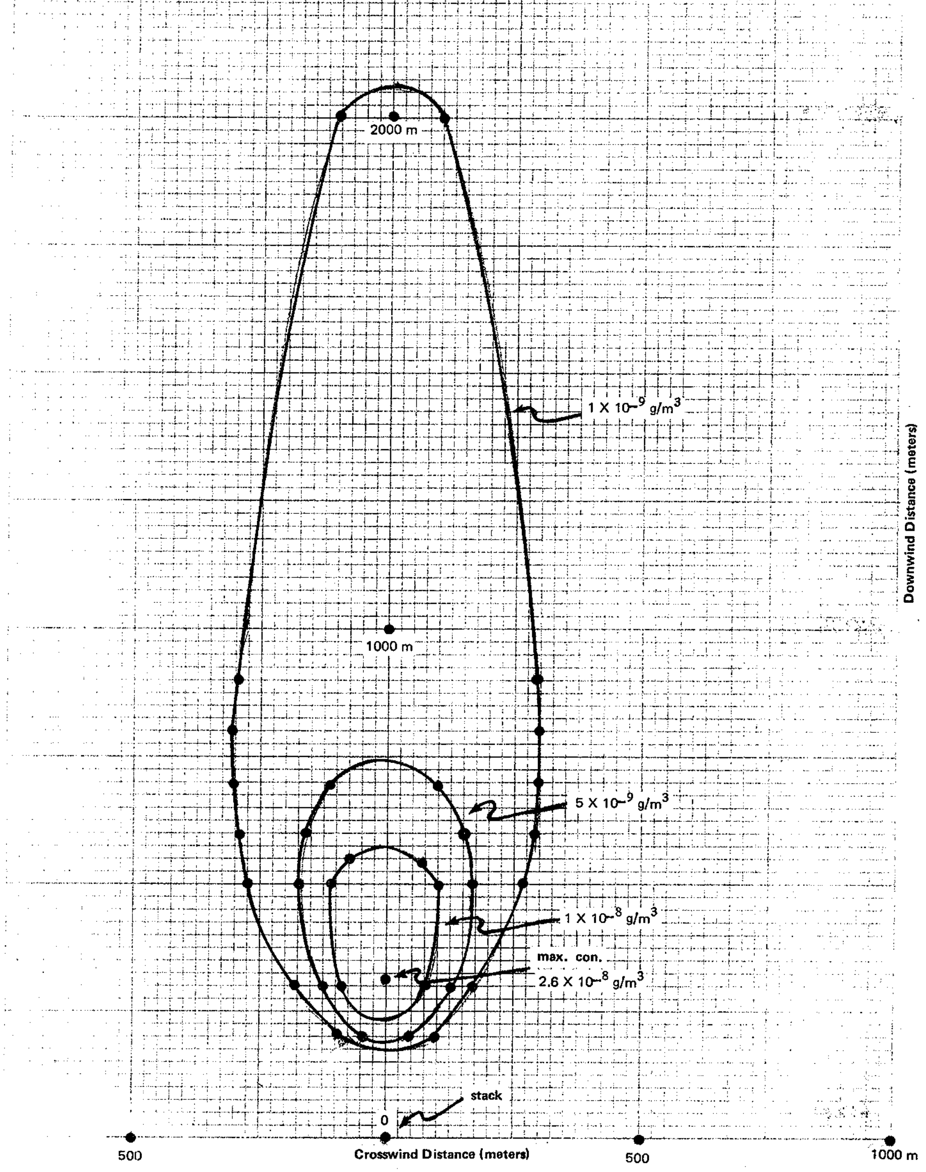
(i) The model was run using the worst case conditions identified in the previous model--stability class 1--and the results are shown in Figure V.A.3-1. The area enclosed in the 1.0×10^{-9} isopleth is 0.81 km^2 or about 200 acres. The 1.0×10^{-8} isopleth encompasses 0.06 km^3 or about 14 acres. The concentrations identified in the PTMAX and PTDIS models are extremely small and in many places in the U.S. would not be discernable from background conditions.

(j) Another impact that will result from land incineration is the deposition of DDT on the land as the material in the air settles out on the ground. There are approximately 286,000 pounds of DDT that could be incinerated. Assuming 99.999% destruction, 2.86 pounds would be emitted from the stack. If all of this were to be placed within the 1×10^{-8} isopleth in Figure V.A.3-1 it would average 0.21 pounds/acre. If it were all deposited in the next isopleth (5×10^{-9}) it would average 0.08 pounds/acre. In reality the unburned DDT will be spread over a much larger area since it will take about twelve days to burn all of the material at a land based incinerator. During that time the wind will blow in many different directions with different stability classes. If the wind blows in six different directions during the burn and each one impacts 200 acres, desposition would be about 0.002 pounds/acre or 1.1 grams/acre. These are also very small numbers. The normal application rate when DDT was in commercial use was 0.75 pounds/acre or 340 grams/acre.

(k) In any incinerator that is used to destroy industrial wastes there can be breakdowns that cause temporary emissions higher than expected under normal operating conditions. Paige et. al. (1978) in a study of incineration of organochlorine wastes identified six possible failure modes in waste incinerators: (1) plugging of the feed nozzle, (2) atomization air loss, (3) burner flame loss, (4) improper fuel rate, (5) improper air/fuel ratio, and (6) injection into a cool combustion zone on startup. The result of these accidents would be an incomplete combustion of DDT and increased emissions. The excess air and temperature moniters that are required as part of these specifications should detect any of the possible failures and shut off the DDT feed before unburned DDT is emitted.

Figure V.A.3-1

WORST CASE GROUND LEVEL DDT CONCENTRATIONS



(l) For the purpose of evaluation, if the excess air for combustion was reduced to -1% (loss of 16% air) and it took ten minutes to shut down the incinerator, approximately 794 grams of DDT would be emitted to the atmosphere. This scenario is extremely unlikely since the incinerator should shut down when there is still 10% excess air instead of delaying until there is a 1% shortage. Depending upon the meteorological conditions, the DDT would be spread over the landscape in the same manner as the normal emissions. If it were deposited over 200 acres it would amount to less than 4 grams/acre.

(m) Any land incinerator that would be used for this project would require a scrubber to clean the exhaust gasses. Most installation use a venturi type in which a fine mist of water is sprayed across the gas stream to remove particulates. The scrubber would also be used to neutralize the hydrochloric acid which would be formed during combustion. Some of the DDT might end up in the scrubber water. The waste would then be treated and either discharged to a stream or reused in the scrubber.

(n) If the water is reused in the scrubber no additional pollutants would be released. If the water is to be discharged it must be treated and a National Pollutant Discharge Elimination System permit must be obtained. Without specific treatment schemes little more can be stated about the discharge. Any acid in the water would definitely have to be neutralized. However, little DDT, if any, is likely to end up in the scrubber water due to the low solubility of DDT in water. If there is any DDT in the water some of it would be removed in the treatment process, which would include settling. The sludge from the water treatment process would be deposited in a secure landfill.

(o) Discharged water could contain DDT at its maximum solubility (in the order of 1.2 ppb). After treatment this concentration would be reduced, but it is not possible to say by what degree. Under "worst case" conditions, therefore, it is assumed that the discharge to the receiving stream could have a DDT concentration of up to 1.2 parts per billion. This value exceeds the proposed USEPA criteria (see Section V.A.3.b). However, the DDT should be diluted by the receiving stream, and the amount of dilution would depend upon the size and quality of this body of water.

(p) It is difficult to quantitatively estimate the impacts of land based incineration due to the large number of unknowns involved. An analysis of the worst case conditions indicates that concentrations of DDT will not exceed the order of magnitude of existing background levels in the United States. Ambient concentrations of DDT measured in the air range from 0.0000008 to 0.002 mg/m^3. The highest concentration that could result from the incineration is 0.000026 mg/m^3 under normal operating conditions. Depositions of DDT around the incinerator after the complete burn will be less than 0.08 pounds/acre, more likely around 0.002 pounds/acre. DDT concentrations in soil have been estimated to be 1.5 pounds/acre in agricultural areas and 0.004 pounds/acre in urban areas. A deposition rate as high as 0.00017 pounds/acre/day has been measured at one location in southern California. In the event of a failure of the incinerator, larger amounts of DDT could be emitted for a short period of time. However, the deposition on the ground that could result from this type of accident is only 0.008 pounds/acre, which is still the same order of magnitude that has been identified as a background level in some areas. It should be noted that the general application rate for DDT was 0.75 pounds/acre, a value significantly higher than any that could occur under any circumstances during the incineration of DDT.

d. Secure Landfill Environmental Impacts

(1) Only DDT powders are being considered for landfill. These are mixed with various inert materials as carriers (inert ingredient used to dilute the pesticide). Neither the carriers nor the DDT are explosive; they do not give off gases, nor do they easily combine with other substances to form gases.

(2) Therefore, the environmental impacts to be addressed in considering landfills are leaching and contamination of ground and surface waters. The solubility of DDT is low (Bowman et al., 1960) and it does tend to adhere to particulate and colloidal matter. Based on this, the potential for leaching appears to be low.

(3) In Triana, Alabama about 4,000 tons of DDT were dumped, leading to a significant increase in DDT concentrations in aquatic organisms in nearby streams. At the time of the writing of this report, the impacts of this incident on water quality have not been published. It, appears that the mechanism of transport of DDT is more likely to have been erosion and runoff rather than leaching as the DDT was dumped into an open ditch (O'Neill, 1979) from which it may have been washed into streams.

(4) As noted, and with justification based on numerous recent incidents of contamination of groundwaters from hazardous waste landfills, there is considerable concern over the risks involved in landfills. Many of these incidents have been caused by dumps or improperly operated landfills. Properly operated secure landfills should prevent the possibility of leaching of hazardous materials. There is still concern at long-term guarantees of proper operation, particularly after the landfill is closed. Hazardous waste landfills tend to be close to generators of wastes and in industrial areas of relatively high population density. Many of these areas are subjected to heavy precipitation and have a geologic structure conducive to the flow of groundwater.

(5) For the DDT the specifications will require selection of landfill where climatic and geologic features effectively eliminate the risk of leaching and contamination of groundwaters. Therefore, there is overall only a remote risk of leaching and groundwater contamination by DDT.

e. Return to Manufacturer

(1) The environmental impacts for collection and transport would be the same as for any other disposal alternative besides the "no action;" they are described in Sections V.A.1 and V.A.2.

(2) There will not be significant negative environmental impact from reuse. The containers would be emptied under controlled conditions to prevent escape of DDT into the environment. The DDT would then be processed in the normal processes of the Montrose plant, and the impacts would not be distinguishable from those close to the manufacture of DDT currently in progress. The containers would be disposed of in a secure landfill or remelted as scrap steel.

(3) It could be argued that the DDT may be used for special uses in the U.S., or overseas, or as the base for another pesticide. The secondary impacts of this alternative should be considered. However, as previously indicated, the return of the DDT should not add to its total use, but only replace DDT currently obtained from other sources. Therefore, its return to the manufacturer will not have any secondary impacts and will not significantly change existing uses of DDT either quantitatively or qualitatively.

f. Special Disposal Techniques

(1) Special disposal techniques cover the emptying and the burning of the contents of the aerosol cans and pressurized cylinders at land incinerators. The only significant difference between this and the land incineration previously analyzed is the burning of the propellant gas dichlorodifluoromethane. This gas commonly used as a refrigerant, is not in itself toxic or hazardous. The major concern is that it's large scale use and release could lead to its collecting in the stratosphere and modifying the earth's climate. The small amounts which might be released unburnt from a land incinerator would be insigificant in global terms.

(2) The products of combustion, as with DDT, are water, carbon dioxide and hydrochloric acid. The hydrochloric acid would be removed by the scrubber.

g. Unacceptable Alternatives

(1) Physical/Chemical Treatment and Reprocessing

The environmental impacts of physical/chemical treatment or reprocessing would be a factor of the process, chemicals uses, and the materials produced. While the risks of impact are believed to be low they have not been analyzed since this alternative was rejected on technical grounds.

(2) Deep Well Injection

The environmental impacts of deep well injection are similar to those of secure landfill in that the DDT is not destroyed but remains in the environment. The environmental impacts are a factor of the risk of its escape from its predetermined sound location. As this alternative was rejected on technical grounds the possibilities for drawing up specifications so as to reduce this risk to a neglible level have not been investigated.

h. No Action

(1) No action covers leaving existing stocks in their storage areas, inspecting them on a regular basis, and repacking or overpacking them as required. Environmental impacts could occur if any of these stocks are inadvertently released through leakage or spillage.

(2) Inspection of ten sites indicated, with the exception of one location, that most of these stocks are in adequate containers, regularly inspected and replaced before leakage occurs. They are stored in large well maintained warehouses, with concrete floors to contain leaks but without drains. The likelihood of any escape of DDT into the outside environment, in the event of leakage or spillage is neglible.

(3) Some stocks are stored under less desirable conditions, presenting some risk of release. The risk of release is a factor of the level of humidity and frequency of rainfall (both increase the risk of external corrosion of packaging), the condition of buildings, and the regularity of inspection of the sites visited. Only in Fort Lewis, Washington, were conditions found which would indicate any significant risk of release. In this case, while the stocks had recently been overpacked and the secondary packaging was in good condition and there was no significant short term risks, the area is humid, subject to heavy rainfalls, and the DDT was stored in a small leaking warehouse, presenting long term risks. Conversations with personnel at the stores visited would indicate that similar situations may exist at a few storage sites not visited. Should leakage of DDT from containers be discovered, within a short time of its occurrence any contaminated soil could be dug out and removed before the DDT spread. On the other hand, though unlikely in view of the ongoing regular inspection of stocks at depots, a leak could go undetected until the DDT had irretrievably entered the environment.

(4) An alternative to leaving stocks at existing stores would be to move stocks from substandard storage sites to high grade warehouses. Should any significant delay occur in the disposal of the stocks in accordance with the specifications, this is an obvious option which will be considered.

(5) If only the powders are held in storage any risk of release is considerably reduced. In addition to decreasing the volume of DDT, powders if stored indoors, require a liquid, i.e., rain to carry them into the environment. The likelihood of both the presence of water and a leakage is obviously less than that of leakage alone. In addition, the DDT powders are not as corrosive as the liquids thus reducing the risk of leakage through internal oxidization of the container. The primary containers of powders were found to be in better condition than the liquids during site visits.

B. RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF THE ENVIRONMENT AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

1. The proposed ocean incineration of liquid DDT stocks provides an environmentally sound, safe method of final disposal of a hazardous substance. Although the DDT formulations retain their value as insecticides, the prohibition of DDT use in this country effectively nullifies their value in the use for which they were intended. The final disposal of this DDT is therefore seen as the preferred alternative to its continued presence in the environment.

2. In contrast to landfill or continued storage of DDT, the releases of DDT to the environment through incineration are predictable, quantifiable, and controllable. With incineration there is no potential for the problem of future uncontrolled releases of DDT. Finally, there are no perpetual or recurring costs associated with incineration, as there are with landfill or continued storage.

3. Ocean incineration is preferred to land incineration because emissions are released to the atmosphere far from inhabited areas. Further, the directly affected environment is an area of low productivity of little use to man.

4. The short-term perturbations in environmental quality at the incineration site will not be expected to persist beyond a few days and the environment will not be altered in any permanent way. After incineration, no noticeable differences in the site or surrounding environs are anticipated. The proposed incineration will not affect other uses of the ocean nor the long-term productivity required to sustain those uses.

5. Since the amount of DDT to be released through ocean incineration is small, the incineration represents a one-time disposal, and the effects on the environment are predicted to be minor and transitory. The ocean incineration of these DDT stocks provides a rare opportunity for scientific study that could lead to the enhancement of long-term productivity of the environment. Through the use of a well-designed monitoring plan the short-term chronic effects and pathways or rates of contaminant accumulation may be delineated. The results of these studies, utilizing relatively small quantities of a well-defined contaminant (DDT), may then be applied in concept to incinerations of more toxic or unknown wastes in larger quantities that may be proposed for the future. Only with this information available can rational judgments be made regarding

the types and quantities of wastes to be incinerated or disposed of in the ocean on a continuing basis. Thus, the ocean incineration of this DDT may be considered an opportunity to increase our understanding of the impacts of ocean disposal and our ability to discern early warning signs of adverse impact. Hence, the long-term productivity of our total environment may be foreseeably increased through the short-term use of the Gulf incineration site for DDT disposal.

6. The advantages of land incinerators are their ability to handle the complete range of materials to be disposed of, availability in the U.S., and lower overall costs. The better control of incineration conditions and the use of flue gas scrubbers allow the reduction of total emissions of DDT and the elimination of those of HCl (compared to ocean incineration), which compensates for the fact that they are located in inhabited areas.

7. Because land incinerators are generally located in industrial areas, it is unlikely that any monitoring program would produce useful differentiation between emissions and background levels of pollutants to be applied to the incineration of other wastes.

8. Landfill does present some risk to the long-term productivity of the environment. While it may be unpredictable, as previously explained, the risk is small.

9. Return to the manufacuturer provides an equally environmentally sound, safe method of disposal of this hazardous substance, while not presenting any impact to long-term productivity.

C. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

1. The incineration of DDT represents an irreversible resource loss, since the DDT has value as an insecticide and remains in extensive use in the world market. However, the U.S. ban on use of DDT in this country for environmental reasons, and hence the implied disapproval of its use elsewhere, would tend to negate its resource value as an insecticide. Therefore, in the context of existing restrictions resulting from increased environmental wisdom, the DDT stocks are properly considered to be a hazardous waste.

2. Transport of DDT will result in the use of fuel and the irretrievable loss of this resource. Trucking the DDT to its final point of disposal will require 10,000-15,000 gallons of petroleum fuel. Rail transport would require less fuel.

3. The kerosene solvent as well as the DDT itself are sources of considerable thermal energy. The DDT in kerosene base occupies over 220,000 gallons. The loss of thermal energy to the environment due to waste combustion represents a significant energy loss. However, the highly corrosive nature of the combustion gases, containing HCl at an approximate 1,250°C, makes recovery or utilization of this energy a very major and expensive undertaking. Additionally, the emission of residual DDT is likely to present significant health or environmental problems if destruction efficiencies are not maintained at a high 99.9+% level (e.g., if the kerosene were used as a heating fuel or in transportation). Therefore, while the waste has a high energy content, limitations of present technology preclude its utilization.

4. The likelihood of utilizing the foreign owned and operated M/T Vulcanus (currently the only such ship capable of ocean incineration) implies that fuel and lease costs to bring the ship from Europe, incinerate the waste, and return the ship will be an irretrievable commitment of resources. Preliminary studies of ocean incinerations indicate that for transport and destruction of wastes in the Gulf of Mexico it would require about 0.1 metric ton of fuel per metric ton of waste destroyed.

5. Ocean incineration operations will require no additional public services, nor will they alter existing land use or trends in land use. The probable incineration vessel is already in existence, and existing port and transport facilities would be utilized to load the wastes on board.

6. Existing land incinerators would be used, and no additional resources in terms of land use will be required. Land incinerators use the heat energy of the wastes they receive to incinerate and require no auxiliary fuel. There are long-term investigations into possiblities of energy recovery from hazardous waste incinerators, but such recovery is unlikely to be effective when the DDT is burned.

7. Secure landfills are scarce and of limited capacity. Their use to bury DDT implies the loss of some of this capacity. However, the amount of DDT is relatively small and the loss of resources is correspondingly insignificant. Any escape of the DDT into the environment implies the risk of an irreversible or irretrievable loss of resources, but the quantities of DDT

being considered for landfill are relatively small. The long- or short-term risks of escape are small.

8. Return to the manufacturer implies a saving in resources in that the use of DoD DDT stocks conserves the materials and energy required to manufacture an equivalent of virgin DDT.

VI. NATIONAL PUBLIC INTEREST GROUP REACTIONS

A. INTRODUCTION

1. Background

a. Large quantities of hazardous wastes are presently in need of permanent disposal throughout the U.S. Though the permanent disposal of hazardous wastes does present certain risks, proper disposal is preferable to the continued storage of the wastes in often inadequate facilities where the possibility of an accident can only increase. However, for a number of reasons, including past abuses in the disposal of hazardous wastes, it has become exceedingly difficult to either site a hazardous waste facility or to dispose of what has become known as a "political waste" at an existing facility. Political wastes are substances that have achieved notoriety in the public mind, generally due to publicity in the national media. Kepone and PCBs are examples of political wastes.

b. Public opposition to the operation of hazardous waste management facilities and to the disposal of political wastes is so widespread that objections might be thought to be unavoidable. To whatever extent this might be true, it is also clear that the extent and ultimately the effectiveness of public opposition is influenced by identifiable factors. These factors include actions taken or not taken by the disposal sponsor, sponsor credibility, and coincidental but unrelated events. Opposition to the disposal of hazardous wastes is not necessarily based on technical considerations related to the site or the disposed wastes.

c. Dichloro diphenyl-trichloro-ethane, or DDT, has become an environmental issue since the publication of Rachel Carson's Silent Spring in the early 1960s and the long, bitter, and emotional campaign to ban DDT. The campaign was finally successful in 1972 when virtually all uses of DDT were prohibited, making it the first toxic substance to be banned for most uses in the U.S. However, in 1976 an EPA program known as Mussel Watch found that these animals were still contaminated with DDT, and in a recent publication--Environmental Quality: The Tenth Annual Report of the Council of Environmental Quality--DDT was still cited as a prominent environmental problem. DDT, then, must be considered a political waste whose disposal has the potential for provoking serious public opposition.

2. Purpose of Assessing National Interest Group Opinion

a. The project being considered involves the disposal of all Department of Defense owned DDT. A number of different disposal options were studied to determine which of them was the most environmentally sound method for disposing of DDT. Public opinion concerning the disposal project was assessed at the same time that the technical aspects of the project were under consideration.

b. The purpose of assessing national interest group reactions to the proposed DDT disposal project was to assure the development of a disposal plan that was not only technically sound, but one that took into consideration the wide range of public concerns surrounding the disposal of hazardous wastes. The interest groups contacted have experience with the hazardous waste question from a number of different perspectives. By assessing their various opinions and ideas concerning the disposal project, an additional goal of identifying potential problem areas in the project was achieved. In performing this assessment, problems that may have later become focal points for public opposition were appropriately addressed early in the EIS process.

c. Many of the interest groups contacted have had extensive experience as participants in the public hearing process. Their advice was sought on the siting of the public hearings for the DDT disposal project to assure that these hearings were sited in a manner that would allow the widest possible participation of both concerned individuals and organizations.

d. Additionally, referrals to other individuals and organizations with a possible interest in the disposal project were sought during contacts with the interest groups. The interest groups were offered the opportunity for continued involvement in the EIS process, including periodic updates concerning the progress of the project and the chance to review draft documents produced during the EIS process.

e. Appendix A includes a list of the interest groups that were contacted during the project. This exhibit also indicates whether a group was interested in the project and whether an interview was conducted. It should also be noted that a number of groups never responded to repeated telephone inquiries, and so were considered not to have an interest in the project.

3. The DDT Disposal Project

a. A broad outline of the project was presented during the interviews with interest group representatives. It was explained that the purpose of the project is to dispose of all Department of Defense (DoD) owned DDT stocks, which amounts to approximately two million pounds in various formulations. The bulk of the DDT (240,662 gallons) is in liquid form using a petroleum based solvent. Approximately 210,000 pounds of the DDT is in a solid form. The remainder of the DDT is in various forms, including aerosols. The various formulations range in concentration from 5% to 100% DDT.

b. The DDT is presently stored at approximately 79 Defense Department installations in 34 states, Puerto Rico, Guam, and three foreign countries. Only about 100,000 pounds of the DDT are stored abroad.

c. A short explanation was given for each of the DDT disposal options presently under study: landfill, land incineration, ocean incineration, and reprocessing. Landfilling of the DDT would be done at a Class I, or most secure, landfill. Land incineration would be done at one or more of the handful of incinerators in the U.S. that are in the process of being licensed to incinerate PCBs. These incinerators use high temperature combustion furnaces that ensure the almost complete destruction of chlorinated hydrocarbons such as DDT. Ocean incineration would be performed on the ship Vulcanus, presently the only operational incinerator ship. The Vulcanus has previously been used to incinerate a number of chlorinated hydrocarbons, including Herbicide Orange. Finally, methods of reprocessing the DDT were being investigated. Ideally, such a process would reduce the DDT to a relatively harmless effluent or to a marketable compound(s) with industrial applications.

d. Three additional options that do not entail the destruction of the DDT were also considered. Under certain circumstances (for example, intense public opposition to the use of the other disposal options), it may be necessary to either leave the DDT in place, recontainerizing it as necessary, or to place it in special long-term storage. The possibility of returning the DDT to the only remaining manufacturer of DDT in the U.S. was the final option considered.

4. Summary Conclusions

a. A number of conclusions were drawn from the interviews of interest group representatives:

(1) At least minor public opposition to the project is inevitable.

(2) Some of this opposition will be unrelated to technical considerations in the proposed disposal.

(3) Most groups feel that the landfill option is unacceptable from both an environmental and public relations point of view.

(4) Leaving the DDT in place or placing it in long-term storage to await better disposal technologies should only be considered if serious public opposition develops to the use of the other options.

(5) Most groups feel that sale to a manufacturer, especially if it would result in the DDT's export, is unacceptable for environmental and ethical reasons.

(6) If either or both of the incineration options would be the preferred disposal option, then several of the groups raised the possibility of toxic emissions, particularly dioxins.

(7) Physical/chemical means of disposal are of great interest to a number of those interviewed and would probably provoke little or no opposition.

(8) Most of the groups feel that the transportation of the DDT, especially by truck, could provoke widespread opposition.

(9) Use of rail transport was preferred by most groups where possible.

(10) Several groups indicated that public trust of the Department of Defense could be an important factor in the development or intensity of public opposition; however, continued willingness on the part of the Department to consult with the public should minimize opposition.

b. The following section outlines the procedure used in selecting the interest groups contacted during the project and the development of the interview guide. The interviews are discussed in detail in Chapter VI.C and the conclusions in Chapter VI.D.

B. PROCEDURES USED IN COMPILING THE INTEREST GROUP LIST AND IN DEVELOPING THE INTERVIEW GUIDE

1. Three sources were used in compiling the list of groups with a potential interest in the DDT disposal project. It was initially proposed to identify these groups by examining the interest group review comments included in past Environmental

Impact Statements (EIS) concerning the use or disposal of DDT and related substances. However, this approach proved to be unsatisfactory because of the limited availability of EISs, particularly from the early 1970s when most studies concerning DDT were done. Additionally, the absence of an EIS subject index made identifying EISs concerning DDT a time consuming, hit or miss process.

2. Therefore, much of the list was compiled through phone contacts with well-known national environmental groups. The purpose of these contacts was threefold: to assess the group's interest in the DDT disposal project; to talk directly, if possible, with their in-house expert on pesticides or hazardous wastes; and to request referrals to additional groups or individuals with a possible interest in the project. Other groups were added to the list through the use of directories such as the <u>Encyclopedia of Associations</u> and the <u>Environmental Protection Directory</u>. For a list of the interest groups contacted see Appendix A.

3. An interview guide was developed for an unstructured open-ended interview since most of the information being sought was qualitative in nature. Through the interviews it was hoped to develop a clear understanding of the issues involved in hazardous waste disposal projects that are of concern to the general public, and that are factors in the development of public opposition. It was also hoped to identify any issues or problems that might provoke or intensify public opposition. These issues could then be addressed in the Environmental Impact Statement.

4. Among the areas of concern to be assessed during the interviews were: reactions to the project as a whole, reactions to the specific disposal options, and reactions to the transportation options. In assessing reactions to the overall project a particular interest was to discover whether those interviewed believed the project to have the potential for provoking substantial public opposition. The possibility of opposition from the interest group itself was also of concern.

5. In assessing reactions to the specific disposal options it was hoped to find which option or options the interviewees found most environmentally acceptable, and what specific concerns they have with the options. The public acceptability of each of the disposal options was an area of particular interest. Suggestions for alternative options that might be used to dispose of the DDT were also sought. Similar areas of concern were assessed for the transportation options.

6. In all of these areas there was particular interest in assessing public concerns so that these concerns could be

addressed and, if possible, resolved before they became a public relations problem. Ideally, such a course would minimize public opposition. Additionally, since many of the interest groups contacted have extensive experience in these areas, suggestions concerning the public hearing process and public hearing siting were sought.

7. Interest groups were also to be given the opportunity for further involvement in the project, specifically in the review of draft documents produced during the EIS process. Finally, the interviews were to be used to add to the list of interest groups.

C. SUMMARY OF NATIONAL INTEREST GROUP REACTIONS

1. Introduction

Because of the preliminary nature of the DDT disposal project when the interest group interviews were conducted, little specific information could be supplied to the interest group representatives either before or during the interviews. Therefore, it must be understood that what follows are the initial reactions of the interest group representatives and not the official positions of the interest groups themselves. Any position taken by an interest group representative during an interview is subject to change as more specific information concerning the project becomes available.

2. Overall Reactions to the Project

a. Overall, the reactions to the project were cautious but favorable, and none of the interest group representatives expressed immediate opposition. A number of the representatives were very much in favor of disposing of the DDT and were concerned only that it be done in an environmentally sound manner. For the reports on the individual interviews, see Appendix A.

b. One of the most commonly raised issues concerning the overall project was a lingering mistrust of the Corps of Engineers. The Corps over the years has developed a reputation, warranted or not, of being insensitive to both public opinion and environmental concerns. For example, Mary Leffler of the International City Management Association (ICMA) feels that public resentment against the Corps is still prevalent. She believes that this is especially true in the Southeast as a result of the Corps' channelization program and their involvement in the construction of the Cross Florida Barge Canal.

c. A number of the interest group representatives expressed suspicions about the Corps' purpose in contacting them. Maureen Hinkle of the Environmental Defense Fund expressed the feeling that the DDT disposal project was not the result of sudden environmental concern on the part of the DoD, but instead was the result of outside pressures applied in the aftermath of the Triana, Alabama incident. She went on to state that the DoD has other, more dangerous substances in need of disposal, which at the moment are not causing them the same public relations problems as DDT.

d. However, some of those interviewed were of the opinion that the Corps had become much more environmentally conscious in recent years. Additionally, most of those interviewed were favorably impressed by the Corps' attempts to involve them early in the EIS process.

e. Most of the interest group representatives interviewed agreed that the project had the potential for provoking public opposition, particularly at specific disposal sites and along transportation corridors. However, opinions on the magnitude of opposition varied.

3. Reactions to the Disposal Options

a. Although in the past landfilling has been the most commonly used form of hazardous waste disposal, all except three of those interviewed found it to be an entirely unacceptable option from both environmental and public relations standpoints. Groundwater contamination, upward seepage, and the generation and eventual escape or explosion of toxic gases were among the problems mentioned as plaguing landfills. The main concern with landfills, however, is the lack of strict enforcement of maintenance and control procedures, particularly after a landfill is closed. There was a general feeling that a landfill can never be made entirely secure, even with careful and meticulous planning. This is of particular concern since many hazardous wastes take tens or hundreds of years to decompose. DDT is just such a long-lived substance, taking as long as thirty years to decompose once in the soil. Subsequent misuse of abandoned landfills is another serious problem, since such misuse can violate the integrity of the site and allow environmental contamination. Love Canal is an extreme example of the misuse of an abandoned landfill, encouraged, in this case, by the company that owned the site. A school and houses built on or adjacent to the site have since been abandoned.

b. It was the general opinion of those interviewed that the use of the landfill option would meet with substantial public opposition. Mary Leffler of ICMA, one of three interviewees who did not dismiss the landfill option out of hand for environmental reasons, felt that it was not a viable option because of the opposition it would provoke. The probability of opposition was viewed as particularly great in the aftermath of the Love Canal incident and the subsequent government disclosure that there are probably over a 1,000 at sites which hazardous wastes are stored, handled, or buried that have substantial contamination problems.

c. Only one of those interviewed, Rodger Guttentag of the Environmental Action Coalition (EAC), felt that landfilling was a viable disposal option. However, it would not be his first choice as a disposal option. He pointed out that certain wastes can be solidified and encased in an inert aggregate prior to landfilling, and he suggested that this process be investigated to see if it would be effective with DDT.

d. Incineration was the most widely preferred disposal option though a number of concerns were expressed about it. The most common concern for land or ocean incineration was the possible emission of toxic substances, particularily dioxins, during incineration. Dr. Karim Ahmed of the National Resources Defense Council (NRDC) mentioned, as an analogous example, that the incineration of PCBs produces trace amounts of two extremely toxic substances, dibenzofuran and dioxin. The emission of toxic breakdown substances was a particular concern, if through a malfunction the incinerator operated at less than optimum temperatures. Possible toxic emissions are a particular concern at land based incinerators since emissions are usually the focus of local public opposition.

e. Sam Gusman of the Conservation Foundation was also concerned with the possible adverse environmental effects of the hydrochloric acid that is produced during the incineration of a chlorinated hydrocarbon such as DDT. This was a particular concern for him if the Vulcanus were used since he understood that the ship had no stack scrubbers for the incinerators.

f. In general, ocean incineration was thought to be preferable to land incineration for two interrelated reasons. Ocean incineration would be carried out farther from human habitation than would be possible with land incineration. This would minimize human exposure to any toxic emissions and would be less likely to provoke serious public opposition. However, it was noted that opposition might be expected in the port while the DDT was loaded.

g. Dr. Ahmed of the NRDC was one of those opposed to ocean incineration. He thought that ocean incineration would be more difficult to monitor than land incineration, as a result of lax and inadequate controls. He speculated that there would be more potential for abuse. Though he recognized the public relations advantages of ocean incineration, he compared it to "burning [the DDT] at night to keep it out of the public eye."

h. Furthermore, Roger Guttentag of EAC was concerned with the high risk of a spill during transfer of the DDT to the incinerator ship. He noted that the greatest number of oil spills occur during transfer operations, and that most of these spills occur not as a result of equipment malfunction, but through human error.

i. During the interviews, a great deal of interest was expressed in the possible use of chemical/physical processes for either detoxifying or reprocessing the DDT. Many inquiries were made as to whether there are any industrial uses for DDT or its constituent parts. A number of those interviewed suggested that a waste exchange might serve to answer this question.

j. Dr. Ahmed of the NRDC suggested two specific processes that might be used. A technique known as ozonization and ultra-violet radiation has been used very successfully to break down PCBs, especially those in low concentration formulations. He cautioned, however, that this process would probably be considerably more expensive than incineration. His second suggestion involved an activated charcoal process that could be used to purify the DDT prior to detoxification or reprocessing. This process might also be used prior to transporting or incinerating the DDT in order to reduce the bulk requiring handling.

k. Rodger Guttentag felt that recycling the DDT through a waste exchange would be the best disposal option. He noted that the recycling of wastes reduces both the amount of hazardous wastes needing disposal and the amount of energy used in industrial processes.

l. Either leaving the DDT in place or placing it in special long-term storage were unanimously considered to be unsatisfactory options, since those interviewed preferred that the DDT be disposed of permanently. They feared that eventually the DDT would either be mishandled or improperly stored, and that these options would pose an unnecessary long-term threat to the environment. Nevertheless, a number of those interviewed felt these options should be studied if public opposition blocked either the transport of the DDT or the use of any of the permanent disposal options.

m. Sale of the DDT to the sole remaining manufacturer of DDT in the U.S. was perhaps the most unpopular of all the options. It was thought that if this option were used, the DDT would eventually be exported to countries where its use was still permitted. It was seen as not only environmentally unsound, but unethical to export a substance for use in a foreign country that we have banned in our own country. Though this option would probably not provoke a great deal of opposition among the general public, it would among national interest groups.

4. Reaction to the Transportation Option

a. A number of those interviewed felt that the DDT's transportation from present storage sites to the disposal site(s) would be the project's major problem. Of particular concern to them is the large number of sites from which the DDT has to be removed and the great distances much of it will have to travel. The use of trucks to transport most or all of the DDT was questioned, and it was felt that with the number of trucks that would be involved, an accident was almost certain.

b. Transport by truck would also be more difficult to monitor to assure that required safeguards were being followed. For example, drivers might not observe restrictions on the number of hours they could drive. The experience and qualifications of the drivers to be used were also areas of concern. Shirley Briggs of the Rachel Carson Council was in favor of using rail transport wherever possible, and a number of others interviewed felt that the respective risks of truck and rail transport should be assessed.

c. If trucks are used, it was stressed that stringent safety standards should be implemented. Jorge Manring of the National Wildlife Federation wanted assurances that the DDT, particularily in liquid form, would be properly containerized for shipment. He did not trust the Corps to do this and suggested that an outside group be hired to monitor all aspects of the DDT's transportation, particularly any necessary recontainerization.

d. According to Eric Jensen of the Friends of the Earth, DDT is still valued as a pesticide, and there is still widespread illegal use of it in the U.S. Therefore, he wanted a proper manifest system for the DDT, epecially during shipment, to assure that none of it is "lost" or stolen on its way to the disposal site. He stressed that reliable people should be employed in transporting the DDT.

e. Dr. Ahmed of the NRDC recommended that any actions to be taken in case of an accident during the DDT's transportation should be precisely specified. Additionally, the Corps should be ready to respond to an accident immediately, since, as Mary Leffler of ICMA pointed out, most communities, especially the smaller ones, are not prepared to handle a serious emergency situation such as a hazardous waste spill.

f. Among those who did not see the transportation of the DDT as a particular problem were Blake Early of the Sierra Club and Alan Kneese of Resources for the Future (RFF). Blake Early pointed out that large amounts of hazardous wastes are transported in the U.S. with few incidents. He feels that it is quite possible to safely manage hazardous waste transportation. Alan Kneese also noted that DDT is a low-toxic substance for humans; it is both non-corrosive and non-explosive.

g. Even those interest group representatives who thought that there is little risk in transporting DDT recognized that the DDT's transport could become the focus of public opposition to the project. Communities along the transportation corridors could pass ordinances banning the DDT's passage. Though these ordinances are usually struck down in the courts they do have their nuisance value. If numerous communities did react to the DDT's tranport in this manner, it could both delay the project and add to its cost.

h. Bruce Rosenthal of the National Association of Towns and Townships suggested that a monitoring committee composed of various government officials be established to determine and assess possible transportation routes and to address public concerns about the transportation. The use of such a committee may help to minimize opposition. However, it is the opinion of Alan Kneese of the RFF that major opposition to the transport of a non-nuclear waste, such as occurred with PCBs in Sharpstown, Maryland, is atypical.

D. CONCLUSIONS

1. A number of conclusions can be drawn from the interest group interviews. It was generally agreed that the disposal project would encounter some public opposition, possibly of a substantial nature. The level of this opposition would be influenced greatly by both the disposal and transportation options chosen and by the manner in which the Corps deals with the public. However, much of the opposition toward hazardous waste disposal is purely emotional in nature and not necessarily dependent on inherent technical shortcomings in a disposal site or option.

2. The use of a number of the disposal options would be unacceptable to both the interest groups and to the general public. Landfilling was deemed unsuitable for a substance as persistent in the soil as DDT. Because of this persistence, it was felt that landfilling would simply prolong the disposal problem.

3. In the aftermath of Love Canal, landfilling would provoke more public opposition than any of the other options being considered. Even those who felt that DDT could be landfilled safely believed it to be an unviable option because of probable public opposition.

4. Leaving the DDT in place or placing it in special long-term storage were options that should only be considered for use if there is very intense public opposition to the project.

5. The return of the DDT to the last remaining DDT manufacturer in the U.S. would be strongly opposed by the interest groups, if not by the general public. It was felt that the manufacturer would have few options but to export the DDT to a country where its use is still permitted. The issue of the U.S. allowing the exporting of chemicals and consumer goods the use of which are either prohibited or restricted at home has been receiving increasing attention in the media in recent months. The State Department has been trying to curb this type of export because of the potential harm it can do to the U.S. image abroad, especially in the Third World where most of these exports go. There was no doubt on the part of those interviewed that this option was environmentally unsound and, of equal consideration, unethical.

6. Incineration was the most widely preferred of the disposal options. However, the question of possible emission of toxic substances, particularly dioxins, during incineration was raised a number of times. It is important to resolve this question, especially if land incineration is chosen as the disposal option. Opposition to hazardous waste incineration facilities is usually based on the possible exposure of nearby residents to toxic emissions. The use of the ocean incineration option would be unlikely to provoke serious public opposition.

7. As noted before, a great deal of interest was shown in the use of a physical/chemical process to either detoxify or reprocess the DDT. As with incinerination at sea, the use of this option was thought unlikely to provoke public opposition.

8. The most widespread opposition to the project might develop around the DDT's transportation. This opposition would be strongest near major storage sites, disposal facilties, or in the port where the Vulcanus loads. The greatest concerns in this area center around the dangers of transporting the DDT by truck, particularly in light of the large number of sites involved. It was thought that particular care should be taken to assure that the DDT is not transported in inadequate or deteriorating containers. The credibility of the firm used to transport the DDT and the reliability of individual drivers were an additional concern. Transporting the DDT by rail wherever possible would minimize interest group concern and public opposition.

9. An uncertain, but possibly important factor in the development of public opposition to the project is the credibility of the Department of Defense itself. More intense public opposition to the project than might normally be anticipated could develop if the public mistrusts the Department. Though there is little the Department can do to change widely held perceptions overnight, if it continues to conduct the project in a spirit of openness and candor, showing a willingness to consult with the public, serious public opposition should be averted.

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LIST OF AGENCIES, ORGANIZATIONS, AND PERSONS TO WHOM COPIES OF THE STATEMENT HAVE BEEN SENT

Federal Agencies

Department of Transportation

Secretary of Transportation
Washington, D. C.

U. S. Coast Guard
Washington, D. C.

Federal Highway Administration
Washington, D. C.

Federal Aviation Administration
Washington, D. C.

Federal Railroad Administration
Washington, D. C.

Research & Special Program
Administration
Washington, D. C.

Environmental Protection Agency

Regional Administrator, I
Boston, MA

Acting Regional Administrator, II
New York, NY

Regional Administrator, III
Philadelphia, PA

Regional Administrator, IV
Atlanta, GA

Regional Administrator, V
Chicago, IL

Regional Administrator, VI
Dallas, TX

Regional Administrator, VII
Kansas City, MO

Regional Administrator, VIII
Denver, CO

Regional Administrator, IX
San Francisco, CA

Regional Administrator, X
Seattle, WA

Federal Regional Councils

New England Federal Regional
Council
Boston, MA

Federal Regional Council
New York, NY

Mid-Atlantic Federal Regional
Council
Philadelphia, PA

Southeast Federal Regional Council
Atlanta, GA

Federal Regional Council
Chicago, IL

Southwest Federal Regional Council
Dallas, TX

Mid-Continental Federal Regional
Council
Kansas City, MO

Mountain Plains Federal Regional
Council
Denver, CO

Western Federal Regional Council
San Francisco, CA

Northwest Federal Regional Council
Seattle, WA

Other Federal Agencies

Office of Environmental Quality
Environmental, Safety and Consumer Affairs
Washington, D. C.

Department of State
Office of the Special Assistant to the Secretary for Environmental Affairs
Washington, D. C.

Office of Environmental Project Review
Department of the Interior
Washington, D. C.

Council on Environment Quality
Washington, D. C.

Department of Fish, Wildlife & Parks
Washington, D. C.

Office of Management & Budget
Washington, D. C.

Department of Health, Education and Welfare

Office of Environmental Affairs
Washington, D. C.

Regional Environmental Officer
Boston, MA

Regional Environmental Officer
New York, NY

Regional Environmental Officer
Philadelphia, PA

Regional Environmental Officer
Atlanta, GA

Regional Environmental Officer
Chicago, IL

Regional Environmental Officer
Dallas, TX

Regional Environmental Officer
Kansas City, MO

Regional Environmental Officer
Seattle, WA

Center for Disease Control
Environmental Health Services Division
Atlanta, GA

U. S. Department of Agriculture
Washington, D. C.

U. S. Department of Commerce
Washington, D. C.

Regional Environmental Officer
San Francisco, CA

Regional Environmental Officer
Denver, CO

State Governors and Agencies

Governor of Alabama
Montgomery, AL

Department of Public Health
Montgomery, AL

Division of Solid Waste &
Vector Control
Montgomery, AL

Governor of Alaska
Juneau, AK

Department of Natural Resources
Juneau, AK

Governor of Arizona
Phoenix, AZ

Bureau of Sanitation
Phoenix, AZ

Department of Health Services
Phoenix, AZ

Office of the State Chemist
Mesa, AZ

Governor of Arkansas
Little Rock, AR

Department of Pollution Control
& Ecology
Little Rock, AR

Department of Transportation
Little Rock, AR

Governor of California
Sacramento, CA

Department of Health, Vector
and Waste Management
Sacramento, CA

Health & Welfare Agency
Sacramento, CA

Governor of Colorado
Denver, CO

Department of Health
Denver, CO

Governor of Connecticut
Hartford, CT

Department of Environmental
Protection
Hartford, CT

Department of Public Safety
Hartford, CT

Governor of Delaware
Dover, DE

Department of Natural Resources
& Environmental Control
Dover, DE

Department of Public Safety
Dover, DE

Governor of Florida
Tallahassee, FL

Department of Natural Resources
Tallahassee, FL

Department of Environmental
Regulation
Tallahassee, FL

Public Service Commission
Tallahassee, FL

Department of Agriculture
Tallahassee, FL

Governor of Georgia
Atlanta, GA

Department of Natural Resources
Atlanta, GA

Department of Transportation
Atlanta, GA

Governor of Hawaii
Honolulu, HI

Department of Health
Honolulu, HI

Department of Transportation
Honolulu, HI

Governor of Idaho
Boise, ID

Department of Health & Welfare
Boise, ID

Department of Agriculture
Boise, ID

Governor of Illinois
Springfield, IL

Department of Public Health
Springfield, IL

Environmental Protection Agency
Springfield, IL

Governor of Indiana
Indianapolis, IN

Board of Health
Indianapolis, IN

Division of Sanitary Engineering
Indianapolis, IN

Governor of Iowa
Des Moines, IA

Natural Resouces Council
Des Moines, IA

Department of Agriculture
Des Moines, IA

Department of Environmental
Quality
Des Moines, IA

Governor of Kansas
Topeka, KS

Department of Health &
Environment
Topeka, KS

Department of Agriculture
Topeka, KS

Governor of Kentucky
Frankfort, KY

Department of Natural Resources
& Environmental Protection
Frankfort, KY

Governor of Louisiana
Baton Rouge, LA

Department of Health & Human
Resources Administration
New Orleans, LA

Governor of Maine
Augusta, ME

Department of Environmental
Protection
Augusta, ME

Department of Conservation
Augusta, ME

Department of Agriculture
Augusta, ME

Department of Transportation
Augusta, ME

Governor of Maryland
Annapolis, MD

Department of Health & Mental
Hygiene
Baltimore, MD

Department of Natural Resources
Annapolis, MD

Maryland Environmental Service
Annapolis, MD

Governor of Massachusetts
Boston, MA

Department of Environmental
Affairs
Boston, MA

Department of Food & Agriculture
Boston, MA

Department of Public Health
Boston, MA

Governor of Michigan
Lansing, MI

Department of Agriculture
Lansing, MI

Governor of Minnesota
St. Paul, MN

Department of Natural Resources
St. Paul, MN

Department of Agriculture
St. Paul, MN

Pollution Control Agency
Roseville, MN

Governor of Mississippi
Jackson, MS

Department of Natural Resources
Jackson, MS

Department of Agriculture &
Commerce
Jackson, MS

Board of Health
Jackson, MS

Solid Waste, Vector Control
Jackson, MS

Governor of Missouri
Jefferson City, MO

Department of Natural Resources
Jefferson City, MO

Division of Environmental
Quality
Jefferson City, MO

Governor of Montana
Helena, MT

Department of Health and
Environmental Services
Helena, MT

Governor of Nebraska
Lincoln, NE

Natural Resources Commission
Lincoln, NE

Public Service Commission
Lincoln, NE

Division of Environmental Control
Lincoln, NE

Governor of Nevada
Carson City, NV

Department of Conservation and
Natural Resources
Carson City, NV

Governor of New Hampshire
Concord, NH

Division of Public Health
Services
Concord, NH

Governor of New Jersey
Trenton, NJ

Department of Transportation
Trenton, NJ
Department of Environmental Protection
Trenton, NJ
Solid Waste Administration
Trenton, NJ

Governor of New Mexico
Santa Fe, NM

Natural Resources Department
Santa Fe, NM

Department of Agriculture
Las Cruces, NM

Health & Environment Department
Santa Fe, NM

Environmental Imporvement Agency
Santa Fe, NM

Governor of New York
Albany, NY

Department of Environmental
Conservation
Albany, NY

Department of Transportation
Albany, NY

Governor of North Carolina
Raleigh, NC

Department of Natural Resources
and Community Development
Raleigh, NC

Division of Environmental
Management
Raleigh, NC

Department of Human Resources
Raleigh, NC

Department of Argiculture
Raleigh, NC

Solid Waste & Vector Control
Raleigh, NC

Governor of North Dakota
Bismarck, ND

Health Department
Bismarck, ND

Division of Pesticides
Bismarck, ND

Governor of Ohio
Columbus, OH

Department of Natural Resources
Columbus, OH

Land Pollution Control
Columbus, OH

Governor of Oklahoma
Oklahoma City, OK

Department of Health
Oklahoma City, OK

Governor of Oregon
Salem, OR

Natural Resources
Office of the Governor
Salem, OR

Department of Agriculture
Salem, OR

Public Utility Commissioner
Salem, OR

Department of Environmetnal
Quality
Portland, OR

Governor of Pennsylvania
Harrisburg, PA

Department of Environmental
Resources
Harrisburg, PA

Department of Transportation
Harrisburg, PA

Governor of Rhode Island
Providence, RI

Department of Environmental
Management
Providence, RI

Division of Solid Waste Management
Providence, RI

Governor of South Carolina
Columbia, SC

Department of Health & Environmental
Control
Columbia, SC

Governor of South Dakota
Pierre, SD

Department of Water & Natural
Resources
Pierre, SD

Department of Environmental Protection
Solid Waste Program
Pierre, SD

Department of Transportation
Pierre, SD

Governor of Tennessee
Nashville, TN

Department of Public Health
Nashville, TN

Department of Agriculture
Nashville, TN

Sanitation and Solid Waste
Management
Nashville, TN

Governor of Texas
Austin, TX

Department of Health
Austin, TX

Department of Public Safety
Austin, TX

Department of Water Resources
Austin, TX

Railroad Commission of Texas
Austin, TX

Governor of Utah
Salt Lake City, UT

Department of Natural Resources
Salt Lake City, UT

Bureau of Solid Waste
Management
Salt Lake City, UT

Governor of Vermont
Montpelier, VT

Agency of Environmental
Conservation
Montpelier, VT

Governor of Virginia
Richmond, VA

Department of Health
Richmond, VA

Department of Agriculture and
Consumer Services
Richmond, VA

Department of Highways and
Transportation
Richmond, VA

Governor of Washington
Olympia, WA

Department of Transportation
Olympia, WA

Department of Natural Resources
Olympia, WA

Department of Agriculture
Olympia, WA

Department of Ecology
Olympia, WA

Governor of West Virginia
Charleston, WV

Department of Health
Charleston, WV

Governor of Wisconsin
Madison, WI

Department of Natural Resources
Madison, WI

Department of Agriculture
Madison, WI

Governor of Wyoming
Cheyenne, WY

Department of Environmental
Quality
Cheyenne, WY

Governor of Puerto Rico
San Juan, PR

Department of Natural Resources
San Juan, PR

Environmental Quality Board
Noise and Solid Waste
Santurce, PR

Associations

American Association of Port Authorities
Washington, D.C.

American Association of State Highway & Transportation Officials
Washington, D.C.

American Public Health Association
Washington, D.C.

American Public Welfare
Washington, D.C.

American Water Works Association
Denver, CO

Association of Metropolitan Sewerage Agencies
Washington, D.C.

Association of State and Interstate Water Pollution
Washington, D.C.

Council for International Urban Liaison
Washington, D.C.

Council of State Community Affairs Agencies
Washington, D.C.

Council of State Governments
Lexington, KY

Environmental Industry Council
Washington, D.C.

International City Management Association
Washington, D.C.

International Longshoremen's and Warehousemen's Union
San Francisco, CA

International Longshoremen's Association
New York, NY

League of Women Voters
Washington, D.C.

National Agricultural Chemicals Association
Washington, D.C.

National Association of Attorneys General
Washington, D.C.

National Association of Counties
Washington, D.C.

National Association of Regional Councils
Washington, D.C.

National Association of Towns and Townships
Washington, D.C.

National Conference of State Legislatures
Denver, CO

State-Federal Relations
Washington, D.C.

National Governor's Association
Washington, D.C.

National Institute of Public Affairs
Washington, D.C.

National League of Cities
Washington, D.C.

Natonal Municipal League
New York,NY

National Solid Waste Management Association
Washington, D.C.

United Association AFL-CIO
Washington, D.C.

Waste Watch
Washington, D.C.

Water Pollution Control
Federation
Washington, D.C.

U.S. Chamber of Commerce
Washington, D.C.

Public Interest Groups

Clean Water Action Project
Washington, D.C.

Conservation Foundation
Washington, D.C.

Defenders of Wildlife
Washington, D.C.

Environmental Action, Inc.
Washington, D.C.

Environmental Defense Fund
Washington, D.C.

Environmental Law Institute
Washington, D.C.

Environmental Policy Center
Washington, D.C.

Friends of the Earth
Washington, D.C.

National Audubon Society
Washington, D.C.

National Wildlife Federation
Washington, D.C.

Natural Resources Defense Council
Washington, D.C.

Rachel Carson Trust
Chevy Chase, MD

Resources for the Future
Washington, D.C.

Sierra Club
Washington, D.C.

Wilderness Society
Washington, D.C.

Academy for Contemporary Problems
Washington, D.C.

Other Interested Parties

Boots Hercules
Washington, D.C.

Mr. Phil Marvin
Lincoln, NE

Abco Industries, Inc.
Roebuck, SC

Hopkins Agri Chemical
Madison, WI

Regional Agencies

Delaware River Basin Commission
Trenton, NJ

New England River Basins Commission
Boston, MA

Susquehanna River Basin Commission
Mechanicsburg, PA

Great Lakes Basin Commissions
Ann Arbor, MI

Pacific Northwest River Basin
Commission
Vancouver, WA

Ohio River Basin Commission
Cincinnati, OH

Missouri River Basin Commision
Omaha, NE

Upper Mississippi River Basin
Commission
Twin Cities, MN

APPENDIX A

INTEREST GROUPS

A1

National Interest Groups Contacted Regarding the DDT Disposal Project

A2

Interview Reports

Appendix A 1

NATIONAL INTEREST GROUPS CONTACTED
REGARDING THE DDT DISPOSAL PROJECT

National Interest Groups Contacted	National Interest Group Responses
1. Academy for Contemporary Problems Ralph Widner, President 400 North Capitol St., N.W. Suite 390 Washington, D.C. 20001 (202) 638-1445	
2. American Association of Port Authorities J. Ron Brinson Ex. Vice President 1612 K Street, N.W., Suite 502 Washington, D.C. 20006 (202) 331-1263	
3. American Association of State Highway & Transportation Officials Henrik E. Stafseth, Ex. Director 444 North Capitol St., N.W. Suite 225 Washington, D.C. 20001 (202) 624-5810	
4. The American Eagle Foundation* Donald Caruth 3306 Winnett Drive Chevy Chase, MD 20015 (301) 652-8910	

National Interest Groups Contacted	National Interest Group Responses
5. American Public Health Association Dr. William H. McBeath Ex. Director 1015 15th Street, N.W. 3rd Floor Washington, D.C. 20005 (202) 789-5600	
6. American Public Welfare Association Edward T. Weaver, Ex. Director 1125 15th Street, N.W. Suite 300 Washington, D.C. 20005 (202) 293-7550	
7. Association of Metropolitan Sewerage Agencies Ron Linton, Ex. Director 1015 18th Street, Suite 200 Washington, D.C. 20036 (202) 659-9161	
8. Association of State and Interstate Water Pollution Control Administrators Robbi J. Savage, Ex. Director 444 North Capitol Street, N.W. Suite 330 Washington, D.C. 20001 (202) 624-7782	

National Interest
Groups Contacted

National Interest
Group Responses

9. Clean Water Action Project
Larry Silverman
1341 6th Street, N.W.
Washington, D.C.
(202) 683-1196

10. Conservation Foundation
Sam Gusman & Richard A. Liroff
1717 Massachusetts Ave., N.W.
Washington, D.C. 20036
(202) 797-4300

11. Council of State Community
Affairs Agencies
Joseph S. Marinich, Ex. Director
444 North Capitol Street, N.W.
Suite 349
Washington, D.C. 20001
(202) 624-5850

12. Defenders of Wildlife
Toby Cooper
1224 19th Street, N.W.
Washington, D.C. 20036
(202) 659-9510

13. Environmental Action Coalition*
Rodger Guttentag
157 Fifth Avenue, Suite 1130
New York, NY 10010
(212) 929-8481

National Interest
Groups Contacted

National Interest
Group Responses

14. Environmental Action, Inc.
Marchant Wentworth
1346 Connecticut Ave., N.W.
Room 731
Washington, D.C. 20036
(202) 833-1845

15. Environmental Industry Council
Frank P. Sebastian
1825 K Street, N.W., Suite 210
Washington, D.C. 20006

16. Environmental Defense Fund
Maureen Hinkle
1525 18th Street, N.W.
Washington, D.C. 20036
(202) 833-1484

17. Environmental Law Institute
Jeff Trauberman
1345 Connecticut Ave., N.W.
Sixth Floor
Washington, D.C. 20036
(202) 452-9600

National Interest
Groups Contacted

National Interest
Group Responses

18. Environmental Policy Center
317 Pennsylvania Ave., S.W.
Washington, D.C. 20003
(202) 547-6500

19. Friends of the Earth
Eric Jensen
530 7th Street, S.E.
Washington, D.C. 20003
(202) 543-4312

20. INFORM*
Greg Cohen
25 Broad Street
New York, NY 10004
(212) 425-3550

21. International City Management Association
Mary Leffler
1140 Connecticut Avenue
2nd Floor
Washington, D.C. 20036
(202) 828-3689

22. International Longshoremen's Association
Battery Place, Room 1530
New York, New York 10004
(212) 425-1200

National Interest
Groups Contacted

National Interest
Group Responses

23. Izaak Walton League of America
Marni Holbrook
1800 N. Kent Street
Arlington, VA
(703) 528-1818

24. League of Women Voters
Debbie Shieman
1730 M Street, N.W., 10th Floor
Washington, D.C. 20036
(202) 296-1770

25. National Agricultural Chemicals
Association
Lawrence Norton
1155 15th Street, N.W.
Washington, D.C. 20005
(202) 296-1585

26. National Association of Counties
Bernard F. Hillenbrand
Ex. Director
1735 New York Avenue, N.W.
5th Floor
Washington, D.C. 20006
(202) 785-9577

27. National Association of Towns
and Townships
Bruce Rosenthal
1527 18th Street, N.W.
Washington, D.C. 20036
(202) 462-0265

National Interest
Groups Contacted

National Interest
Group Responses

28. National Audubon Society
Bett Tedford
950 Third Avenue
New York, NY 10022
(212) 832-3200

29. National Clean Air Coalition*
Betsy Agle
530 7th Street, S.E.
Washington, D.C. 20003
(212) 543-0305

30. National Conference of State Legislatures
William Pound, Director
State-Federal Relations
444 North Capitol Street, N.W.
2nd Floor
Washington, D.C. 20001
(202) 624-5402

31. National Governor's Association
Stephen B. Farber, Ex. Director
400 North Capitol Street, N.W.
2nd Floor, Suite 250
Washington, D.C. 20001
(202) 624-5300

32. National Institute of Public Affairs
Enid Beaumont, Ex. Director
1225 Connecticut Avenue, N.W.
Room 300
Washington, D.C. 20036
(202) 828-6500

National Interest Groups Contacted

National Interest Group Responses

33. National League of Cities
Alan Beals, Ex. Director
1620 Eye Street, N.W.
4th Floor
Washington, D.C. 20006
(202) 293-6915

34. National Municipal League
William Cassella, Ex. Director
47 East 68th Street
New York, New York 10021
(212) 535-5700

35. National Solid Wastes Management Association
Chemical Wastes Committee
1120 Connecticut Avenue, N.W.
Washington, D.C.
(202) 659-4613

36. National Wildlife Federation
Ken Kamlet
1412 16th Street, N.W.
Washington, D.C. 20036
(202) 797-2945

37. Natural Resources Defense Council
Dr. Karim Ahmed
122 E. 42nd Street
New York, NY 10017
(212) 949-0049

National Interest
Groups Contacted

National Interest
Group Responses

38. Rachel Carson Trust
Shirley Briggs
8940 Jones Mill Road
Chevy Chase, Md. 20015
(301) 652-1877

39. Resources for the Future
Allen Kneese
1755 Massachusetts Ave., N.W.
Washington, D.C. 20036
(202) 462-4400

40. Sierra Club
Blake Early
330 Pennsylvania Ave., S.E.
Washington, D.C. 20003
(202) 547-1144

41. United Association AFL-CIO
Alex Bell
815 16th Street, N.W., Room 307
Washington, D.C. 20006
(202) 628-6328

42. U.S. Chamber of Commerce
Tatiana Roodkowsky
1615 H Street, N.W.
Washington, D.C. 20062
(202) 659-6173

National Interest Groups Contacted	National Interest Group Responses
43. United State Conference of Mayors John J. Gunther, Ex. Director 1620 Eye Street, 4th Floor Washington, D.C. 20006 (202) 293-6796	
44. Waste Watch Arthur Purcell 1346 Connecticut Avenue, N.W. Washington, D.C. 20036 (202) 337-2500	
45. Water Pollution Control Federation Robert Canham, Ex. Director 2626 Pennsylvania Avenue 3rd Floor Washington, D.C. 20037 (202) 337-2500	

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* These groups have not received the scoping letter.

Appendix A2

INTERVIEW REPORTS

AMERICAN EAGLE FOUNDATION
CONSERVATION FOUNDATION
ENVIRONMENTAL ACTION COALITION
ENVIRONMENTAL DEFENSE FUND
ENVIRONMENTAL LAW INSTITUTE
FRIENDS OF THE EARTH
INTERNATIONAL CITY MANAGEMENT ASSOCIATION
LEAGUE OF WOMEN VOTERS
NATIONAL ASSOCIATION OF TOWNS AND TOWNSHIPS
NATIONAL WILDLIFE FEDERATION
NATURAL RESOURCES DEFENSE COUNCIL
RACHEL CARSON COUNCIL
RESOURCES FOR THE FUTURE
SIERRA CLUB

The American Eagle Foundation

Date: March 19, 1980
Interviewers: John Bennett & Michael Frankel
Name of Interviewee: Donald Carruth (301) 652-8910
Address: 3306 Winnet Drive, Chevy Chase, Md. 20015

The American Eagle Foundation was founded in 1971 to help foster cooperation between government and private industry in the area of pollution control. The development and use of waste incinerator ships is an area of particular interest to the Foundation.

Overall Reaction: He anticipated little or no environmental or public opposition problems with the project if the ocean incineration option was used. He was very much in favor of the accelerated disposal of wastes by ocean incineration and in the development of U.S. incinerator ships.

Disposal Option: He did not feel that the options other than incineration were viable due to a combination environmental and public relations concerns. Though he saw no technical problem with land incineration, he thought experience showed that it too often provokes public opposition. He was convinced that ocean incineration was the solution to the hazardous waste disposal problem. His group had involved itself in the projects that used the Vulcanus to dispose of organochlorines and 2, 4, 5-T. He mentioned that the owners of the Vulcanus were building a much improved, second-generation incinerator ship in Germany. It was his impression that it was near completion and might be investigated for use in this project.

Conservation Foundation

Date: March 11, 1980
Interviewers: John Bennett & Christopher Niemczewski
Name of Interviewees: Sam Gusman & Richard A. Liroff (202) 797-4300
Address: 1717 Massachusetts Avenue, N.W., Washington, D.C. 20036

The Conservation Foundation, founded in 1948, is a non-profit research and communications organization based in Washington, D.C. The stated purposes of the Foundation are to "improve the quality of the environment and promote wise use of the earth's resources". The Foundation does not have members nor is it a lobbyist organization. It has approximately 50 employees.

Overall Reaction: They questioned why a scoping meeting with environmentalists was not held prior to beginning of work on EIS. Otherwise, they had no disagreement with the purpose and conduct of the project.

Disposal Options: They suggested that physical-chemical means of reduction and/or reprocessing be given greater consideration. They questioned whether DDT is used as a chemical intermediate, and if so, suggested that some form of reprocessing would be the preferred options. They stated that the emphasis should not be solely on dealing with the DDT in its present physical state, in general, chemicals can be purified. Both questioned what the end products of DDT incineration are, and questioned what would be done with resulting hydrochloride acid. They felt there were potential political problems with incineration on land, and potential political and environmental problems with landfill.

Transportation Options: They saw no major problems with transportation.

Further Contact: They might be interested in further contacts and suggested that we send future information to Chris Dirksen also with the Conservation Foundation. They suggested we contact Dr. Karim Ahmed of the Natural Resource Defense Council.

Public Participation: They suggested public hearings should be held in Washington, D.C. and near major storage sites and transportation routes.

Environmental Action Coalition

Date: March 27, 1989
Interviewers: John Bennett & Christopher Niemczewski
Name of Interviewee: Roger Guttentag (212) 929-8481
Address: 156 Fifth Avenue, New York, N.Y. 10010

The Environmental Action Coalition (EAC) is a regional environmental group which concentrates on urban environmental problems. Their major areas of interest are in solid wastes, recycling and resource recovery. The EAC presently has 5,000 members in 16 local chapters.

Overall Reaction: His overall reaction to the project was favorable. However, he thought we should look more carefully at possible industrial reuses of the DDT.

Disposal Options: He was not as opposed to landfill as the other interviewees. He thinks landfilling is a viable option, and it would be his third choice if the DDT was first solidified and encased in an inert aggregate. He thinks that incineration on land is a very good option, but, he was concerned that even more toxic substances, dioxin for example, might be produced during the incineration process. He was also concerned about what would be done with DDT contaminated containers. He was not favorable to incinceration at sea because he feels that there is potential for a serious spill while the DDT is being transferred to the incinerator ship. He believes that the best option for disposing of the DDT is, if this were possible, to market it through a waste exchange to an industry that can make use of it or its constituent parts.

Transportation Options: If models and safeguards similiar to those applied to the transport of nuclear materials, scaled down for the lower level of risk presented by DDT are used, then transport should not be a major problem. Mr. Guttentag was much more concerned about the potential for an accident during the transfer of the DDT to a truck or other vehicle, or from a vehicle to, for example, an incinerator. He believes that it is during the transfer of a substance from one receptacle to another that human error plays the greatest role. As an example, he pointed out that more oil is lost to the environment during transfer than through tanker accidents or well blow outs. He feels that the disposal options should be carefully analyzed to minimize the opportunity for human error. He suggested a mobile incinerator as a way to minimize both

Further Contact: He would like to be kept informed about the project and would be willing to comment on any draft documents produced.

Environmental Defense Fund

Date: February 27, 1980
Interviewers: John Bennett & Christopher Niemczewski
Name of Interviewee: Maureen Hinkle (202) 833-1484
Address: 1525 18th Street, N.W., Washington, D.C. 20036

The Environmental Defense Fund was founded in 1967 and today is a national environmental organization with over 45,000 members. The EDF's goal is to end "environmental degradation". Toxic chemicals and wastes are their foremost areas of concern.

Overall Reaction: She expressed skepticism over DoD's decision to dispose of this particular waste at this particular time, given the incident at Triana, Alabama. She thought there were other wastes the DoD should be concerned with as well. Otherwise she was favorably disposed toward the project.

Disposal Options: She rejected the landfill option out of hand noting that public opposition was liable to be intense. She had some reservations about the use of the Vulcanus. She had heard that its operation had been suspended temporarily after incinerating Agent Orange due to residues in the stacks. She quoted a Dow Chemical representative as saying that for this or other reasons they "wanted to have nothing to do with Vulcanus". She also noted that the Vulcanus' contingency plan called for jettisoning its cargo if it ran into trouble at sea. In spite of these objections, she was generally in favor of incineration at sea. She noted that organochlorine incineration tests on the Vulcanus had been very successful. Under certain circumstances, for example if there were severe transportation problems, she might favor leaving the DDT in place and recontainerizing it as necessary. She also suggested that we investigate chemical decomposition methods.

Transportation Options: The Corps should use any system that will minimize the risk of a spill. She was particularly concerned about the spill risk associated with transportation by truck. If trucks are used, she felt elaborate safety procedures should be implemented. She thought that rail was probably the safest method of transporting hazardous wastes.

Further Contact: She is interested in further involvement in the EIS process. Suggested we contact Jack Blanchard, now at the State Department, who was in charge of the Agent Orange disposal. Also the Farm Bureau which may favor continued use of DDT.

Public Participation: She said that a hearing should be held in Michigan where previous hearings in DDT were held, and in the vicinity of major storage sites. She thinks that groups which support the use of DDT may well attend the hearings.

Friends of the Earth

Date: February 25, 1980
Interviewers: Michael Frankel & Janet Kelley
Name of Interviewee: Eric Jensen (202) 543-4312
Address: 530 7th Street, Washington, D.C. 20003

The Friends of the Earth is an international environmental organization with more than 20,000 members. It attempts to bring important but little known environmental issues before the public.

Overall Reaction: He is very much in favor of the complete and final safe disposal of DDT. His primary concern in the project was that a adequate manifest system be used to guard against theft of any of the DDT. He cited a number of examples in which DDT or other hazardous wastes had been stolen for personal use or sale. He mentioned a lake in N.Y. that had recently been contaminated through the illegal use of DDT. He suggested that we contact Chris Beck of the EPA concerning a comprehensive manifest system he is developing.

Disposal Options: He was completely opposed to landfill. He felt that either ocean or land incineration should be used.

Transportation Options: He was not particularly worried about the DDT's transport. He mentioned that hazardous wastes, many of them, like PCBs, much more dangerous than DDT, are transported all the time.

Further Contact: He wishes to stay informed and offered to be of assistance in any way possible. He is currently compiling a list of regional organizations in affected areas that may have an interest in the DDT disposal project.

Public Participation: He suggested that meetings should be held in the regions and near the affected areas.

International City Management Association

Date: March 25, 1980
Interviewers: Janet Kelly & John Bennett
Interviewee: Mary Leffler (202) 828-3689
Address: 1140 Connecticut Avenue, N.W., Washington, D.C. 20036

The International City Management Association (ICMA) is a professional society of city and county managers and municipal administrators. It currently has a membership of 7500 persons representing 3200 communities. The majority of the member towns have a population of less than 50,000. ICMA has an active solid waste program and has been receiving grants from the EPA for this program since 1974.

Overall Reaction: Her reaction to the project was favorable but she believes that there is a good chance that the project will encounter vehement public reaction. She thinks that much of the negative reaction is due to suspicion and mistrust of the Army Corps of Engineers. She mentioned the Cross Florida Barge Canal as an example of the Corps' insensitivity to public opinion, and she feels that public resentment against the Corps is still prevalent, especially in the South East.

Disposal Options: She feels that landfill should be considered in the EIS but also believes that public opposition will eliminate landfill as a viable option. Although she does not see any technical problems with incineration on land she feels that the public will react unfavorably, and that there will be siting problems. She feels that incineration at sea is the best option because it would meet with the least public opposition. She opposes sale to a manufacturer because it could result in the DDT export.

Transportation: She feels that the DDT's transport will be a focus for public opposition. She gave as an example town ordinances preventing hazardous waste transportation. She feels that small towns are not prepared to handle serious hazardous waste spills. She noted that there are often no clear-cut lines of authority at a local level for handling serious emergency situations.

Further Contact: She wished to be kept informed and offered us her assistance. She suggested that we contact the Public Works Director in Niagara, N.Y., who was involved in the Love Canal incident; the IT Corporation in San Francisco, CA, a hazardous waste detoxification center; the Portland Waste Exchange; Lonnie Hickman (formerly with EPA) of the Government Refuse Collection Disposal Association; and Burt McKinney at the Rock Island Arsenal, Rock Island, Ill., who has extensive experience in working with the public on controversial disposal issues involving military ordinance.

Public Participation: She suggested that national public hearings should be held in Washington, D.C., California, in either San Francisco or Los Angeles, Denver and Chicago.

League of Women Voters

Date: February 29, 1980
Interviewers: John Bennett & Christopher Niemczewski
Name of Interviewee: Debby Sheiman (202) 296-1770
Address: 1730 M Street, N.W., Washington, D.C. 20036

The League of Women Voters was founded in 1920 to educate the newly enfranchised women voters. Today it supplies non-partisan information on candidates for public office, and it is also a source of information on voter registration and voting. Though strictly non-partisan, the League lobbies on issues of national concern.

Overall Reaction: She was slightly skeptical of the DoD's willingness to take into account public opinion and suggested that attempts to satisfy public opinion, either on a national or local level, should not be allowed to override real environmental concerns.

Disposal Options: Incineration was her preferred option but she also mentioned physical-chemical means of disposal. She was completely opposed to landfill. She repeated the rumor that "something was wrong with Vulcanus," and questioned whether it was now in operation.

Transportation Options: She expressed concern about potential for spills, and stressed proper recontainerization and labeling.

Further Contact: The League might be willing to review draft EIS materials as they are prepared. She suggested we contact EPA Office of Solid Waste on pesticide disposal.

Public Participation: She mentioned that we should hold public hearings at major storage sites. She suggested that an aggressive public information campaign to inform all interested groups including all towns and local environmental groups in the vicinity of current storage sites would be helpful.

National Association of Towns & Townships

Date: February 26, 1980
Interviewers: Janet Kelly and Christopher Niemczewski
Name of Interviewee: Bruce Rosenthal (202) 462-0265
Address: 1521 16th Street, N.W., Washington, D.C. 20036

The National Association of Towns and Townships represents 13,000 towns and townships, with populations under 10,000, in 14 states, primarily in New England and the Midwest.

Overall Reaction: Since none of the proposed disposal sites are located in these areas, he was only concerned with the transportation of DDT. Although he is not against disposing of the DDT, he foresees major problems related to its transport. He proposes that a monitoring committee, composed of various government officials, be established to determine and assess possible transportation routes.

Disposal Options: He expressed general support for incineration. However, he also expressed interest in recontainerization so as to avoid spills during transportation. He wants to know about the technology and potential risks associated with recontainerization and long-term storage.

Transportation Problems: He believes that there will be major public reaction against the transport of the DDT. He related stories about towns passing ordinances banning nuclear transport through their areas and feels that the same reaction might be produced with the transport of DDT. He feels that all risk-factors relating to DDT transportation should be carefully studied and assessed, e.g., competence of truckers, safeguards, etc.

Further Contact: He wants to publish information regarding the potential transportation routes and risks, and notice of the public hearings in their bi-monthly newsletter, and would like enough lead time to "get the word out". He suggested that we contact the League of Cities, Association of Counties, and the Governors' Council.

Public Participation: "The more the better." He advocates holding five "national" hearings in addition to the on-site hearings in the impacted areas.

National Wildlife Federation

Date: February 25, 1980
Interviewers: John Bennett & Christopher Niemczewski
Interviewee: Jorge Manring (202) 797-2945
Address: 1412 16th Street, N.W., Washington, D.C. 20036

The National Wildlife Federation has 6,500 local groups and 3,500,000 members. The NWF's major area of concern is in the intelligent management of our forest and wildlife resources.

Overall Reaction: He felt he could not take a firm stand until he had more technical information concerning the disposal options. NWF's position would depend on the means of disposal and transportation selected, and safeguards implemented. However, he did seem to favor disposing of the DDT.

Disposal Options: He was completely opposed to disposal in a landfill. He felt that no landfill could be secured at a reasonable cost. He favored the incineration option. However, he was worried that incineration might produce other noxious chemicals, such as dioxins. He was interested in emmission monitoring procedures and asked about the monitoring done on the Vulcanus during the incineration of 2,4,5-T. He was opposed to selling the DDT to Montrose, especially if it might be exported. He also expressed a lack of confidence in the operators of disposal sites, particularly incinerators, insinuating that cost concerns could lead them to "cut corners".

Transportation Options: He was very concerned about the transportation of the DDT feeling that with the number of sites involved a mishap was almost inevitable. He was especially concerned that the DDT might be transported in inadequate or deteriorating containers. He thought that an outside group should be hired to monitor all aspects of the transportation, including needed recontainerization.

Further Contact: He expressed interest in continued participation in the EIS process, including the public hearings and suggested that we contact Lawrence Fishbein, chemist at the National Toxicological Research Center, Little Rock, Arkansas, with regard to potential problems with the incineration of DDT.

Public Participation: He suggested that the public hearings be held around the nation, in Washington, D.C. and in the places of immediate impact.

Rachel Carson Council, Inc.*

Date: February 26, 1980
Interviewers: John Bennett and Michael Frankel
Name of Interviewee: Shirley Briggs (202) 652-1877
Address: 8940 Jones Mill Road, Chevy Chase, Md. 20015

The Rachel Carson Trust for the Living Environment was founded in 1965 to advance the environmental causes supported by Rachel Carson. In 1962 Rachel Carson wrote "Silent Spring", one of the seminal books on environmental damage resulting from hazardous chemicals. The book devoted considerable attention to DDT. The Council's major areas of concern are hazardous chemicals and wastes. The Council acts as a clearinghouse for information on these subjects.

Overall Reaction: She was in favor of disposing of the DDT by incineration. She was most concerned with the safe transportation of the DDT to the disposal sites.

Disposal Options: She was entirely opposed to the landfill option because it does not really solve the disposal problem but only postpones it for a few years. She felt that incineration at sea was the most acceptable option, but had no major objections to incineration on land. However, she expressed concern about possible noxious emmissions from the incinerator. She was particularly concerned about what would be done with the containers, drums, tank cars etc. that the DDT was stored in. How would they be decontaminated, or would they also be incinerated? She was opposed to the use of the remaining options particularly sale to a manufacturer, since the DDT might then be exported.

Transportation Options: She was concerned with the potential for a spill, and expressed the belief that transportation by rail would be safer than transportation by truck. She was also concerned that the DDT be properly recontainerized before shipment. She was interested to know what safety standards would apply to the transportation of DDT.

Further Contact: She was very interested in continued contact during the EIS process. She suggested a number of individuals and organizations we might contact: Dr. Warren Shaw at USDA; the Toxicology and Chemical Society; Mississippi State University where some of the earliest research on the disposal of DDT was done; the Izaak Walton League; Keith Long of the University of Iowa; and the Conservation Community.

Public Participation: She suggested that there should be regional public meetings as well as one in Washington. She fears that the chemical industry will be active at such hearings attempting to protect their image, and that they will try to use the hearings to reopen the controversy over the banning of DDT.

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* Formerly the Rachel Carson Trust for the Living Environment.

Sierra Club

Date: February 25, 1980
Interviewer: Janet Kelly & Michael Frankel
Name of Interviewee: Blake Early (202) 547-1144
Address: 330 Pennsylvania Avenue, S.E., Washington, D.C. 20003

Overall Reaction: He would like the DDT disposed of in the safest manner possible. The Sierra Club's goal is to reduce the total amount of DDT worldwide. His biggest concern is that the disposal project not be done too hastily, or in a manner that in any way could jeopardize safety and health. He is extremely interested in the DDT's current storage conditions. He would like proof (an inventory list stating DDT location and storage conditons) to insure that there is minimal risk in handling and transporting it all over the country. He also inquired about test burns, and wants assurance that DDT can be totally destroyed if incinerated. He wants DDT destroyed carefully and competently. The Sierra Club is actively supporting the hazardous waste/superfund legislation.

Disposal Options: Landfill is unacceptable because it could become a problem later. Incineration at sea was his preferred option; however he would like to know more about its impact on the marine environment. He also found incineration on land acceptable if test burns prove that DDT can be totally destroyed. He was vehemently opposed to reselling the DDT abroad.

Transportation Options: He sees transportation as a potential problem but feels that if it can be demonstrated that DDT can be handled and transported safely it should pose no real problem. All modes, e.g., railroad, truck, ship, etc., should be thoroughly investigated and evaluated for competency and safety hazards. He readily acknowledged that hazardous wastes are transported all over the U.S. and basically feels that it is possible that it can be safely managed. He felt that the Sharpetowne incident over PCB storage and transportation was an atypical situation and that the problem was basically one of volume, and that the contents were liquid. He believes that transportation of the liquid forms of DDT will face the most opposition.

Further Contacts: He explained that the local Sierra Club offices have independent interests and concerns and feels that their West Coast office would be more interested in the DDT project than the Washington office. He suggested that we contact Steve Rieftling, in San Francisco whose major concern is pesticide control.

Public Participation: He recommends that hearings be held at the places of impact, incineration sites and/or Gulfport, Mississippi as well as in Washington, DC. and on the West Coast.

Resources for the Future

Date: March 7, 1980
Interviewers: Christopher Niemczewski and Janet Kelly
Name of Interviewee: Alan Kneese (202) 462-4400
Address: 1755 Massachusetts Avenue, N.W., Washington, D.C. 20036

Resources for the Future is a nonprofit, nonproprietary organization performing comprehensive nonadvocacy public policy research on national and international problems of energy, environmental quality, and natural resources. RFF has been influential in natural resources and environmental policy. Their staff (100 employees) is consulted frequently by public and private groups.

Overall Reaction: He had little reaction to the project. The interview served to make him aware of the project. He believes that DDT is basically a low-toxic hazardous substance for humans and poses no real danger to human health. Hence, there should be no real problem in either incinerating or transporting it. He believes that if the project is rationally approached and explained, there will be little public reaction, i.e., that rationality will prevail.

Disposal Options: The only option he thought viable was incineration on land. He thinks incineration at sea is too costly and could not be justified if incineration on land will adequately perform the job.

Transportation Problems: He does not think that there will be any transportation problems. He stressed that DDT's low-toxic and non-explosive characteristics must be conveyed.

Further Contact: He wants to be kept informed, and offered his assistance in any way possible. He recommended that we talk to Fred Smith of the Association of American Railroads, regarding the safety of various transportation modes.

Public Participation: "The less the better." He sees no real need in holding a number of them. He thinks that they will needlessly serve to arouse public opposition to the project.

Natural Resources Defense Council

Date: March 3, 1980
Interviewers: John Bennett & Christopher Niemczewski
Name of Interviewee: Dr. Karim Ahmed (202) 949-0049
Address: 122 E. 42nd Street, New York, N.Y. 10017

The Natural Resources Defense Council (NRDC) is a non-profit national environmental group with a membership of over 45,000. It's staff of 27 lawyers and scientists works to protect the environment through litigation, monitoring, cooperation with government agencies, citizen education and scientific research. The NRDC has been active in the areas of nuclear power, hazardous wastes, strip-mining, air and water pollution, forestry, and consumer safety.

Overall Reaction: In general, he approved of the project. He thought that incineration was a good option (see below), but suggested that we take a careful look at other disposal options particularly some form of reprocessing. He also suggested that we may want to consider using a combination of options.

Disposal Options: Landfill is the least desirable option from both an environmental and public relations standpoint. Among the problems associated with landfill are ground water pollution, upward seepage, and subsequent improper use of abandoned disposal sites.

A potential problem with incinerating the DDT would be the breakdown of the DDT into even more hazardous substances. An analogous example is the production of dibenzofuran and trace amounts of dioxin during the incineration of PCB's. Incineration on land is preferable to incineration at sea because a land incinerator is easier to inspect and monitor. He feels that burning the DDT at sea is like burning it at night to keep it out of the public eye. However, land incineration has the disadvantage that it would necessarily be done closer to population centers.

A technique that has been used to breakdown PCBs in low concentration is ozonization and ultra-violet radiation. This technique offers "fantastic" breakdown of organochlorines but is considerably more expensive than incineration. At least two vendors can now offer this service. For more information we should contact either the Office of Water Programs or the Office of Toxic Substances at EPA.

Activated charcoal can be used to purify organic substances such as DDT. This process works particularly well for dilute effluents. The Calgon Corp. is the major vendor for this process.

Transportation Options: To minimize transportation risks it may make sense to concentrate the DDT to reduce bulk. Mitigating actions to be taken in case of an accidental DDT spill should be precisely specified.

Further Contact: Dr. Ahmed is willing to review draft documents produced during the project. He will send us any pertinent information on the subject he runs across. The organizations and people he suggested we contact include: Battel; Mid-West Research; Mitre Corporation; General Electric's PCB plant in Port Edwards, N.Y. and; Craig Koralek a resource specialist in the NRDs Washington, D.C. office.

Public Participation: He said that we should develop a framework to formally involve interest groups in the EIS process. He suggested that summaries of our reports should be prepared in laymans' language and made available to the public.

APPENDIX B

INVENTORY OF DEPARTMENT OF DEFENSE DDT STOCKS

JOINT MESSAGEFORM

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BOOK	MESSAGE HANDLING INSTRUCTIONS
NO	

FROM: HQ DPDS BATTLE CREEK MI

TO: DPDR EUROPE LINDSEY AS GER

UNCLAS DPDS-R_________. Subj: EIS Baseline Validated DDT Inventory.

1. Listed below are the DDT assets for which DPDS has accountability. This baseline DDT inventory will be provided to the contractor for inclusion in the environmental impact statement for disposal of DDT.

RIC	DESCRIPTION	QTY	CONTAINER SIZE	DDT QUANTITY	NIIN	STORAGE SITE
SQU	5% Liquid	1	55 GL DR	55 GL	*253-3892	Leghorn AD IT
SQU	20% Liquid	19	55 GL DR	1045 GL	*281-3462	Leghorn AD IT
SQU	25% Powder	4	55 GL DR	*A	*264-6692	Leghorn AD IT
SQV	25% Liquid	8	5 GL PL	40 GL	*246-6432	Eng Vicenza IT
	25% Liquid	2	5 GL PL	10 GL	*246-6432	40 TAC AB SUP IT
SQV	5% Liquid	3	55 GL DR	165 GL	*253-3892	Eng Vicenza IT
SQV	5% Liquid	4	5 GL CN	20 GL	LSN-3333	Sigonella IT
SQV	10% Powder	3	25 LB PL	75 LB	*252-3002	Eng Vicenza IT
SQV	75% Powder	50	50 LB BG	2500 LB	*B264-6692	Eng Vicenza IT
		11	15 LB PL	165 LB	*B264-6692	Eng Vicenza IT
SQV	75% Powder	3	50 LB DR	150 LB	*598-7313	40TAC AB SUP IT

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A. L. MATHENY, LCDR, SC, USN DPDS-R, 6967, 18 Apr 80, rsz	

RELEASER	TYPED NAME TITLE OFFICE SYMBOL AND PHONE	
	COL BOBBY L. SANDLES, USA, DIR, DPDS-R/6700	
	SIGNATURE	SECURITY CLASSIFICATION UNCLASSIFIED	DATE TIME GROUP

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BOOK	MESSAGE HANDLING INSTRUCTIONS

FROM:

TO:

*Confirmed by IDMS. *A Nr. of LBS required. *B IDMS reflect 29 CN; Ltr 10 Jan 80 reports 11 PL and 50 50 LB BG; ltr 11 Feb 80 reports 4 55 GL DR. Clarify.

SQG *5% Liquid	50	55 GL DR	2750 GL	253-3892	10th Med Lab
	111	5 GL CN	555 GL	253-3892	10th Med Lab
SQG *25% Powder	288	5 GL CN	5760 LB	264-6692	10th Med Lab
	150	20 LB DR	3000 LB	264-6692	10th Med Lab
SQG *Misc	1272	16 OZ CN	1272 EA	254-8770	10th Med lab

*Not DPDS accountability. Ref your msg 201434Z Feb 80. Confirm future intentions on reporting this property for disposal.

2. LCDR Matheny, DPDS-R, has the responsibility for maintenance of positive inventory control for all DDT assets for which DPDS has accountability. The crucial EIS inventory elements are as follows:

a. Specific size and number of containers at each storage location.

b. The storage location, specific city and state.

c. The volume of the DDT product by formulation and percent of DDT concentration.

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SPECIAL INSTRUCTIONS

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TYPED NAME, TITLE, OFFICE SYMBOL AND PHONE

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MESSAGE HANDLING INSTRUCTIONS

FROM:

TO:

Therefore, any change to any of these elements, including correction of transcription errors, changes as result of recontainerization (re-packaging), new receipts, losses (which must be fully explained in writing) and addition of DDT contaminated materials as result of clean-up actions shall be reported by msg to DPDS-R. DDT products shall not be moved from present storage site (city) to another site (city) without specific prior approval of DPDS-R.

3. The inventory data has been correlated to IDMS records and, to extent known, repackaging efforts recorded. Inasmuch as the IDMS will serve the record keeping requirements and as the audit trail, changes to DDT records will not be made to IDMS, except for new receipts, without prior knowledge of DPDS-R. All DDT items on IDMS records should indicate freeze code 8 indicating DPDS control. If this action has not been taken by the DPDO, direct them to do so.

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BOOK	MESSAGE HANDLING INSTRUCTIONS
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FROM: HQ DPDS BATTLE CREEK MI

TO: DPDR PAC HONOLULU HI

UNCLAS DPDS-R________. Subj: EIS Baseline Validated DDT Inventory.

1. Listed below are the DDT assets for which DPDS has accountability. This baseline DDT inventory will be provided to the contractor for inclusion in the environmental impact statement for disposal of DDT.

RIC	DESCRIPTION	QTY	CONTAINER SIZE	DDT QUANTITY	NIIN	STORAGE SITE
SSE	10% Powder	2	25 LB PL	50 LB	250-3002	Yokota AB SUP
SSE	75 Powder	75	20 LB PL	1500 LB	264-6692	Yokota AB SUP
SSE	75 Powder	19	20 LB CN	380 LB	264-6692	DPDO Sagami
SSE	75 Powder	7*	20 LB CN	140 LB	264-6692	Yokota AB ENG
SSE	100 Powder	25	25 LB PL	625 LB	242-4222	Yokota AB SUP
SSE	5 Liquid	2	5 GL CN	10 GL	253-3892	Yokota AB SUP
SSE	20 Liquid	16*	55 GL DR	880 GL	281-3462	Yokota AB SUP
SSE	25 Liquid	111	5 GL CN	555 GL	246-6432	Yokota AB SUP
SSE	10 Misc	73	2 OZ CN	73 EA	274-5415	Yokota AB SUP
SSE	10 Misc	13	2 OZ CN	13 EA	274-5415	DPDO Sagami
SSE	42.5 Misc	15**	13 GM CT	15 BX*	180-6143	Yokota AB ENG

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JOINT MESSAGEFORM

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DATE TIME	MONTH	YR	ACT	INFO					

OF 3

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MESSAGE HANDLING INSTRUCTIONS

FROM:

TO:

SSE	LSN Low % Dust	3** CN			Yokota AB ENG

*Inv variance see 475 ABW Yokota AB JA/LGSD msg 110401Z Mar 80

**New assets not in DPDS accountability see above msg, NSN 6840-00-180-6143 cartridges packed 144 per box. More complete identity of LSN item required.

SSB	5% Liquid	14 1 GL CN	14 GL	655-8287	DPDO Guam
SST	75% Powder	10 55 GL DR	550 LB	598-7313	DPDO Oki
SST	75% Powder	2**25 LB CN	50 LB	264-6692	Kadena AB
SST	5% Liquid	1**5 GL CN	5 GL	253-3892	Kadena AB

**See new assets not in DPDS accountability. See HQ PACAF Hickam AFB/LSGG msg 242215Z Mar 80.

2. LCDR Matheny, DPDS-R, has the responsibility for maintenance of positive inventory control for all DDT assets for which DPDS has accountability. The crucial EIS inventory elements are as follows:

a. Specific size and number of containers at each storage location.

b. The storage location, specific city and state.

c. The volume of the DDT product by formulation and percent of DDT concentration.

DISTR:

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SPECIAL INSTRUCTIONS

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DD FORM 1 MAR 64 173/1

PREVIOUS EDITION IS OBSOLETE

US GPO 1979-0 302 175

JOINT MESSAGEFORM

SECURITY CLASSIFICATION
UNCLASSIFIED

DTG/RELEASER TIME			PRECEDENCE		CLASS	SPECAT	LMF	CIC	ORIG. MSG IDENT
DATE TIME	MONTH	YR	ACT	INFO					

JF 3

JK

MESSAGE HANDLING INSTRUCTIONS

FROM:

TO:

Therefore, any change to any of these elements, including correction of transcription errors, changes as result of recontainerization (repackaging), new receipts, losses (which must be fully explained in writing) and addition of DDT contaminated materials as result of clean-up actions shall be reported by msg to DPDS-R. DDT products shall not be moved from present storage site (city) to another site (city) without specific prior approval of DPDS-R.

3. The inventory data has been correlated to IDMS records and, to extent known, repackaging efforts recorded. Inasmuch as the IDMS will serve the record keeping requirements and as the audit trail, changes to DDT records will not be made to IDMS, except for new receipts, without prior knowledge of DPDS-R. All DDT items on IDMS records should indicate freeze code 8 indicating DPDS control. If this action has not been taken by the DPDO, direct them to do so.

DISTR:

DRAFTER TYPED NAME, TITLE, OFFICE SYMBOL, PHONE

SPECIAL INSTRUCTIONS

RELEASER

TYPED NAME, TITLE, OFFICE SYMBOL AND PHONE

SIGNATURE

SECURITY CLASSIFICATION
XXXXX UNCLASSIFIED

DATE TIME GROUP

DD FORM 1 MAR 74 173/1

PREVIOUS EDITION IS OBSOLETE

☆U.S. GPO 1979-0 302-175

RIC	ACCOUNTABLE DPDO	DESCRIPTION	QUANTITY	CONTAINER SIZE	PRODUCT QUANTITY	UNIT OF MEASURE	NIIN	REMARKS
STB	BRUNSWICK, ME	POWDER 75% DDT	1	20 LB CN	20	POUNDS	264-6692	
		LIQUID 5% DDT	7	1 GL CN	7	GALLON	253-3892	
STD	AYER, MA	POWDER 10% DDT	2	5 LB CN	10	POUNDS	240-2540	
		LIQUID 5% DDT	2	5 GL CN	10	GALLON	253-3892	
		LIQUID 5% DDT	7	1 GL CN	7	GALLON	655-8287	
		LIQUID 20% DDT	8	55 GL DR	440	GALLON	281-3462	Watertown Arsenal, MA
STK	ROME, NY	POWDER 10% DDT	44	5 LB CN	220	POUNDS	240-2540	PACKED 4 TO A CASE (11 CASES) OSB ROMULUS
		POWDER 75% DDT	249	20 LB CN	4,980	POUNDS	264-6692	OSB ROMULUS
			4	50 LB DR	200	POUNDS	598-7313	
		LIQUID 5% DDT	7	5 LB CN	35	GALLON	253-3892	OSB ROMULUS
		LIQUID 5% DDT	5	5 GL CN	25	GALLON	253-3892	
		LIQUID 5% DDT	1	1 GL CN	5	GALLON	655-8287	
		LIQUID 10% DDT	8	5 GL CN	40	GALLON	285-4307	OSB ROMULUS
		LIQUID 20% DDT	4	55 GL DR	220	GALLON	281-3462	
		LIQUID 25% DDT	1	55 GL DR	55	GALLON	246-6432	
		LIQUID 25% DDT	2	5 GL CN	10	GALLON	543-4038	
		LIQUID 25% DDT	2	55 GL DR	110	GALLON	598-7314	
		LIQUID 25% DDT	3	55 GL DR	165	GALLON	598-7314	OSB ROMULUS
STS	ABERDEEN, MD	POWDER 10% DDT	90	5 LB CN	450	POUNDS	240-2540	Base Supply
		POWDER 75% DDT	22	15 LB PL	330	POUNDS	264-6692	
		LIQUID 5% DDT	77	55 GL DR	4,210	GALLONS	253-3892	REPACKED: 1 DR ½ FULL Base Supply
		LIQUID 10% DDT	12	55 GL DR	660	GALLONS	285-4307	Base Supply
		LIQUID 20% DDT	2	55 GL DR	110	GALLON	281-3462	Base Supply
		25% DDT	4	5 GL PL	20	GALLON	246-6432	Base Supply
		MISC 10% DDT	6,939	2 OZ CN	6,939	EACH	274-5415	Base Supply
STU	BRANDYWINE, MD	LIQUID 20% DDT	1	55 GL DR	55	GALLON	281-3462	Naval Propellent Plant, Indianhead, MD
		POWDER 100% DDT	2	85 GL DR	350	POUNDS	576-5008	(Now LSN - SX1193-0052-0001)

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RIC	ACCOUNTABLE DPDO	DESCRIPTION	QUANTITY	CONTAINER SIZE	PRODUCT QUANTITY	UNIT OF MEASURE	NIIN	REMARKS
STW	MEADE, MD	POWDER 75% DDT	5	DR		POUNDS	264-6692	
			27	PL		POUNDS	264-6692	
		LIQUID 5% DDT	1	CN		GALLON	253-3892	
STZ	BAYONNE, NJ	POWDER 10% DDT	5	5 LB CN	25	POUNDS	240-2540	
		POWDER 75% DDT	4	20 LB PL	80	POUNDS	264-6692	
		POWDER 100% DDT	32	25 LB DR	800	POUNDS	252-3002	
		LIQUID 5% DDT	2	55 GL DR	110	GALLONS	253-3892	
		LIQUID 20% DDT	3	55 GL DR	165	GALLONS	281-3462	
ST1	NORFOLK, VA	POWDER 75% DDT			80	POUNDS	264-6692	
		LIQUID 5% DDT			10	GALLON	253-3892	
ST3	BELVOIR, VA	POWDER 10% DDT	34	5 LB CN	170	POUNDS	240-2540	32 CNS @ CAMERON STA; 2 CNS @ VINT HILL FARM
		POWDER 75% DDT	35	20 LB PL	700	POUNDS	264-6692	Base Supply
		POWDER 75% DDT	9	50 LB DR	450	POUNDS	598-7313	Cameron Station, VA
		POWDER 100% DDT	15	25 LB PL	375	POUNDS	242-4222	8 CNS @ CAMERON STA; 7 CNS @ Base Supply
		LIQUID 5% DDT	11	5 GL CN	55	GALLON	253-3892	
		LIQUID 5% DDT	4	1 GL CN	4	GALLON	655-8287	CAMERON STATION, VA
		LIQUID 10% DDT	11	5 GL DR	55	GALLON	285-4307	
		MISC 2% DDT	6	12 OZ CN	6	EACH	254-8770	CAMERON STATION, VA
		MISC 10% DDT	237	2 OZ CN	237	EACH	274-5415	
ST4	RICHMOND, VA	POWDER 75% DDT	710	20 LB PL	14,200	POUNDS	264-6692	DGSC RICHMOND, VA
		LIQUID 5% DDT	614	55 GL DR	33,770	GALLON	253-3892	DGSC RICHMOND, VA
		LIQUID 10% DDT	33	55 GL DR	1,815	GALLON	285-4307	DGSC RICHMOND, VA
		LIQUID 25% DDT	109	5 GL CN	545	GALLON	246-6432	DGSC RICHMOND, VA

RIC	ACCOUNTABLE DPDO	DESCRIPTION	QUANTITY	CONTAINER SIZE	PRODUCT QUANTITY	UNIT OF MEASURE	NIIN	REMARKS
ST7	WHITMAN, MO	POWDER 75% DDT	8	PL	350	POUNDS	264-6692	(1 - 30 GL LP; 7 - 5 GL PL) BASE CIVIL ENGINEER
		LIQUID 20% DDT	1	55 GL DR	55	GALLON	281-3462	BASE CIVIL ENGINEERS
		LIQUID 20% DDT	1	25 GL DR	25	GALLON	281-3462	BASE CIVIL ENGINEERS
		LIQUID 25% DDT	2	5 GL DR	10	GALLON	246-6432	BASE CIVIL ENGINEERS
ST9	OFFUTT, NE	POWDER 10% DDT	6	CN	55	POUNDS	240-2540	BASE SUPPLY
		POWDER 100% DDT	1	5 LB CN	5	POUNDS	242-4221	BASE SUPPLY
		POWDER 100% DDT	16	CN	505	POUNDS	242-4222	BASE SUPPLY
		LIQUID 25% DDT	13	5 GL CN	61	GALLONS	543-4038	BASE SUPPLY
SVB	COLTS NECK, NJ	LIQUID 25% DDT	20	5 GL DR	100	GALLONS	246-6432	
SVE	MECHANICSBURG, PA	POWDER 10% DDT	34	5 LB DR	170	POUNDS	252-3002	
		POWDER 75% DDT	1	35 LB CO	35	POUNDS	264-6692	
		POWDER 75% DDT	1	50 LB CO	50	POUNDS	264-6692	
		LIQUID 5% DDT	486	5 GL CN	2,438	GALLONS	253-3892	
		LIQUID 10% DDT	5	5 GL DR	25	GALLONS	285-4307	
		LIQUID 25% DDT	11	5 GL DR	55	GALLONS	246-6432	
SVF	PHILADELPHIA, PA	POWDER 75% DDT	3	20 LB PL	45	POUNDS	264-6692	NAVAL AIR PROPULSION TEST CENTER, NJ
		POWDER 10% DDT	2	DR	30	POUNDS	252-3002	
SVG	TOBYHANNA, PA	POWDER 10% DDT	46	25 LB DR	1,125	POUNDS	252-3002	BASE SUPPLY, DOVER, NJ
		POWDER 75% DDT	20	17 LB PL	340	POUNDS	264-6692	BASE SUPPLY
		POWDER 75% DDT	4	15 LB PL	60	POUNDS	264-6692	
		LIQUID 5% DDT	29	5 GL CN	145	GALLONS	253-3892	25 CNS @ TOBYHANNA, 4 CNS AT BASE SUPPLY, DOVER
		LIQUID 20% DDT	3	55 GL DR	165	GALLONS	281-3462	
		LIQUID 25% DDT	78	5 GL DR	390	GALLONS	246-6432	
SVH	CHANUTE, IL	LIQUID 5% DDT	20	50 GL DR	1,000	GALLONS	253-3892	
SVJ	GREAT LAKES, IL	LIQUID 5% DDT	10	5 GL DR	50	GALLONS	253-3892	

RIC	ACCOUNTABLE DFDO	DESCRIPTION	QUANTITY	CONTAINER SIZE	PRODUCT QUANTITY	UNIT OF MEASURE	NIIN	REMARKS
SVK	ROCK ISLAND, IL	POWDER 10% DDT	8	5 LB CN	40	POUNDS	240-2540	
		POWDER 75% DDT	17	20 LB CN	340	POUNDS	264-6692	
SVM	SCOTT, IL	POWDER 75% DDT	2	CN	74	POUNDS	264-6692	U.S. ARMY SUPPORT CENTER, GRANITE CITY, IL
		POWDER 100% DDT	3	1 GL BT	5	POUNDS	242-4221	U.S. ARMY SUPPORT CENTER, GRANITE CITY, IL
		LIQUID 5% DDT	1	5 GL CN	5	GALLONS	253-3892	U.S. ARMY SUPPORT CENTER, GRANITE CITY, IL
		LIQUID 10% DDT	7	5 GL DR	35	GALLONS	285-4307	U.S. ARMY SUPPORT CENTER, GRANITE CITY, IL
		LIQUID 20% DDT	4	55 GL DR	220	GALLONS	281-3462	
SVV	DULUTH, MN	POWDER 10% DDT	5	5 LB CN	25	POUNDS	240-2540	
		POWDER 75% DDT	7	50 LB DR	350	POUNDS	598-7313	
		POWDER 75% DDT	2	20 LB DR	40	POUNDS	058-1934	
		LIQUID 20% DDT	1	55 GL DR	55	GALLONS	281-3462	
SVW	SPARTA, WI	POWDER 75% DDT	7	20 LB PL	129	POUNDS	264-6692	BASE CIV ENG, FT McCOY, WI
		LIQUID 5% DDT	270	5 GL CN	1,350	GALLONS	253-3892	
SVX	COLUMBUS, OH	LIQUID 5% DDT	5	1 GL CN	5	GALLONS	655-8287	
		LIQUID 20% DDT	5	55 GL DR	275	GALLONS	281-3462	
		LIQUID 25% DDT	2	5 GL CN	10	GALLONS	246-6432	YOUNGSTOWN, OH
		MISC 10% DDT	152	2 OZ CN	152	EACH	274-5415	

RIC	ACCOUNTABLE DPDO	DESCRIPTION	QUANTITY	CONTAINER SIZE	PRODUCT QUANTITY	UNIT OF MEASURE	NIIN	REMARKS
STB	BRUNSWICK, MA							
	N63038-6279-8204	POWDER 10% DDT	1	25 LB PL	25	POUNDS	LSN-1010	INERT TYROTHYLITE - RETORT [illegible] CO.
	N63038-6279-8205	POWDER 10% DDT	2	5 LB CN	10	POUNDS	LSN-1010	1 CN - D.E. LINCH CO. (90% TALC) (LSN-LAVA) 1 CN - J.R. WATKINS CO. (90% TALC) (LSN-LAVA)
	N63038-6279-8203	POWDER 50% DDT	2	1 LB BX	2	POUNDS	LSN-1050	50% INERT, CA SPRAY CHEMICAL CO. (LSN-ORTHO)
	N00702-6320-8347	LIQUID 25% DDT	15	1 QT BT	3.75	GALLON	LSN-3025	70% PETROLEUM, 5% INERT PESTROY ACME QUALITY PRODUCTS
STD	AYER, MA							
	W13BW5-8160-0067	POWDER 10% DDT	1	25 LB DR	25	POUNDS	LSN-1010	FIBERDRUM, U.S. PAT. NO. 22,700 (NSN-G)
		POWDER 75% DDT	3	15 LB CN	3	POUNDS	LSN-1075	FED-51-I-158
		POWDER 100% DDT	2	10 LB CN	20	POUNDS	LSN-1100	
		LIQUID 5% DDT	1	1 GL CN	1	GALLON	LSN-3005	FED-51-I-250
		LIQUID 5% DDT	1	5 GL CN	5	GALLON	LSN-3005	U.S. PAT. NR. 2,329,074
STK	ROME, NY							
	W16BE9-5329-0004	POWDER 10% DDT	36	5 LB CN	180	POUNDS	LSN-1010	INSECTICIDE MIL-SPEC 0-I-578 CHEMICAL 9 CASES (4 CNS PER CASE)
	W16BE9-5329-0002	POWDER 100% DDT	7	5 LB CN	35	POUNDS	LSN-1100	LARVICIDE, DUPONT
	FY9760-1214-0001	LIQUID	1	5 GL CN	5	GALLONS	LSN-3333	
	FB4616-1162-2144	LIQUID	1	55 GL DR	55	GALLONS	LSN-3333	
STS	ABERDEEN, MD							
	W23HYY-7167-3002	LIQUID	6	55 GL DR	330	GALLONS	LSN-3333	BASE SUPPLY 6840-EXZ-0388
STU	BRANDYWINE, MD							
	FB4200-2026-0097	LIQUID	2	30 GL DR	60	GALLONS	LSN-3333	
	N00421-7298-0002		1	5 GL CN	5	GALLONS	LSN-3333	
	N00421-7298-0003		12	5 GL CN	60	GALLONS	LSN-3333	
	N00421-7298-0004		3	5 GL CN	15	GALLONS	LSN-3333	
	N00421-7298-0005		3	5 GL CN	15	GALLONS	LSN-3333	
	N00421-7298-0006		1	5 GL CN	5	GALLONS	LSN-3333	
	SX1193-0052-0001		2	85 GL DR	350	POUNDS	LSN-1111	
ST2	BRANDYWINE, MD							
	N93004-4102-A033	POWDER 50% DDT	1	50 GL DR	44	POUNDS	LSN-1050	50% INERT, PAPER BAG IN METAL DRUM

Columbus Region - Local NSNs - Page 1 of [illegible]

RIC	ACCOUNTABLE DHO	DESCRIPTION	QUANTITY	CONTAINER SIZE	PRODUCT QUANTITY	UNIT OF MEASURE	NIIN	REMARKS
ST3	BELVOIR, VA							
	W26RFL-5294-0310		1	55 GL DR	55	GALLON	LSN-3333	
	W73850-4207-1006		1	1 GL CN	1	GALLON	LSN-3333	
	W73BFU-6069-6509		1	1 GL CN	1	GALLON	LSN-3333	
	W26RFL-5294-0311		1	55 GL DR	55	GALLON	LSN-3333	
	W26RFL-5294-0312		1	5 GL CN	5	GALLON	LSN-3333	
	W73BFU-6069-0510		1	5 GL CN	5	GALLON	LSN-3333	
ST4	RICHMOND, VA							
	W26DXG-6350-0005		24	1 GL CN	24	GALLON	LSN-3333	
ST9	OFFUTT, NE							
	J900IV-6259-0007	LIQUID 25% DDT	3	55 GL DR	165	GALLONS	LSN-3025	BASE SUPPLY/AMOCO 114513 USDA
	J900IV-6272-0008	MISC 12.5% DDT	1,200		1,200	EACH	LSN-4012	BASE SUPPLY WYCO - 4 DRUMS WITH 250 PACKETS 1 DRUM WITH 200 PACKETS (LC1-8756)
SVD	CHAMBERSBURG, PA							
	W23G1L-5167-0901	LIQUID 25% DDT	3	5 GL PL	12	GALLONS	LSN-3025	2 LX XYLENE BASE CHITMAN CHEMICAL CO. BURLINGAME C
SVG	TOBYHANNA, PA							
	W25G1V-6188-8003	POWDER 100% DDT	1	100 LB DR	100	POUNDS	LSN-1100	FIBERDRUM (REPACKED IN LINDANE DRUM) (6840-00-242-4219)
SVX	COLUMBUS, OH							
	FB4601-2208-N236-A		1	55 GL DR	55	GALLONS	LSN-9999	RINSE SOLUTION FROM REPACKING
SVM	SCOTT, IL							
	W52H01-7147-0007	POWDER 10% DDT	1	88 LB DR	88	POUNDS	LSN-1010	INSECTICIDE DUSTING POWDER
	W52H01-7147-0008	POWDER 50% DDT	4	5 LB BG	20	POUNDS	LSN-1050	WETTABLE POWDER
	W52H01-7147-0006	25% DDT	7	5 GL CN	50	POUNDS	LSN-1111	EMULSIFIABLE CONCENTRATE
SVG	TOBYHANNA, PA							
	W15BW9-6124-9006A	POWDER 25% DDT	17	15 LB PL	255	POUNDS	LSN-1025	PRENTIS DRUG CO., BASE SUPPLY, DOVER, NJ
	W15B89-6124-9007A	POWDER 50% DDT	7	50 LB BG	350	POUNDS	LSN-1050	B.G. PRATT & CO.
	W15BW9-6124-9008A	POWDER	1	55 GL DR	195	POUNDS	LSN-1111	FIBER DRUM
	W15BW9-6203-9006	POWDER 10% DDT	1	25 LB PL	25	POUNDS	LSN-1010	

Columbus Region - Local NSNs - Page 2 of 2

RIC	ACCOUNTABLE DPDO	DESCRIPTION	QUANTITY	CONTAINER SIZE	PRODUCT QUANTITY	UNIT OF MEASURE	NIIN	REMARKS
SWA	LEJEUNE, NC	MISC 10% DDT	5,094	2 OZ CN	5,094	EACH	274-5415	
SWB	CHERRY POINT, NC	LIQUID 25% DDT	32	55 GL DR	1,760	GALLONS	246-6432	REPACKED
SWC	BRAGG, NC	POWDER 75% DDT	1	20 LB PL	20	POUNDS	264-6692	
		LIQUID 5% DDT	12	55 GL DR	660	GALLONS	253-3892	REPACKED (123 CNs)
SWE	ANNISTON, AL	POWDER 75% DDT	84	20 LB CN	1,680	POUNDS	264-6692	
SWF	RUCKER, AL	POWDER 75% DDT	40	15 LB CN*	600	POUNDS	264-6692	
		POWDER 100% DDT	2	25 LB CN	50	POUNDS	242-4222	
		LIQUID 5% DDT	1	35 GL DR	35	GALLONS	253-3892	
		LIQUID 10% DDT	1	15 GL DR	15	GALLONS	285-4307	
		LIQUID 25% DDT	1	25 GL DR	25	GALLONS	246-6432	
SWH	HUNTSVILLE, AL	POWDER 75% DDT	8	20 LB DR	160	POUNDS	058-1934	
SWJ	ALBANY, GA	POWDER 10% DDT	7	25 LB CN	175	POUNDS	252-3002	
			30	5 LB CN	150	POUNDS	252-3002	
		POWDER 100% DDT	189	25 LB CN	4,725	POUNDS	290-6274	
		LIQUID 20% DDT	127	55 GL DR	6,985	GALLONS	281-3462	
		LIQUID 25% DDT	19	55 GL DR	1,045	GALLONS	246-6432	
			1	25 GL DR	25	GALLONS	246-6432	
			275	55 GL DR	15,125	GALLONS	543-4038	
		LIQUID DDT % UNK	2	55 GL DR	110	GALLONS	281-1990	
SWL	FORREST PARK, GA	POWDER 75% DDT	4	30 GL DR	80	POUNDS	264-6692	
		LIQUID 5% DDT	488	55 GL DR	26,590	GALLONS	253-3892	REPACKED (5,217 CNS)
		LIQUID 10% DDT	1	5 GL CN	5	GALLONS	285-4307	
		LIQUID 25% DDT	2	55 GL DR	110	GALLONS	246-6432	

RIC	ACCOUNTABLE DPDO	DESCRIPTION	QUANTITY	CONTAINER SIZE	PRODUCT QUANTITY	UNIT OF MEASURE	NIIN	REMARKS
SWM	BENNING, GA	POWDER 10% DDT	75	5 LB CN	375	POUNDS	240-2540	
		POWDER 100% DDT	118	25 LB CN	2,950	POUNDS	242-4222	
		LIQUID 5% DDT	71	5 GL CN	355	GALLONS	253-3892	
		MISC 10% DDT	1,035	2 OZ CN	1,035	EACH	274-5415	
SWN	GORDON, GA	POWDER 75% DDT	5	20 LB CN	100	POUNDS	264-6692	
SWR	WARNER ROBINS, GA	POWDER 75% DDT	10	55 GL DR	725	POUNDS	264-6692	REPACKED 29 CN
		LIQUID 10% DDT	1	20 GL DR	20	GALLON	285-4307	
		LIQUID 25% DDT	4	55 GL DR	220	GALLON	598-7314	
SWU	CHARLESTON, SC	POWDER 10% DDT	8	25 LB PL	200	POUNDS	252-3002	
		POWDER 75% DDT	30	20 LB CN	600	POUNDS	264-6692	
		LIQUID 25% DDT	5	5 GL DR	25	GALLONS	246-6432	
SWX	FORT JACKSON, SC	POWDER 75% DDT	8	25 LB CN	200	POUNDS	264-6692	
		POWDER 100% DDT	9	15 LB CN	135	POUNDS	242-4222	
		LIQUID 10% DDT	1	5 GL CN	5	GALLONS	285-4307	
		LIQUID 25% DDT	4	5 GL CN	20	GALLONS	246-6432	
SW3	McALESTER, OK	POWDER 75% DDT	2	50 LB DR	100	POUNDS	598-7313	
		LIQUID 5% DDT	22	55 GL DR	1,210	GALLONS	253-3892	REPACKED (273 5 GL CN, 1365 GL) Ft. Smith, AK
		LIQUID 25% DDT	5	55 GL DR	275	GALLONS	598-7314	
SW4	DYESS, TX	POWDER 75% DDT	1	7 LB CN	7	POUNDS	264-6692	

RIC	ACCOUNTABLE DPDO	DESCRIPTION	QUANTITY	CONTAINER SIZE	PRODUCT QUANTITY	UNIT OF MEASURE	NIIN	REMARKS
SW6	SAN ANTONIO, TX	POWDER 75% DDT	1	20 LB CN	20	POUNDS	058-1934	
		POWDER 75% DDT	2	20 LB BG	40	POUNDS	264-6692	AS LABELED - BUT NOT BELIEVED TO BE CORRECT NSN
			29	20 LB CN	580	POUNDS	264-6692	AS LABELED - BUT NOT BELIEVED TO BE CORRECT NSN
			4	50 LB DR	200	POUNDS	598-7313	LAUGHLIN AFB
			1	50 LB BG	50	POUNDS	598-7313	LAUGHLIN AFB
		LIQUID 5% DDT	2	5 GL CN	10	GALLONS	253-3892	
		LIQUID 5% DDT	1	55 GL DR	55	GALLONS	655-8287	LAUGHLIN AFB 54 1 GL CNS REPACKED
		LIQUID 20% DDT	39	55 GL DR	2,145	GALLONS	281-3462	LAUGHLIN AFB
		LIQUID 25% DDT	4	55 GL DR	220	GALLONS	543-4038	LAUGHLIN AFB REPACKED 48 CNS
		LIQUID 25% DDT	2	5 GL CN	10	GALLONS	543-4038	LAUGHLIN AFB
		LIQUID 25% DDT	3	55 GL DR	165	GALLONS	598-7314	
SW7	HOOD, TX	LIQUID 5% DDT	164	5 GL CN	820	GALLONS	253-3892	
			1	55 GL DR	55	GALLONS	253-3892	
SW8	CHEPPARD, TX	POWDER 10% DDT	11	5 LB CN	55	POUNDS	240-2540	BASE SUPPLY
		POWDER 75% DDT	2	50 LB DR	100	POUNDS	598-7313	BASE SUPPLY
		LIQUID 5% DDT	244	1 GL CN	244	GALLON	655-8287	
		LIQUID 10% DDT	2	5 GL CN	10	GALLON	285-4307	BASE SUPPLY
		LIQUID 25% DDT	6	5 GL CN	30	GALLON	543-4038	BASE SUPPLY
		MISC 10% DDT	144	2 OZ CN	144	EACH	274-5415	
SXA	LITTLE ROCK, AK	POWDER 75% DDT	1	20 LB PL	20	POUND	264-6692	
SXM	PENSACOLA, FL	LIQUID 25% DDT	9	55 GL DR	495	GALLONS	246-6432	
SXP	EGLIN, FL	POWDER 75%	32	55 GL DR	10,240	POUNDS	264-6692	320 LB PER DR
			12	50 LB DR	600	POUNDS	598-7313	
		POWDER 75% DDT	4	55 GL DR	1,280	POUNDS	264-6688	320 LB PER DR - DDT MIXED w/SOMETHING ELSE
		LIQUID 5% DDT	6	55 GL DR	330	GALLON	246-6432	
		20% DDT	42	55 GL DR	2,310	GALLON	281-3462	
		25% DDT	16	5 GL PL	80	GALLONS	543-4038	
			1	55 GL DR	55	GALLON	543-4038	

RIC	ACCOUNTABLE DPDO	DESCRIPTION	QUANTITY	CONTAINER SIZE	PRODUCT QUANTITY	UNIT OF MEASURE	NIIN	REMARKS
SXR	MEMPHIS, TN	POWDER 10% DDT	298	5 LB CN	1,490	POUNDS	240-2540	
		POWDER 75% DDT	167	20 LB CN	3,320	POUNDS	264-6692	
		LIQUID 5% DDT	825	5 GL CN	4,125	GALLON	253-3892	REPACKED 343 CNS
		5% DDT	28	55 GL DR	1,540	GALLON	253-3892	
		10% DDT	120	5 GL CN	600	GALLON	285-4307	
		20% DDT	198	55 GL DR	10,890	GALLON	281-3462	
		25% DDT	25	55 GL DR	1,375	GALLON	246-6432	
SXT	LEXINGTON, KY	POWDER 75% DDT	5	5 LB CN	25	POUNDS	264-6692	
SXU	KNOX, KY	LIQUID 5% DDT	2	55 GL DR	110	GALLON	253-3892	
			5	5 GL CN	25	GALLON	253-3892	
		20% DDT	10	55 GL DR	550	GALLON	281-3462	
SXV	CAMPBELL, KY	POWDER 75% DDT	17	20 LB CN	340	POUNDS	264-6692	
SXW	CANNON, NM +	POWDER 10% DDT	20	20 LB CN	400	POUNDS	240-2540	REESE AFB, TX
		POWDER 75% DDT	4	20 LB CN	80	POUNDS	264-6692	REESE AFB, TX
		MISC 3% DDT	65	12 OZ CN	65	EACH	766-9631	REESE AFB, TX
SX1	TEXARKANA, TX	POWDER 10% DDT	14	5 LB CN	70	POUNDS	240-2540	
		75% DDT	3	20 LB CN	60	POUNDS	264-6692	
		100% DDT	1	25 LB CN	25	POUNDS	242-4222	
SX4	BLISS, TX	POWDER 75% DDT	10	20 LB CN	200	POUNDS	264-6692	
		LIQUID 5% DDT	141	5 GL CN	705	GALLON	253-3892	
SX8	ROOSEVELT ROADS, PUERTO RICO	POWDER 10% DDT	132	5 LB CN	660	POUND	240-2540	
		POWDER 75% DDT	30	55 GL DR	1,650	POUND	264-6692	
		LIQUID 5% DDT	95	5 GL DR	475	GALLONS	246-6432	
		25% DDT			380	GALLON	598-7314	

RIC	ACCOUNTABLE DPDO	DESCRIPTION	QUANTITY	CONTAINER SIZE	PRODUCT QUANTITY	UNIT OF MEASURE	NIIN	REMARKS
SWP	STEWART, GA	POWDER 75% DDT	3	5 GL CN	60	POUNDS	264-6692	
		LIQUID 5% DDT			11	GALLON	253-3892	
		LIQUID 10% DDT			7	GALLON	285-4307	
LOCAL STOCK NUMBERS								
SWF	RUCKER, AL							
	W31NWO-D131-0372	POWDER 10% DDT	60	5 LB DR	300	POUNDS	LSN-1010	90% INERT
	W31NWO-D131-0872	POWDER 50% DDT	1	25 LB CN	25	POUNDS	LSN-1050	50% INERT
SW8	SHEPPARD, TX							
	FB3020-5302-0238	POWDER	12	50 LB BG	600	POUNDS	LSN-1111	
	FB3020-5302-0241	LIQUID	1	5 QT CN	5	GALLONS	LSN-3333	

RIC	ACCOUNTABLE DPDO	DESCRIPTION	QUANTITY	CONTAINER SIZE	PRODUCT QUANTITY	UNIT OF MEASURE	NIIN	REMARKS
SYA	TOOELE, UT	LIQUID 5% DDT	3	5 GL CN	15	GALLONS	253-3892	
SYB	HILL, UT	POWDER 75% DDT	1	20 LB CN	20	POUNDS	264-6692	
		LIQUID 5% DDT	37	50 GL DR	1,850	GALLONS	253-3892	
		5% DDT	5,692	5 GL CN	28,460	GALLONS	253-3892	
		5% DDT	14	1 GL CN	14	GALLONS	655-8287	
		LIQUID 10% DDT	16	5 GL DR	80	GALLONS	285-4307	
		LIQUID 25% DDT	7	55 GL DR	385	GALLONS	598-7314	
SYC	COLORADO SPRINGS, CO	POWDER 10% DDT	38	5 LB CN	190	POUNDS	240-2540	
		POWDER 100% DDT	3	25 LB CN	75	POUNDS	576-5008	
		LIQUID 5% DDT	~~16~~ 17	5 GL CN	~~80~~ 85	GALLONS	253-3892	
		5% DDT	6	55 GL DR	330	GALLONS	253-3892	
		LIQUID 20% DDT	18	55 GL DR	990	GALLONS	281-3462	
		20% DDT	4	55 GL DR	220	GALLONS	281-3462	DENVER, CO
		LIQUID 24.57% DDT	5	55 GL DR	275	GALLONS	6840-00-LSN	} ORIG REPORTED AS 281-3462
		LIQUID 5% DDT	1	55 ~~5~~ GL CN	~~5~~ 53	GALLONS	6840-00-LSN	
		LIQUID 25% DDT	1	5 GL CN	5	GALLONS	242-4210	
		LIQUID 25% DDT	7	5 GL CN	35	GALLONS	246-6432	
		LIQUID 25% DDT	1	55 GL DR	55	GALLONS	598-7314	
		LIQUID 25% DDT	36	5 GL CN	180	GALLONS	246-6432	CHEYENNE, WY
SYJ	MINOT, ND	LIQUID 25% DDT	8	5 GL CN	40	GALLONS	246-6432	
SYK	ELLSWORTH, SD	LIQUID 5% DDT	2	5 GL CN	10	GALLONS	253-3892	RAPID CITY, SD
SYM	BARSTOW, CA	POWDER 10% DDT	9,261	5 LB CN	46,305	POUNDS	240-2540	
		POWDER 100% DDT	18	5 LB CN	90	POUNDS	242-4221	
		LIQUID 5% DDT	2,728	5 GL CN	13,640	GALLONS	253-3892	
		LIQUID 25% DDT	14	5 GL CN	70	GALLONS	246-6432	
		LIQUID 25% DDT	39	55 GL DR	645	GALLONS	246-6432	(129 5 GL PLS OVERPACKED)
		1 LB CY 6% DDT	17,155		17,155	EACH	264-6694	(NOT REPACKED)

RIC	ACCOUNTABLE DPDO	DESCRIPTION	QUANTITY	CONTAINER SIZE	PRODUCT QUANTITY	UNIT OF MEASURE	NIIN	REMARKS
SYN	PENDLETON, CA	POWDER 100% DDT	24	25 LB PL	600	POUNDS	242-4222	
		POWDER 10% DDT	1,202	2 OZ CN	1,202	EACH	274-5415	OVERPACKED IN 21 12"x6"x7" METAL CANS/1 WOOD BOX
SZC	STOCKTON, CA	POWDER 75% DDT	3,453	20 LB PL	69,060	POUNDS	264-6692	
		LIQUID 5% DDT	392	5 GL CN	1,960	GALLONS	253-3892	
		LIQUID 10% DDT	67	5 GL CN	335	GALLONS	285-4307	
		5 GM CARTRIDGE 42.5% DDT	101	1 GR BX	14,544	EACH	180-6142	10 LB PER BX; 1,010 LBS TOTAL
		13 GM CARTRIDGE 42.5% DDT	37	1 GR BX	5,328	EACH	180-6143	10 LB PER BX; 370 LBS TOTAL
SZE	ALAMEDA, CA	POWDER 10% DDT	2	55 GL DR	200	POUNDS	240-2540	40 5 LB CNS OVERPACKED INTO 55 GL DRS
		POWDER 10% DDT	1	25 LB DR	25	POUNDS	252-3002	
		POWDER 75% DDT	25	20 LB PL	500	POUNDS	264-6692	
		POWDER 100% DDT	5	25 LB PL	125	POUNDS	242-4222	
		LIQUID 5% DDT	940	5 GL CN	4,700	GALLONS	253-3892	
		LIQUID 10% DDT	8	5 GL CN	40	GALLON	285-4307	OAKLAND, CA
		LIQUID 25% DDT	300	5 GL PL	1,500	GALLON	246-6432	
		MISC 2% DDT	28	55 GL DR	4,008	EACH	254-8770	OVERPACKED - 12 OZ CNS
		MISC 10% DDT	1	55 GL DR	336	EACH	274-5415	OVERPACKED - 2 OZ CNS
SZG	McCLELLAN, CA	LIQUID 5% DDT	651	55 GL DR	35,805	GALLONS		REPACKED - HERLONG, CA See Attachment A
		LIQUID UNK % DDT	8	55 GL DR	440	GALLONS		REPACKED - HERLONG, CA
		POWDER	2	CONEX CONTAINERS	12,000	POUNDS		REPACKED - MIXED % - HERLONG, CA
SZS	TUCSON, AZ	LIQUID 25% DDT	23	55 GL DR	1,265	GALLON	246-6432	
		POWDER 75% DDT	5	5 GL PL.	100	POUNDS	264-6692	
SZT	LUKE, AZ	POWDER 10% DDT	1	1 CONTAINER	150	POUNDS	252-3002	REPACKED INTO AMMO REPELLANT CONTAINER
		POWDER 75% DDT	4	CONTAINERS	70	POUNDS	264-6692	11, 20, 19 and 20 LBS CONTAINERS
SZV	ANCHORAGE, AK	POWDER 10% DDT	28	25 LB DR	700	POUNDS	252-3002	
		LIQUID 20% DDT	44	55 GL DR	2,420	GALLON	281-3462	
		LIQUID 25% DDT	14	55 GL DR	770	GALLON	598-7314	

RIC	ACCOUNTABLE DFDO	DESCRIPTION	QUANTITY	CONTAINER SIZE	PRODUCT QUANTITY	UNIT OF MEASURE	NIIN	REMARKS
SZW	FAIRBANKS, AK	LIQUID 10% DDT	10	5 GL CN	50	GALLON	285-4307	
		LIQUID 25% DDT	19	55 GL DR	1,045	GALLON	598-7314	
SZP	LEWIS, WA		115	65 GL DR		MIXED - REPACKED		See Attachment A
			6	55 GL DR		MIXED - REPACKED		
			105	55 GL DR		MIXED - REPACKED		

MASS REPACKAGED DDT PRODUCTS
(ASSETS ASSUMED TO HAVE BEEN REPACKED)

SZG - DPDO McClellan - At OSB Sierra, Herlong, CA

12,000 pounds - powder

10%	240-2540	9 DR	(5 LB CN)
	252-3002	1 CN	(25 LB DR)
75%	058-1934	1 DR	(20 LB DR)
	264-6692	533 CN	(20 LB PL)
100%	242-4222	4 CN	(25 LB PL)

10% (2 OZ CN)	14 DR 163 CN	274-5415

659 - 55 GL DR - liquid

5%	253-3892	551 DR	(5 GL CN)
	253-3892	10 CN	(5 GL CN)
10%	285-4307	3 DR	(5 GL DR)
20%	281-3462	19 DR	(55 GL DR)
25%	264-6432	5 DR	(5 GL PL/DR)
	543-4016	4 DR	(1 GL BT)
	543-4038	19 DR	(5 GL CN)
	598-7314	4 DR	(55 GL DR)
	655-8287	1 DR	(1 GL CN)

SZP - DPDO Lewis, Ft. Lewis, WA and OSB Hermiston, OR, Umatilla Army Depot

Powder

100%	242-4222	139 LB	(25 LB PL)
75%	264-6692	45 LB	(20 LB PL)
	264-6692	12 EA	(20 LB PL)

Liquid

5%	253-3892	31 EA	(5 GL CN)
	253-3892	250 CN	(5 GL CN)
	253-3892	7 GL	(5 GL CN)
10%	285-4307	558 CN	(5 GL DR)
25%	246-6432	8 CN	(5 GL PL)
	543-4038	20 GL	(5 GL CN)

Misc

10%	(2 OZ CN)	274-5415	1,130 CN	2 OZ CN
		274-5415	2 BX	2 OZ CN

Attachment A

APPENDIX C

TECHNICAL DATA

Appendix C

TECHNICAL DATA

Combustion efficiency may be defined in terms of removal of either the entire combustible feed or the total hydrocarbon content of a specific compound. In this report combustion efficiency refers to percent destruction of DDT.

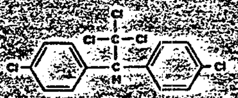
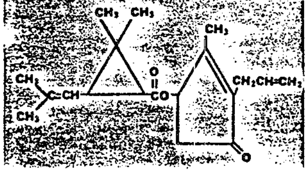
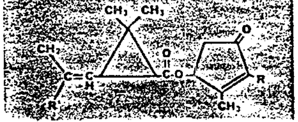
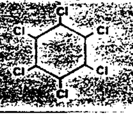
Given a temperature and a dwell time in an incinerator, the combustion efficiency and quality of an emission are functions of heat transfer efficiency, extent of exposure or frequency of collisions between oxygen and the material that is being incinerated, quantity of oxygen present in excess of the stoichiometric requirements, or, in other words, the theoretical quantity of oxygen required to burn the material.

Although one might think that the collison frequency between oxygen and the material being combusted can be increased by using large excesses of air, there is an optimum value for the volume of air required, particularly from a cost standpoint, since excess air requires additional fuel (greater operating costs) and reduces the dwell time in the firing portion of the furnace (larger capital investment). Excess air or oxygen is required to approach 100% combustion. A theoretical quantity is not sufficient to attain this result because of the inefficiencies of the incinerator, as indicated in the next paragraph.

Sufficient gas turbulence must be maintained in the firing zone to ensure that the heat transfer is optimized and that all of the molecules of the material being burned come in contact with oxygen during the firing period. This requirement affects the design of the firing chamber.

Some maintain that attainment of 99.999% combustion is guaranteed if the furnace is designed and operated for 99.99999% combustion. Even if one agrees with that premise, the problem lies with the verification of the combustion efficiencies, which require that the instruments have sensitivity and precision in the parts per trillion rante. This is presently not attainable.

Figure C-1
Structural Formulas of Pesticides in DDT
Formulations

Products producers	U.S. patents	Chemical name and formula	Physical properties	Product form *	Oral toxicity LD_{50}	Major end-uses
DDD TDE Dichloro-diphenyl-dichloroethane Rohm & Haas Allied		**1,1-Dichloro-2,2-bis(*p*-chlorophenyl) ethane** 	Colorless m.p. 112 C	EC WP D	2,500–3,400	Insecticide for fruits and vegetables against leaf-rollers, mosquito larvae and hornworms
DDT Dichloro-diphenyl-trichloroethane Genitox* Anofex* Chlorophenothane Lebanon Allied Diamond Montrose Olin Geigy		**1,1,1-Trichloro-2,2-bis(*p*-chlorophenyl) ethane** 	Colorless or cream m.p. 108.5-109 C	EC WP D G	113	Broad-spectrum insecticide for fruits, vegetables, cotton, household, livestock, timber and industrial use
Allethrin Allyl homolog of cinerin I MGK	2,574,500	**DL-2-Allyl-4-hydroxy-3-methyl-2-cyclopenten-1-one esterified with a mixture of *cis* and *trans* DL-chrysanthemum monocarboxylic acid** 	Pale yellow liquid b.p. 160 C d^{25}_{4} 1.005	OS A	920	Control of housefly in household space sprays and aerosols; post-harvest application in fruits, vegetables and mushrooms for control of fruit fly; used with synergist
Pyrethrins Pyrethrum Chem. Ins. FMC Penick Prentiss MGK		**Insecticidal components present in the flowers of *Pyrethrum cinuraefolium*** R R' Pyrethrin I CH_2-CH=CH-CH=CH_2 CH_3 Cinerin I CH_2-CH=CH-CH_3 CH_3 Pyrethrin II CH_2-CH=CH-CH=CH_2 $COOCH_3$ Cinerin II CH_2-CH=CH-CH_3 $COOCH_3$ Jasmolin II CH_2-CH=CH-CH_2-CH_3 $COOCH_3$ 		S A D	1,500	Knockdown and killing agent for household insects; protection of food in warehouses; dairy application and control of fruitfly on harvested fruits and vegetables; used with a synergist
Lindane gamma BHC Diamond Hooker		**1, 2, 3, 4, 5, 6-Hexachlorocyclohexane containing at least 99% gamma isomer** 	Colorless, odorless crystals m.p. 112.9 C	EC WP D A	90	Broad-spectrum insecticide for apples and other fruits, beans, peas, cole crops, cucurbits, tomatoes, other vegetables; also for dairy, livestock, household and seed-treatment use

* OS	Oil Solution	* D	Dust	* EC	Emulsifiable Concentrate
A	Aerosol	G	Granules	C	Concentrate
WP	Wettable Powder	S	Spray	ULV	Ultralow Volume

Table C-1

CHEMICAL/PHYSICAL PROPERTIES OF PESTICIDES IN THE DDT FORMULATIONS

Pesticide Name[1]	Melting Point °C	Vapor Pressure (mm Hg @ 20°C)	Water Solubility ppm	Toxicity[2]	
				Rat, Acute Oral LD_{50} (mg/kg)	Fish[3] LC_{50} (mg/l)
DDT pp'[4]	108.5	1.9×10^{-7}	~ insoluble	113	0.002
Lindane	112.8	3.26×10^{-5}	10	88	0.018
Pyrethrin	160° (boiling point)		~ insoluble		
Allethrin			~ insoluble	680	0.019

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[1] Current chemical manufacturers of the various pesticides:
DDT - Montrose Chemical of California
Lindane - Hooker Specialty Chemical
Pyrethrin - Fairfield American Corporation
Allethrin - Fairfield American Corporation

NOTE: It is not implied that the pesticides in the DDT formulations are those of the current manufacturers.

[2] Expressed as the lethal dose, or lethal concentration, to 50% of the test animals (LD_{50} and LC_{50}, respectively).

[3] 48- or 96-hour LC_{50} for bluegills or rainbow trout.

[4] The compound DDT can exist in 27 isomeric forms, depending on the position of the substituted chlorine form.

TABLE C-2

APPROXIMATE COMPOSITION OF TECHNICAL DDT

COMPOUND	APPROXIMATE PERCENTAGE
1,1,1-Trichloro-2,2-bis(p-chlorophenyl) ethane (p,p'-DDT)	63-77
1,1,1-Trichloro-2-(o-chlorophenyl-2-(p-chlorophenyl) ethane (o,p'-DDT)	8-21
1,1-Dichloro-2,2-bis(p-chlorophenyl) ethane (p,p'-TDE)	0.3-4.0
1,1-Dichloro-2-(o-chlorophenyl)-2-(p-chlorophenyl) ethane (o,p'-TDE)	0.04
1-o-Chlorophenylethyl-2-trichloro-p-chlorobenzene sulfonate	0.1-1.9
2-Trichloro-1-p-chlorophenylethanol	0.2
Bis(p-chlorophenyl) sulfone	0.03-0.6
α-Chloro-α-p-chlorophenylacetamide	0.01
α-Chloro-α-o-chlorophenylacetamide	0.01
Chlorobenzene	0.3
p-Dichlorobenzene	0.1
1,1,1,2-Tetrachloro-2-(p-chlorophenyl) ethane	present
Sodium p-chlorobenzene sulfonate	0.02
Ammonium p-chlorobenzene sulfonate	0.01
Inorganic	0.01-0.1
Unidentified and losses	5.1-10.6

SOURCE: Ottinger, et al., "Recommended Methods of Reduction Neutralization, Recovery, or Disposal of Hazardous Waste - Volume V," 1973.

TABLE C-3

KEY TO CAUTIONS FOR CHEMICALS IN THE DDT FORMULATIONS

Name	Caution	Flash Point (°F)	Explosive Limits (%,Upper & Lower Limit)	Maximum Allowable Concentration in Air (ppm)	Warning	Storage and Handling	Antidote and Treatment	Fire Fighting
DDT[1]	I,V			1	2,3,5,6 8,9,10,11	A,D,F G,H,I	12,13, 14,16,17, 18,19,20	a,b,e
DDT Emulsifiable Concentration	I,V			0.5	1,3,5,6, 8,9,10,11	A,D,F G,H,I	12,13,14 16,17,18, 19,20	a,b,e
DDT Solution	I,V			0.5	1,3,5,6, 8,9,10,11	A,B,D,F, G,H,I	12,13,14 16,17,18, 19,20	a,b,e
Kerosene Sprays[2]	III,V	150, 185	0.7, 5	0.5	1,5,6,7 9,10,11	A,B,F, G,H,I	12,13,14, 16,17,19, 20,21	b,c,e
Lindane[3]	I,V			0.2	1,4,6,7 10,11	A,D,H,I	12,13,14, 17,19,22	a,b,e
Lindane Solutions Conc. Emulsifiable Sol.	I,V			0.2	2,4,6,7, 10,11	A,B,H,I	12,13,14, 17,19,22	a,b,e
Lindane Dry Formulations	I,V			0.2	2,4,6,7 10,11	A,D,H,I	12,13,14, 17,19,22	
Naptha, Aromatic	II,VII	Varies with the fraction		100	11	A,B,C	13,18,20	b,c,e
Aromatic Petroleum Derivative	II,VII	Varies with the fraction		500-1000	11	A,B,C	13,18,20	b,c,e
Solvents	IV,VI, VII			10-100	1,4,5,9, 10,11	A,B,C, F,H	12,13,14, 18,20	b,c,e
Pyrethrin	III			0.05	5,6,10, 11	A,H	12,13,14, 17,19	a,b,e
Talc	III			0.1	6,7,8,9	A,C,D,E	12,13,18, 20	

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[1] Dichlorodiphenyltrichloroethane
[2] Also sprays containing other petroleum distillates
[3] 1,2,3,4,5,6-hexachlorocyclohexane

KEY TO CAUTIONS CLASSIFICATION

Cautions

I	Poison
II	Danger
III	Caution
IV	Flammable Liquid
V	Economic Poison
VI	Toxic Material
VII	Dangerous Fire Hazard

Warning

1	Hazardous Liquid
2	Hazardous Solid
3	Poisonous if Inhaled or in Contact with Skin
4	May Be Fatal if Swallowed, Inhaled or in Contact with Skin
5	Harmful if Taken Internally, Inhaled, or by Skin Absorption
6	May Cause Irritation to Skin and Eyes
7	May Cause Illness from Repeated Absorption
8	May Prove Dangerous from Repeated Absorption
9	Avoid Breathing Dust or Vapor
10	Avoid Contact with Skin, Eyes, and Clothing
11	Avoid Breathing Air Containing This Gas or Dust

Storage and Handling

A	Store in Cool, Dry Place, Tightly Closed
B	Keep Away from Heat, Spark or Open Flame
C	Keep Containers Closed and Dry
D	Wear Gloves, Goggles, and Respiratory Protector
E	Contact with Combustible Material May Cause Fire
F	Store in Well-Ventilated Area
G	Wear Clothes Resistant to Chemicals
H	Use with Adequate Ventilation
I	Keep All Unprotected Persons out of the Area

Antidote and Treatment

12 IN CASE OF CONTACT:

Immediately wash skin with large quantities of soap and water. Flush eyes with large quantities of water for 15 minutes or more. Remove all contaminated clothing and shoes. First aid may be needed or a *physician should be called.*

13 IN CASE OF INHALATION OR SUSPICION OF INHALATION:
Remove victim to fresh air. Keep victim absolutely quiet. Start oxygen inhalation with suitable equipment. *Call a physician.*

14 REMOVAL OF POISON WITH AN EMETIC:
Dissolve a tablespoonful of table salt (sodium chloride) in a pint of water. Administer a glassful of this solution to the victim every 3 or 4 minutes until vomiting begins.

15 CHEMICAL BURNS:
Wash with large quantities of water. Make sure all adhering chemical is removed. Cover the surface with gauze moistened with a 1% to 2% solution of sodium bicarbonate (baking soda). *Call a Physician.*

16 AFTER WORK:
Take a hot shower. Use large quantities of soap and water. Wash clothing before its reuse.

17 Keep away from children and domestic animals. Avoid contamination of foodstuffs and feed.

18 The label should contain directions for use and appropriate protection.

19 WHEN USED AS AN ECONOMIC POISON:
Include directions for use and appropriate precautions.

20 *Call a Physican Immediately.*

21 Label and container must comply with the provisions of the federal caustic poisons act.

22 Label should list the specific antidote.

Fire Fighting

a In Case of Fire: Cover with sand or earth
b In Case of Fire: Use carbon dioxide
c In Case of Fire: Use foam
d In Case of Fire: Use carbon tetrachloride
e In Case of Fire: Use dry chemical
f Moderate fire hazard -- may catch fire. Do not use water.

APPENDIX D

TRANSPORTATION REGULATORY REQUIREMENTS

Appendix D

TRANSPORTATION REGULATORY REQUIREMENTS

1. Hazardous Classification of DDT Formulations to be Shipped

a. Table D-1 shows the hazard classification of the formulations to be shipped in this project as found in the inventory in Appendix B. The four categories of hazard classification listed on the table are discussed in this section.

b. ORM-A materials (Other Regulated Materials-Types A) referred to in Column (1) are defined as materials that have an "anesthetic, irritating, noxious, toxic, or other similar property and which can cause extreme annoyance or discomfort to passengers or crew in the event of leakage during transportation." 49CFR173.500. With one exception, the ORM-A materials under consideration within this EIS have no specific packaging requirements and no limitation on quantity in one package when carried by any mode other than air. 49CFR172.101. The exception is formula 285-4307, and requirements are explained in Note 2 of Table D-1.

c. Column (2) of Table D-1 refers to liquid DDT formulations where the flashpoints must be ascertained by the contractor before the hazard classification can be assigned. A "flashpoint is the minimum temperature at which a liquid gives off vapor within a test vessel in sufficient concentration to form an ignitable mixture with air near the surface of the liquid," as determined by specified testing procedures. 49CFR173.115(d).

d. Six liquid formulations--242-4210, 253-3892, 281-1990, 281-3462, 655-8587, and 981-7536--must be tested by the contractor. If the flashpoint is below 100°F. (37.8°C), the formulation is classed as a flammable liquid. If the flashpoint is at or above 200°F. (93.3°C), the formulation is classed as ORM-A material, regulated only when carried by air, because of its DDT content. 49CFR173.115, 49CFR172.101, 49CFR173.2.

e. If a formulation qualifies as a combustible liquid but is contained in packaging with a rated capacity of 110 gallons or less, it will be classed and treated as an ORM-A material. 49CFR173.118a(a).

f. A combustible liquid in a portable tank, cargo tank, or tank car is not subject to Subchapter C (USDOT Hazardous Material Regulations) requirements except those that pertain to:

(1) shipping paper, waybills, switching orders, or other billing

(2) marking and placarding of portable tank

Table D-1

HAZARD CLASSIFICATION OF DDT FORMULAS

Formula # (Last seven digits)	(1) Powder or Liquid ORM-A: DOT Regulation by Air Only	(2) Liquid: Requires Sampling for Hazard Classification	(3) Nonflammable Gas	(4) Gas: Requires Sampling for Hazard Classification	Remarks
058-1934	x				
180-6142	x				
180-6143	x				
240-2540	x				
242-4210		x			
242-4221	x				
242-4222	x				
246-6432	x				Note 1
250-3002	x				
252-3002	x				
253-3892		x			
254-8770			x		Notes 1, 3
264-6692	x				
264-6694			x		Notes 1, 3
274-5415	x				
281-1990		x			
281-3462		x			
285-4307	x				Notes 1, 2
290-6274	x				
543-4038	x				Note 1
576-5008	x				
598-7313	x				
598-7314	x				Note 1
655-8287		x			
664-0110				x	Note 3
766-9631				x	
981-7536		x			
LSN-1010	x				
LSN-1025	x				
LSN-1050	x				
LSN-1075	x				
LSN-1100	x				
LSN-1111	x				
LSN-3005		x			
LSN-3025	x				
LSN-3333		x			
LSN-4012					Note 4
LSN-9999					Note 4
6840-00-LSN					Note 4

NOTES:

1. Designated as nonflammable by DPDS Inventory.

2. Contains 83% tetrachloroetylene. If carried by passenger railcar, a maximum net quantity of 10 gallons per package is allowed. If carried by passenger aircraft, a maximum net quantity of 10 gallons per package is allowed, and a metal drum or other specified container must be used, as stated in 49CFR173.605.

3. Contains either or both dichlorodifluoromethane and trichloromonoflouromethane. If carried by passenger railcar or passenger aircraft, a maximum net quantity of 150 lbs. per package is allowed. If carried by cargo only aircraft, a maximum net quantity of 300 lbs. per package is allowed.

4. Formulation unknown, contractors' responsibility to test for hazard declassification.

Source: 49CFR172.100, 49CFR172.101, 49CFR173.2.

(3) placarding of tank car tanks and motor vehicles

(4) carriage aboard aircraft and vessel

(5) reporting incidents as prescribed in 49CFR171.15 and 171.16, 49CFR173.118a(b)

Items (1), (3), and (5) are applicable to alternatives considered in this EIS and will be discussed later in this section.

(g) Three formulations--254-8770, 264-6694, and 656-1417--have been identified as nonflammable gasses. A nonflammable gas may be further classified as a compressed gas if the formulation has in the container an absolute pressure exceeding 40 psi at 70°F. or, regardless of the pressure at 70°F., having an absolute pressure exceeding 104 p.s.i. at 130°F. A compressed gas may be further classified as a non-liquified or liquified compressed gas, depending upon satisfaction of further criteria. 49CFR173.300.

(h) Three gaseous formulations--664-0110, 766-9631, and 857-8212--require testing by the contractor. If nonflammable, further classification based upon criteria of paragraph (7) above may be used. If flammable, four tests are used to determine if the gas can be further classified as a flammable compressed gas. 49CFR173.300.

(i) There are many formulations within the inventory listed as LSN (Local Stock Number). The make-up of several of these formulations is unknown as indicated in Table D-1. It will be the responsibility of the contractor to determine the appropriate hazard classification and shipping method of the unclassified LSNs, to be in accordance with applicable regulations.

2. General Packaging Requirements

a. For ORM liquids in packaging of 110 gallon capacity or less, sufficient outage must be provided so that the packaging will not be liquid full at 130°F. (55°C). 49CFR173.510(2). This rule is provided so that expansion of carried materials due to heat is unlikely to rupture the container.

b. When an ORM liquid or solid has an absolute vapor pressure exceeding 16 pounds per square inch at 100°F. (38°C), the primary packaging must be capable of withstanding the inside vapor pressure at 130°F. without leakage. 49CFR173.510(3). This is another safety measure to provide for expansion due to heat.

c. Flammable liquids must be shipped in USDOT specified containers, chosen according to their Reid vapor pressures and measured by using American Society for Testing Materials Test D323. If this vapor pressure does not exceed 16 pounds per square inch, absolute, at 100°F., a specific set of requirements must be met for containers and tank cars. If this vapor pressure exceeds 16 pounds per square inch, absolute, at 100°F., stricter requirements apply, including extra placarding and labeling. 49CFR173.119.

d. Compressed gasses must also be shipped according to USDOT requirements that refer to testing of containers, allowable pressures, valve protection, outside packagings, and other safety measures. 49CFR173.301, 173.302.

3. Labeling, Marking, and Placarding Requirements

a. All containers of 110 gallons or less offered for transportation off-site must be marked with the following: Hazardous Waste - Federal Law Prohibits Improper Disposal. If found, contact the nearest police or public safety authority or the U.S. Environmental Protection Agency.

Generator's Name and Address_______________________________ Manifest
Document Number___________________________________ 40CFR262.32(b).

b. All containers to be shipped for disposal must be marked that the product is "For Disposal Only" and must bear a statement of ingredients, a label bearing the name and address of the responsible official, and the net weight or measure of content. 40CFR162.5(b)(3) (Promulgated Feb. 26, 1980).

c. Liquid materials must be packed with closures upward and marked "THIS SIDE UP" or "THIS END UP" as appropriate. 49CFR172.312(2).

d. Packages categorized as ORM-A must be marked "ORM-A" on at least one end or side. 49CFR172.316.

e. When hazardous materials having different hazard classes are packed within the same packaging or within the same USDOT-approved container or overpack, the packaging, outside container, or overpack must be labeled as required for each class of hazardous material contained therein. 49CFR172.404(a).

f. When two or more packages containing compatible hazardous material are placed within the same outside container or overpack, the outside container or overpack must be labeled as required for each class of hazardous material contained therein. 49CFR172.404(b).

g. Placarding of motor vehicles or rail cars may be required, depending upon the weight of shipment. If required by weight of shipment, a vehicle or rail car carrying nonflammable gas will be placarded "NONFLAMMABLE GAS;" carrying a flammable gas, "FLAMMABLE GAS;" carrying a flammable liquid, "FLAMMABLE;" and carrying a combustible liquid, "COMBUSTIBLE," but only when transporting DDT formulations by tank car. Where two or more classes of material are carried by a single motor vehicle or rail car, a "DANGEROUS" placard may be utilized unless more than 5,000 pounds of one class of material are loaded at a single loading facility, in which case the placard for that class must be assigned. 49CFR172.504.

h. USDOT is also expected to ensure regulations requiring the identification of reportable quantities of hazardous substance in one package by the entry of the letters "RQ" in association with the proper shipping name. The reportable quantity for DDT is designated by USEPA as one pound. 40CFR117 (effective September 28, 1979).

i. Empty packagings offered for transportation must have any USDOT labels identifying hazardous classes removed and replaced by an "EMPTY" label. 49CFR173.29.

4. Shipping Paper

a. A manifest shall be prepared, with adequate copies for the generator, each transporter, and each operator of the designated facility, containing the following information:

(1) a manifest document number

(2) name, mailing address, telephone number, and USEPA identification number of DPDS

(3) name and USEPA identification number of each transporter

(4) name, address, and USEPA idenification number of the designated facility and our alternate facility, if any

(5) description of the waste(s) (proper shipping name, etc.) required by USDOT

(6) the total quantity of each hazardous waste by units of weight or volume, and the type and number of containers as loaded into or onto the transport vehicle

A certification of compliance with USDOT and USEPA regulations must also appear on the manifest. 40CFR262.21 (promulgated February 26, 1980).

b. A representative of DPDS will:

(1) sign the manifest certification by hand

(2) obtain the handwritten signature of the initial transporter and date of acceptance on the manifest

(3) retain one copy and give the transporter the remaining copies. 40CFR262.23.

c. If DPDS does not receive a copy of the manifest with the handwritten signature of the owner or operator of the designated facility within 35 days of the date the waste was accepted by the initial transporter, this person shall be contacted to determine the status of the hazardous waste. 40CFR262.42 (promulgated February 26, 1980).

d. If DPDS does not receive the signed manifest within 45 days of the date the waste was accepted by the initial transporter, an Exception Report must be filed with the USEPA Region Administrator. This will include a copy of the manifest lacking information of delivery and a cover letter explaining efforts to locate the hazardous waste and the results of those efforts. 49CFR262.42 (promulgated February 26, 1980).

5. Carriage by Motor Vehicle

a. The loading and unloading of trucks is subject to many general requirements, including the assurance that packages are secured against movement within the vehicle, preventing exposure to sources of fire and flame, supervisory requirements, and other directives.

b. Cargo tanks must satisfy DOT construction specifications and pass a biennial inspection. 49CFR177.824.

c. An empty cargo tank must be tightly closed and, unitl cleaned, must be offered for transportation in the same manner as when it previously contained a greater quantity of a hazardous material. 49CFR173.29.

d. Drivers must have at least 8 hours rest after each 10 hours of driving, and they may not drive more than 10 hours following 8 consecutive hours off duty or drive for any period after having been on duty 15 hours following 8 consecutive hours off duty. Sleeper-berth equipment allows the 8 hours off duty to be taken in two periods of at least two hours each. 49CFR395.3.

e. Drivers may not be on duty more than 60 hours in any 7 consecutive days, unless the carrier operates vehicles every day in the week, in which case the driver may not exceed 70 hours in 8 consecutive days. In the state of Alaska these respective times are 70 hours in any 7 consecutive days and 80 hours in any 8 consecutive days. 49CFR395.3.

f. Drivers must maintain a daily and multi-day "driver's log" on the prescribed from to show their activities during each 24-hour period. Failure to keep logs, failure to make required entries therein, falsification of entries, or failure to preserve logs shall make both the driver and the carrier liable to prosecution. 49CFR395.8, 395.9.

6. Carriage by Rail

a. Loading and unloading regulations for rail include many general requirements. Among these are the blocking and bracing of packages to prevent movement in transit, measures to minimize the risk of damage to packages, and security of hazardous materials carried. 49CFR174.55.

b. Operating regulations include notification of train crews when materials requiring placarding are carried, procedures for replacing lost or destroyed labels, incident reporting, and leak procedures. 49CFR174.25 et seq.

c. Tank cars are subject to numerous requirements to qualify for use. These include acceptable test pressures, inspections, testing intervals and standards reporting requirements, and others. 49CFR173.31 et seq.

d. An empty tank car must be tightly closed and offered for transportation in the same manner as when it previously containted a greater quantity of a hazardous material. 49CFR173.29.

e. Carriers must keep records of hours of duty of employees and train movements. 49CFR228.11, 228.17.

7. Carriage by Barge or Vessel

a. Handling of hazardous material aboard barge or vessel is subject to many general requirements. These inlcude supervision, vessel preparation, stowage, segregation, and others. 49CFR176, Subparts C and D.

b. Special requirements for barges include specifications for materials of construction and stowage location. 49CFR176.96, 176.98.

c. For piping liquid hazardous materials to a vessel, arrangement and fabrication of piping systems, valving requirements, instrumentation, transfer methods, and other items necessary to this procedure are covered. 46CFR151 et seq.

8. Carriage by Aircraft

Carriage by aircraft is subject to a number of requirements. These include notification of pilot in command, keeping and replacing of labels, quantity limitations, orientation and location of cargo, and others. 49CFR175.

9. Incidents or Discharges

The following action is required in the event of a discharge of hazardous waste during transportation:

(1) Appropriate immediate action is required to protect human health and the environment.

(2) A responsible government official may authorize removal of the waste without requiring compliance with certain USEPA regulations, providing this official determines immediate removal of the waste is necessary.

(3) The transporter must notify the National Response Center if, as a direct result of hazardous materials discharge, death, injuries requiring hospitalization, or property damage estimated to exceed $50,000 are caused, and any other time the carrier believes notification is prudent. A written report is necessary if a discharge and/or one of the above events occurs.

(4) A water transporter who has discharged hazardous waste must give notice under similar criteria. 40CFR263.30, 49CFR171.15, 171.16.

(5) An air transporter is also required to observe similar criteria. 49CFR175.45.

10. Interim Storage Facilities

Tanks used in storage facilities must meet basic requirements. Tanks must be steel, with certain exceptions, and suitable diked areas or drainage systems must be included. 29CFR1910.106.

11. State Requirements

a. Transportation of hazardous materials is also regulated by many state regulatory entities. The degree of regulation at present varies considerably, but most states have adopted the USDOT transportation regulations by reference. Many states also require manifests to track hazardous waste shipments.

b. A list of state hazardous waste legislation and regulations is included in Appendix F. The contractor involved in the DDT project will be required to observe all state requirements in effect at the time of transport.

c. A list of persons and agencies contacted to ascertain information concerning regulations has been provided in this EIS.

APPENDIX E

DETAILED COSTS

Appendix E

DETAILED COSTS

I. COLLECTION COSTS

Detailed Costs of Collection Options

A detailed cost breakdown for the regional consolidation, partial consolidation, and direct collection options is presented below.

1. Option I - Regional Consolidation

a. Repackaging Labor Costs

At the storage sites a total of 127 8-hour days would be spent repackaging 50% of the containers of liquid and powder DDT at a cost of $26,900. It is assumed that the vendor charges $25 per hour for labor and that the amount of material at a given site determines the length of time it takes two men per truck to repackage. The men would spend approximately 147 days at the various storage sites, charging $60 per day for expenses. Repackaging expense costs would equal $9,350. Assuming approximately 40% of the estimated repackaging time is required to load and then unload the containers, a loading cost of $10,600 is determined. Unloading costs would also be $10,600. Repackaging 50% of all materials for direct collection has a total labor cost of $57,450.

b. Container Costs

(1) At the storage sites, there are approximately 3,100 55-gallon drums and 13,500 5-gallon cans of liquid DDT (the number of containers has been rounded upward to account for smaller amounts of odd-sized packages). Damaged or leaking containers of liquid would be overpacked in 85-gallon metal overpack drums, which cost $52.50 each. Assuming that one 85-gallon metal overpack drum can hold one 55-gallon drum or six 5-gallon cans, then 2,675 overpacks, at a cost of $140,440, would be required for 50% repackaging of the liquid DDT.

(2) The approximate number of containers of powder DDT at all the storage sites is 10,200 5-pound cans, 100 15-pound cans, 5,300 20-pound cans, and 600 25-pound cans. The number of containers has been rounded upward to account for odd-sized packages. Damaged or leaking containers of powder would be overpacked into 35-gallon fibre drums. Assuming that a 35-gallon fibre drum can hold 21 5-pound cans, 15-pound cans, 20-pound cans, and 25-pound can, approximately 1,881 fibre drums would be needed for 50% repackaging of the powder DDT. The cost of these drums at $6.05 each is $11,380.

(3) Container costs for other units of DDT (miscellaneous packages) are assumed to be equal to 6% of the container costs required for 50% repackaging of the liquid and powder DDT. Therefore, other units of DDT could be repackaged for $79,110.

(4) The cost of shipping new containers to the storage sites is $31,500, based upon a shipping charge of $9 per 85-gallon metal overpack drum and $3 per 35-gallon fibre drum.

(5) The total container cost for 50% repackaging of all materials is $192,430.

c. Tank Truck Charges

(1) Tank trucks of 6,500-gallon capacity would be sent to six consolidation sites. The manpower cost associated with pumping liquids into a single tank truck is $1,180, based upon a crew of two men each charging $20 per hour. If it takes 15 minutes to pump the liquid contents from one 55-gallon drum into a tank truck, then the cost per gallon of liquid DDT is $0.18.

(2) The labor costs associated with pumping 240,662 gallons of liquid DDT into tank trucks at the consolidation sites is $43,300. Pumping costs per site were assumed to be $7 or $42 for six sites. A $200 charge per consolidation site, or $1,200 total, is required for extra charges.

(3) Approximately 134 8-hour days would be required to pump the liquid DDT into the tank trucks. Expense costs would be $24,120, based upon a crew of three (including the driver of the tank truck) charging $60 per day in expenses for 134 days. In addition, approximately $150 per day for 134 days, or $20,100, would be charged for safety equipment.

(4) The total cost associated with the tank trucks is $88,800.

d. Rinsing Costs

The empty liquid DDT containers would be triple rinsed at the disposal site(s) in preparation for container disposal, reconditioning, or recycling. Approximately 5,775 large, metal drums (greater than 50 gallons capacity), weighing 190 tons, would need rinsing. If 70 drums can be rinsed in one day at a cost of $1,000, then $82,500 would be required for triple rinsing.

e. Total Costs Associated With Regional Consolidation

The cost associated with regional consolidation includes the cost of labor ($57,450), the cost of containers ($192,430), tank truck charges ($88,800), rinsing costs ($82,500), plus a contingency of 10% ($42,040), for a total of $462,430 or $462,000. A summary of these costs is presented below:

REGIONAL CONSOLIDATION REPACKAGING COST SUMMARY

Labor*	
Manpower	$ 26,900
Expenses	9,350
Loading	10,600
Unloading	10,600
LABOR SUBTOTAL	$ 57,450
Containers*	
Metal Overpack Drums (for liquids)	$140,440
Fibre Drums (for powders)	11,380
Metal & Fibre Drums (for other units)	9,110
Shipping Charges	31,500
CONTAINER SUBTOTAL	$192,430
Tank Truck Charges	
Manpower	$ 43,300
Expenses	24,120
Pumping Charge	42
Extra Charges	1,200
Safety Equipment	20,100
TANK TRUCK SUBTOTAL	$ 88,800
Rinsing	$ 82,500
Contingency (10%)	$ 42,118
GRAND TOTAL	$463,298 $463,000

*50% repackaging.

2. Option II - Partial Consolidation

a. Repackaging Labor Costs

At storage sites with liquid DDT amounts less than 500 gallons and/or DDT powder formulations or other units of DDT, it would take approximately 35 days to overpack 50% of the containers at a cost of $13,730. It is assumed that the vendor charges $25 per hour and that the amount of material at a given site determines the amount of time it takes a crew of two men per truck to overpackage. Assuming each man charges $60 per day for expenses and that 48 days are spent at the various storage sites, overpacking expense costs are calculated to be $5,810. If approximately 40% of the estimated overpacking time is required to load and then unload the containers, a loading cost of $5,400 is determined. Unloading costs would also be $5,400. It is important to note that loading and unloading of the DDT containers would occur at the storage sites, consolidation sites, and finally the disposal site(s). The total labor cost associated with overpacking for partial consolidation is $30,340.

b. Container Costs

(1) The majority of the powder containers at the storage sites are 5-pound cans, 15-pound cans, 20-pound cans, and 25-pound cans. The approximate number of these containers (rounded upward to account for odd-sized packages) is as follows: 10,200 5-pound cans, 100 15-pound cans, 5,300 20-pound cans, and 600 25-pound cans. Damaged powder containers will be overpacked into 35-gallon fibre drums. Assuming that a 35-gallon fibre drum can hold twenty-one 5-pound cans, four 15 pounds cans, two 20-pound cans, and one 25-pound can, approximately 1,881 fibre drums would be required for 50 percent overpacking. The cost of these drums at $6.05 each is $11,380.

(2) At sites where liquid DDT amounts are less than 500 gallons, fifty 85 gallon metal overpack drums, each costing $52.50, would be required for 50% overpacking of the liquid containers. The total cost of the metal drums would be $2,630. Other units of DDT could be overpacked for $9,110, a figure based on 6% of the overpacked cost of all DDT liquids (greater than or less than 500 gallons) and all DDT powder formulations.

(3) Using a shipping charge of $9 per 85-gallon metal overpack drum and $3 per 35-gallon fibre drum, the cost of shipping new containers to the storage sites for overpacking purposes is $7,870.

(4) Approximately 3,072 55 gallon and 57 50-gallon metal containers oi DDT liquid would be emptied into tank trucks. In addition, the liquid contents of 13,412 smaller metal cans would be vacuumed and pumped into the tank trucks. Since triple rinsing of the empty containers at the storage sites is not feasible due to a lack of proper facilities for rinsing purposes, 50% of the empty containers would be enclosed in 3-mil

polyethylene bags to prevent leakage during transport to the disposal site(s). Assuming one 3-mil polyethylene bag costs $10 and can enclose one damaged 50- or 55-gallon metal drum or five smaller metal cans, then the cost of overpackaging 50% of the empty liquid containers is $29,060.

(5) The total container costs for liquid DDT, powder DDT, and empty containers is $57,420.

c. Tank Truck Costs

(1) A tank truck of 6,500 gallon capacity would be sent to twenty-eight of the storage sites which have liquid DDT amounts greater than 500 gallons. The manpower costs associated with pumping liquids into a single tank truck is $1,180 based upon a crew of two men each charging $20 per hour. It takes 15 minutes to pump the liid contents from one 55-gallon drum into a tank truck. The cost per gallon of liquid DDT is $0.18.

(2) The labor cost associated with pumping the liquid DDT into tank trucks at the twenty-eight storage sites and the consolidation sites is $43,300. Pumping costs per site were assumed to be $7 or $200 for all sites. Approximately $200 per storage site, or $5,600 total, is required for extra charges.

(3) Expense costs of $24,120 to pump all the liquid DDT into tank trucks is based upon a crew of three men (including the driver of the tank truck) charging $60 per day in expenses for 134 days. Additionally, for 134 days, approximately $150 per day in costs would be required for a van with safety equipment. The total charge for safety equipment would be $20,100.

(4) The total cost associated with collection by tank truck is $93,320.

d. Rinsing Costs

(1) At the disposal site(s), the empty liquid DDT containers would be triple rinsed in preparation for container disposal or reconditioning. Triple rinsing requires a cemented diked area to contain spills, diesel fuel for rinsing, and safety equipment. The storage sites are not adequately equipped to handle the triple rinsing. Triple rinsing would be done at the disposal site(s).

(2) Delivered to the disposal site(s) would be 3,129 empty 50- and 55-gallon metal drums, and fifty empty 85-gallon metal overpack drums. These large metal containers, weighing approximately 88 tons, would be tripled rinsed. Where 50- or 55-gallon drums have been overpacked, both the 50- or 55-gallon drum and the overpack drum would be triple rinsed. All empty, small metal containers of liquid would be incinerated.

(3) Using a cost of $1,000 to triple rinse seventy drums in one day, $45,000 would be required to triple rinse all the larger, empty metal drums.

e. Total Costs Associated With Partial Consolidation

The costs associated with partial consolidation include the cost of labor ($30,340), the cost of the containers ($57,420), tank truck charges ($93,320), rinsing costs ($45,000), plus a contingency of 10% ($22,600) for a total of $248,680 or $248,000. These costs are summarized below:

PARTIAL CONSOLIDATION REPACKAGING COST SUMMARY

Labor*	
Manpower	$ 13,730
Expenses	5,810
Loading	5,400
Unloading	5,400
LABOR SUBTOTAL	$ 30,340
Containers*	
Metal Overpack Drums (for liquids)	$ 2,630
Fibre Drums (for powders)	11,380
Metal & Fibre Drums (for other units)	9,110
Shipping Charges	7,870
Polyethylene Bags	29,060
CONTAINER SUBTOTAL	$ 57,420
Tank Truck Charges	
Manpower	$ 43,300
Expenses	24,120
Pumping Charge	200
Extra Charges	5,600
Safety Equipment	20,100
TANK TRUCK SUBTOTAL	$ 93,320
Rinsing	$ 45,000
Contingency (10%)	$ 22,600
GRAND TOTAL	$248,680 $249,000

3. Option III - Direct Collection

a. Overpacking Labor and Container Costs

(1) As in the regional consolidation option, 50% of all DDT materials would be overpacked at the storage sites. For this reason, overpacking labor and container costs would be identical to those for regional consolidation. The labor and container cost associated with overpacking 50% of the material is, therefore, $57,450 plus $192,430 or $249,880.

(2) The approximate number of containers of powder DDT at all the storage sites is 10,200 5-pound cans, 100 15-pound cans, 5,300 20-pound cans, and 600 25-pound cans. The number of containers has been rounded upward to account for odd-sized packages. Damaged or leaking containers of powder would be overpacked into 35-gallon fibre drums. Assuming that a 35-gallon fibre drum can hold twenty-one 5-pound cans, four 15-pound cans, two 20-pound cans, and one 25-pound can, approximately 1,881 fibre drums would be needed for 50% overpacking of the powder DDT. The cost of these drums at $6.05 each is $11,380.

(3) Container costs for other units of DDT (miscellaneous packages) are assumed to be equal to 6% of the container costs required for 50% overpacking of the liquid and powder DDT. Therefore, other units of DDT could be overpacked for $9,110.

(4) The cost of shipping new containers to the storage sites is $31,500, based upon a shipping charge of $9 per 85-gallon metal overpack drum and $3 per 35-gallon fibre drum.

(5) The total container cost for 50% overpacking of all materials is $192,430.

b. Pumping Charges

At the disposal site(s), the contents of the containers of liquid DDT would be vacuumed out. Assuming an $0.18 per gallon pumping charge, it would cost $43,300 to vacuum out all the containers of liquid DDT. In addition, 134 days would be required to pump out the liquids. At $150 per day for a van with safety equipment, the safety equipment cost would be $20,100.

c. Rinsing Costs

The empty liquid DDT containers would be triple rinsed in preparation for container disposal or reconditioning. Approximately 5,775 large, metal drums (greater than 50 gallons capacity) would need rinsing. These empty containers weigh approximately 190 tons. Using a cost of $1,000 to triple rinse seventy drums in one day, $82,500 would be required for triple rinsing.

d. Total Costs Associated With Direct Collection

The costs associated with direct collection include the cost of labor ($57,450), the cost of containers ($192,430), pumping charges ($63,400), rinsing costs ($82,500), plus a contingency of 10% ($39,500), for a total of $434,530 or $435,000. A summary of these costs is presented below:

DIRECT COLLECTION REPACKAGING COST SUMMARY

Labor*	
Manpower	$ 26,900
Expenses	9,350
Loading	10,600
Unloading	10,600
LABOR SUBTOTAL	$ 57,450
Containers*	
Metal Overpack Drums (for liquids)	$140,440
Fibre Drums (for powders)	11,380
Metal & Fibre Drums (for other units)	9,110
Shipping Charges	31,500
CONTAINER SUBTOTAL	$192,430
Pumping Charges	
Manpower	$ 43,300
Safety Equipment	20,100
PUMPING CHARGES SUBTOTAL	$ 63,400
Rinsing	$ 82,500
Contingency (10%)	$ 39,600
GRAND TOTAL	$435,380 $435,000

* 50% repackaging.

II. TRANSPORTATION COSTS

1. Basic Transport (US)

Option I (Regional Consolidation) = $200,000

Option III (Direct Collection) = $320,000

2. Basic Transport (overseas stocks)

Option I (Regional Consolidation) = $ 20,000

Option III (Direct Collection) = $ 15,000

3. Other

	Option I (Regional Consolidation)	Option III (Direct Collection)
- truck cleaning	$15,000	$15,000
- transport "other"	15,000	20,000
- mixed substances	14,000	16,000
- demurrage	11,000	5,000
- additional vacuum, truck charges, etc.	10,000	9,000
TOTAL	$65,000	$65,000

4. Repackaging Crew

Cost of Labor:

200 days x 3 people x
($160 labor/day + $40 per diem) = $120,000

- 104 days to empty drums
- 36 days repackaging
- 60 days travel

Total miles traveled for repackaging:

60 days/travel x 8 hrs/day x 50 mph = 24,000 miles

Total cost of travel for repackaging:

24,000 mi x $1.50/mi for special truck = $ 36,000

Overtime:

20% overtime labor = .20 x 120,000 = $ 24,000

Subtotal = $180,000

Subtract cost of emptying drums = $ 50,000

104 days x 3 people x
$160 labor/day = $50,000
(cost included in collection costs)

TOTAL $130,000

5. Radio/Telephone Communication System

WATS line $1,000/month x 6 month	=	$ 6,000
answering service, beepers, etc. (24 hr service - $50/month x 6 month)	=	300
overtime for experts on call ($20/hr x 16 hr/day x 6 month)	=	58,000
room, supplies, administration, etc. for control center	=	3,900
C-B radios (30 x $60)	=	1,800
TOTAL		$70,000

III. OCEAN INCINERATOR LOADING COSTS

1. Staffing

(a) Truck Unloading

Foreman	13 wks x 48 hrs/wk	=	624 hrs
Operator	13 wks x 48 hrs/wk	=	624 hrs
Second Shift Guard	13 wks x 48 hrs/wk	=	624 hrs
TOTAL			1,872 hrs

(b) Railroad Car Storage Monitoring

Foreman	4 wks x 40 hrs/wk	=	160 hrs
Second Shift Guard	4 wks x 40 hrs/wk	=	160 hrs
TOTAL			320 hrs

(c) Shiploading

Foreman	2 wks x 48 hrs/wk	=	96 hrs
Operator	2 wks x 48 hrs/wk	=	96 hrs
Second Shift Guard	2 wks x 48 hrs/wk	=	96 hrs
TOTAL			288 hrs

(d) Support Activities

Foreman Start-up and Shutdown			
	4 wks x 40 hrs/wk	=	160 hrs
Operator	4 wks x 40 hrs/wk	=	160 hrs
TOTAL			320 hrs
GRAND TOTAL			2,800 hrs

2. Costs

(a)	Railroad Car Rental (12 month minimum lease) 31 cars x $180	=	$67,000
(b)	Facility Rental	=	$30,000
(c)	Facility Construction and Dismantling	=	$120,000
(d)	Labor, Including Fringes and Labor Related Costs 2,800 hours x $20	=	$56,000
(e)	Supplies, Materials, Utilities and Services	=	$15,000
	TOTAL	=	$288,000

APPENDIX F

STATE LEGISLATION AND REGULATIONS PERTAINING TO HAZARDOUS WASTE

Appendix F

STATE LEGISLATION AND REGULATIONS PERTAINING TO HAZARDOUS WASTE

ALABAMA

1. Hazardous Waste Management Act of 1978: Act No. 129 (regulations being drafted)
2. Solid Waste Management Regulations, adopted July 19, 1972
3. Solid Waste Disposal Act, No. 771, amended by Act No. 2247
4. Standards for Disposal of Solid Waste, State Board of Health, June 18, 1969
5. Alabama Pesticide Act

ALASKA

1. Department of Environmental Conservation Act, Alaska Statutes, Title 44, Chapter 46, Article 1-2, as amended
2. Water, Air and Environmental Conservation Act, Title 46, Chapter 3, as amended
3. Alaska Administrative Code, Title 18, Environmental Conservation Chapter 60.000 et seq., Solid Waste Management

ARIZONA

1. Arizona Rev. Stat. Section 36-104.2(b), 3,6,7,8,13; 36-132A.12; 36-132.01; 36-136 A.7; and 36-136.G
2. Solid Waste Rules, Arizona Code, Title 9 (hazardous waste regulations have been proposed)

ARKANSAS

1. Arkansas Hazardous Waste Management Act, Act 406, March 14, 1979
2. Arkansas Resource Reclamation Act, Act 1098, March 19, 1979
3. Arkansas Solid Waste Management Act, Act 237, Senate Bill 341, 1971
4. Hazardous Material Transportation, Chapter 29
5. Hazardous Waste Management, 82-4203

CALIFORNIA

1. Health and Safety Code Section 25100 et seq., as amended
2. Water Code Section 14000 et seq., as amended
3. Water Code Section 13260 et seq.
4. Solid Waste Management and Recource Recovery Act of 1972, Title 7.3, Section 66700 et seq. of CA Health and Safety Code
5. Department of Health Hazardous Waste Control Law, Chapter 6.5, Hazardous Waste Control
6. Administrative Code, Title 22, Div. 4, Chapters 1 and 2
7. Administrative Code, Title 23, Sections 2511, 2512, 2521, 2523

COLORADO

1. Solid Waste Disposal Sites and Facilities Law, Rev. Stat. Section 30-20-101 et seq. and Section 36-23-1 et seq.
2. SB No. 336 (provides for hazardous waste study), 1979
3. Solid Waste Disposal Sites and Facilities Regulations, April 1972

CONNECTICUT

1. Gen. Stat. Ann. - Chapter 361a, Section 19-524a et seq., Solid Waste Management
2. Gen. Stat. Ann. - Chapter 474(a), Section 25-54a et seq., Clean Water Act
3. Regulations Section 19-524-1 et seq. (proposed hazardous waste bill)

DELAWARE

1. Code Title 7, Delaware Environmental Protection Act, Chapter 60
2. Solid Waste Management Regulations, Chapter 1 - Disposal Regulation (proposed hazardous waste legislation)

FLORIDA

1. Stat. Section 403.701 et seq., Resource Recovery and Management Act of 1974
2. Stat. Section 403.011 et seq., Air and Water Pollution Control Act
3. Regulations: Chapter 17-7.01 et seq., Part 1, Solid Waste Facilities (proposed hazardous waste legislation)

GEORGIA

1. Hazardous Waste Management Act, Act No. 613, April 16, 1979
2. Rules of the State Department of Transportation, Transportation of Hazardous Materials, Chapter 672-10
3. Transportation of Hazardous Materials Act, Act No. 487, 1979

HAWAII

1. Rev. Stat. Sec. 342-51 et seq., Hawaii Environmental Quality Law, Title 19, Chapter 342, Part V, Solid Waste Pollution
2. Hawaii Solid Waste Ownership Act, Act 184
3. Regulations: Hazardous Waste Control, Hawaii Environmental Laws and Regulations, Vol. II, Chapter 46, Solid Waste Management Control
4. Regulations: Hawaii Environmental Laws and Regulations, Section 4, Standards for Hazardous Waste Disposal

IDAHO

1. Solid Waste Law, ID Code Section 31.4401 et seq.
2. Dept. of Health & Welfare, ID Code Section 39-103 et seq.
3. Solid Waste Regulations and Standards, Board of Environmental and Community Services

ILLINOIS

1. Environmental Protection Act-Title V, a 1974-Rev. Stat., Chapter 111 1/2, Section 1001 et seq.
2. Pollution Control Board Rules and Regulations, Chapter 9, Special Waste Hauling Regulations
3. Illinois EPA Solid Waste Regulations, Chapter 7

INDIANA

1. Refuse Disposal Act, Code Ann. Section 19-2-1, as amended
2. Environmental Management Act, Code Ann. Section 13-7, as amended
3. Solid Waste Management Permit Regulations, SPC 18
4. Industrial Waste Hauler Permit, SPC 17
5. Spills, SPC 16

IOWA

1. Hazardous Waste Management Act, Code Ann. Chapter 455B, as amended
2. Solid Waste Disposal Comm., Ann. Section 455B75, Iowa Department of Environmental Quality Act Div. IV
3. Iowa Solid Waste Disposal Rules, Title IV, Chapters 25-31
4. House File 719: An Act Relating to Hazardous Waste Management and Providing Penalties and Injunctive Relief

KANSAS

1. Solid Waste Management Act, Stat. Section 65-3401 et seq., as amended
2. Solid Waste Disposal Act, 1973 KS Sess. Laws
3. Solid Waste Management Standards and Regulations, Art. 29, 28-29-1 et seq.

KENTUCKY

1. Solid Waste Disposal Act, Rev. Stat. Section 211.700 et seq. 211.992 et seq.
2. Environmental Protection Law, as amended
3. Solid Waste Regulations - 401KARA 2:010 (hazardous waste regulations being drafted)

LOUISIANA

1. Hazardous Waste Management Plan, Act 334 of 1978, Rev. Stat. 30:1101 et seq.
2. H.B. 433, providing for reorganization and changes to above

3. Hazardous Waste Management Plan - Rules and Regulations effective August 1, 1979

MAINE

1. Septage and Solid Waste Management Act
2. Regulations (Draft) 38 MRSA Sections 1302, 1303, 1304, Chapter 431, Hazardous Waste Management Rules

MARYLAND

1. Natural Resources Code Ann. Title 8, Section 1413.210, Hazardous Substance Control Law, Safe Disposal of Hazardous Substances Act, Chapter 618
2. Public Health Law, Art. 43, Section 394B-Landfills
3. Control of the Disposal of Designated Hazardous Substances, Admin. Code Section 8.05-05.01 et seq.

MASSACHUSETTS

1. Solid Waste Disposal Law, Gen. Laws Ann. Chapter 16, Sections 18-24, as amended
2. Clear Waters Act, Gen. Laws Ann. Chapter 21, as amended
3. Chapter 704, An Act Regulating the Generation, Transportation, Storage, Treatment and Disposal of Hazardous Waste

MICHIGAN

1. Hazardous Waste Management Act, Act No. 64, 1979
2. Solid Waste Management Act, Act No. 641, 1979
3. Liquid and Industrial Waste Haulers, Act No. 136, 1969
4. Licensing and Resource Recovery Act, 1974
5. Solid Waste Regulations R325.2701 et seq.
6. Hazardous Waste Regulations, Sections 299.401 to 299.437 (proposed)

MINNESOTA

1. Code of Agency Rules, Pollution Control Agency, Hazardous Waste, GMCAR Section 4.9001 et seq.
2. MN Stat. Ann. Sections 115,116, 400.000 et seq., 473.801 et seq.

MISSISSIPPI

1. Hazardous Waste Act, 1979 (regulations in hearings)

MISSOURI

1. Hazardous Waste Management Law, Ann. Stat. Section 260.350 et seq.
2. Rules 10 CSR 25-3,010 et seq. (proposed)

MONTANA

1. Solid Waste Management Act
2. Adm. Rules, Solid Waste Management Section, 16-2.14(8) S14315
3. Refuse Disposal Areas, Rule 16-2.14(2) - S1400

NEBRASKA

1. Environmental Protection Act, Rev. Stat. Section 81-1501 et seq.
2. Regulation of Disposal Sites, Rev. Stat. Section 19-4101 et seq.
3. Solid Waste Disposal Sites Law, Rev. Stat. Section 19-2106, 2107
4. Rule 10, Solid Waste Management, Department of Environmental Control

NEVADA

1. Solid Waste Disposal Law, Rev. Stat. Section 444.440 et seq.
2. Water Pollution Control Act, Section 445.131
3. Solid Waste Management Regulations

NEW HAMPSHIRE

1. House Bill No. 555, Chapter 347 (establishes a hazardous waste program)

NEW JERSEY

1. Solid Waste Management Act, Stat. Ann. Section 13.1E-1 et seq., amended 1976
2. Solid Waste Utility Control Act of 1970, Stat. Ann. Section 48:13A-1 et seq., as amended

3. NJAC 7:26-1 et seq., Solid Waste Regulations
4. Spill Compensation and Control Act, P.L. 1976, Chapter 141
5. Proposed New Rules and Amendments Concerning the Operation, Regulation, and Engineering Plan Requirements for Special Waste (chemical and hazardous waste) Facilities [Docket No. 052-78-11]
6. Supplement to the Rules of the Solid Waste Administration
7. Guidelines for Disposal of Surplus or Waste Pesticides and Pesticide Containers

NEW MEXICO

1. Hazardous Waste Act, Chapter 313
2. Hazardous Waste Regulations, Admin. Code, Section 101 et seq.

NEW YORK

1. Inactive Hazardous Waste Sites, Bill S6326-A
2. Industrial Hazardous Waste Management Act of 1978, Chapter 639
3. Solid Waste Management Facilities, Section 27-0701 et seq., Part 360
4. Transport Regulations, Chapter 641

NORTH CAROLINA

1. Solid Waste Management Act
2. Solid Waste Disposal Proposed regulations, Gen. Stat. Section 130 166.16 et seq.

NORTH DAKOTA

1. Solid Waste Management and Land Protection Act, Century Code Section 23-29-01 et seq.
2. Solid Waste Management Regulations, R23-29-01

OHIO

1. Rev. Code Ann. Section 3734.01 et seq., Solid Waste Disposal, as amended
2. Rev. Code Ann. Section 6123.01 et seq., Solid Waste Projects

3. Water Pollution Control Act, Chapter 6111

4. Hazardous Waste Management Rules, Ohio Admin. Code, Section 3745-27-01 et seq., and 3745-37.01 et seq.

OKLAHOMA

1 Controlled Industrial Waste Disposal Act, 630.5 Supp. 1979, as amended

2. Rules and Regulations for Industrial Waste Management, ODH Bulletin No. 0525

OREGON

1. Hazardous Waste Law, Rev. Stat. Section 459.410 et seq. Chapter 459

2. Rules, Hazardous Waste Management, Chapter 340, Division 63

3. Procedures for Licensing Hazardous Waste Management Facilities, Chapter 340, Division 62

4. Proposed Transportation Regulations, 860-36-060 et seq.

PENNSYLVANIA

1. Solid Waste Management Act, Stat. Ann. Title 35, Section 6001 et seq.

2. Hazardous Substances Transportation Act, 35 Penn. Stat., Section 841.1 et seq.

3. Clean Streams Law, Water Quality Criteria, Chapter 93

4. Industrial Wastes, Chapter 97

5. Solid Waste Management, Rules and Regulations, Chapter 75

6. Special Water Pollution Regulations, Title 25, Chapter 101

RHODE ISLAND

1. Hazardous Waste Management Act of 1978, Gen. Laws of RI, Section 23-46.2-1 et seq.

2. Extremely Hazardous Waste, Rules and Regulations

3. Hazardous Waste Management Facility Operating Permit. Rules and Regulations-Landfills

4. Proposed Hazardous Waste Transport Permit Rules and Regulations

SOUTH CAROLINA

1. Hazardous Waste Management Act, SC Code Section 44-56-10 et seq.
2. Proposed Hazardous Waste Management Regulations

SOUTH DAKOTA

1. Solid Waste Disposal Act, Compiled Laws Ann. Section 34A-6-1 et seq.
2. Solid Waste Rules, 345 et seq.

TENNESSEE

1. Hazardous Waste Management Act - TN Code Ann. Section 53-6301 et seq.
2. Proposed Rules Governing Hazardous Waste Management
3. Hazardous Waste Management, Chapter 63, Health and Safety Code
4. Senate Bill No. 1278, Storage and Disposal of Hazardous Wastes

TEXAS

1. Solid Waste Disposal Act, Rev. Cir. Stat. Ann. Art. 4477-7 et seq.
2. Water Quality Act, Art. 7621-d-1 et seq.
3. Solid Waste Regulations
4. Industrial Solid Waste Management Regulations, Department of Water Resources
5. Municipal Solid Waste Management Regulations, Department of Health Resources
6. Nine Technical Guidelines Pertaining to Industrial Solid Waste Management, Department of Water Resources
7. County Solid Waste Control Act, Art. 4477-8

UTAH

1. Hazardous Waste Law, SB No. 269

VERMONT

1. Solid Waste Management, VT Stat. Ann. Title 10, Section 6601 et seq.

2. Solid Waste Regulations, VT Health Regulations, Chapter 11, Section 5-1101 et seq.

3. Environmental Protection Regulations, Solid Waste Management, Section 101 et seq. (hazardous waste regulations being drafted)

VIRGINIA

1. Solid Waste Disposal, VA Code Section 32-9.1

2. State Water Control Law, Industrial Waste, VA Code Section 62.1-44.16

3. Groundwater Act of 1973, VA Code Section 62.1-44.83 et seq.

4. Solid Waste Regulations, VA Department of Health

WASHINGTON

1. Hazardous Waste Disposal, Rev. Code Ann. Section 70.105.010 et seq.

2. Hazardous Waste Regulations, WAC, Chapter 173.302-010 et seq.

3. Order No. 1538, Department of Agriculture, WAC 16-228-160, Transportation and Disposal of Pesticides

WEST VIRGINIA

1. County Courts and Offices, WV Code Sections 7-1-3, 7-1-5, 7-1-6

2 Municipalities and Counties: Intergovernmental Relations, WV Code Sections 8-11-3, 8-11-4, 8-13-5, 8-13-13, 8-16-2, 8-23-1, 8-23-2, 8-23-3, 8-23-7

3. Public Health, WV Code Sections 16-1-9, 16-1-18, 16-3-6, 16-9-2, 16-9-3, 16-9-8

4. Roads and Highways, WV Code Section 17-23-1 et seq., 17C-17-6, 17-24-1 et seq.

5. Agriculture, WV Code Section 19-2, 19-9A-1 et seq.

6. Water Pollution Control Act, WV Code Section 20-4-11, 20-5A-1 et seq., 20-6-35c

7. Solid Waste Regulations, Chapter 1, Art. 12

8. Rules and Regulations, Motor Carriers, Section 7

WISCONSIN

1. Hazardous Waste Management Act, WI Stat. Ann. Section 144.60 et seq.
2. Solid Waste Regulations, N.R.-151 (hazardous waste regulations are being drafted)

WYOMING

1. Solid Waste Law, Stat. Section 35-462 et seq.
2. Environmental Quality Act, Stat. Section 35-11-101 et seq.
3. Solid Waste

DISTRICT OF COLUMBIA

1. Hazardous Waste Management Act of 1977

PUERTO RICO

1. Regulation for the Control of Land Pollution, Proposed Amendments, Environmental Quality Board
2. Public Policy Environmental Act, Law No. 9

APPENDIX G

ENVIRONMENT OF THE GULF OF MEXICO AND THE INCINERATION SITE

GEOMORPHIC ASPECTS

PHYSIOGRAPHY OF THE NORTHERN GULF OF MEXICO

GEOLOGIC NATURE OF THE GULF

The Gulf of Mexico is a semi-enclosed sea with an approximate surface area of over 1,600,000 square kilometers and a maximum depth of about 3,840 meters. Most of the oceanic input is from the Caribbean Sea via the Yucatan Strait (169 km wide and 1650-1900 meters deep) with outflow being primarily through the Florida Straits (less than 160 km wide and only around 800 meters deep). The facts that both of these connections with the parent Atlantic are confined to the southeastern sector and that runoff from approximately two-thirds of the United States and more than half of Mexico also empties into the basin contribute greatly to the characteristics of the Gulf in general and the western Gulf in particular. Those vastly different influences are used as a basis for dividing the Gulf into two major provinces: a carbonate province to the east and a terrigenous one, containing the proposed site, to the west (Uchupi, 1967). These provinces are separated by De Soto Canyon in the northeast quadrant and by Campeche Canyon off the Yucatan Peninsula in the southwestern region (Antoine and Bryant, 1968). Significant characteristics of this basin are the great width of the shelves, the steepness of the lower part of the continental slope (the scarps) and the flatness of the floor of the main basin with its exceptionally thick sequence of sediments.

STRUCTURAL SUBDIVISIONS

The Gulf of Mexico is divided basically into two major provinces: a carbonate province to the east and a terrigenous one to the west (Uchupi, 1967). Further topographic division of the Gulf of Mexico follows Ewing et al. (1958) and Uchupi (1967), including the following physiographic provinces: the continental shelf (sub-divided into West Florida Shelf, Texas-Louisiana Shelf, East Mexico Shelf and Campeche Shelf), the continental slope (including the Sigsbee, Florida and Campeche escarpments), the Mississippi Fan (Cone), the continental rise and the Sigsbee Abyssal Plain (floor of the main basin) (see Fig. G-1).

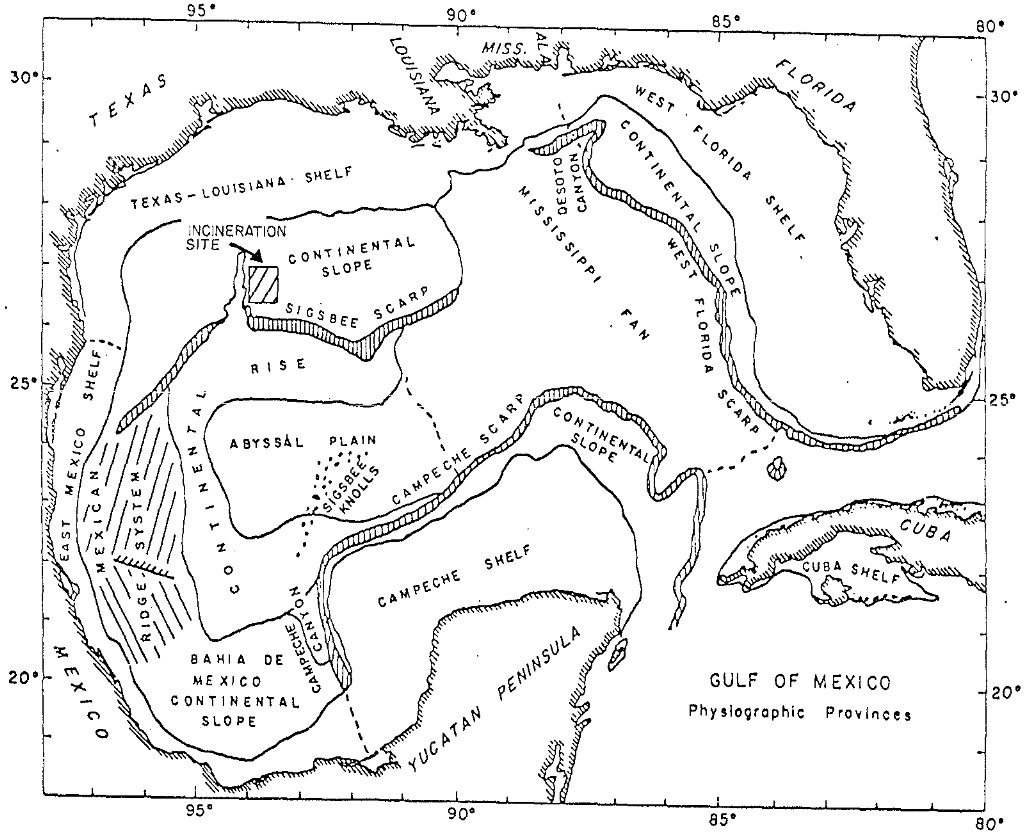


Fig. G-1. Physiographic provinces in the Gulf of Mexico.

Antoine (1972) divides the Gulf of Mexico into seven geologic provinces (Fig. G-2) that he considers to be geologically distinct. Shallow seismic reflection methods were utilized to demonstrate unique characteristics of each province, then viewed from a background of other studies to outline the specific geologic areas - 1) Gulf of Mexico Basin, 2) Northeast Gulf of Mexico, 3) South Florida Continental Shelf and Slope, 4) Campeche Bank, 5) Bay of Campeche, 6) Eastern Mexico Continental Shelf and Slope, and 7) Northern Gulf of Mexico. Insight into the origin and evolution of the Gulf led Antoine to describe the basin as geologically old and representing a subsided oceanic area that has been partially filled with sediments.

PROVINCE ENCOMPASSING INCINERATION SITE (NORTHERN GULF OF MEXICO-#7)

The northwestern Gulf, at least from a structural point of view, is constituted of the continental shelf and slope of Texas, Louisiana, Mississippi, and Alabama. According to Ewing et al. (1968), it is bordered on the east by De Soto Canyon, on the south and southwest by the bottom of Sigsbee Scarp, and at the United States-Mexico border by the beginnings of the anticlinal folds that more or less parallel the shoreline. (These folds mark the northern extension of the Eastern Mexico Province, #6.)

The major structural element of the continental margin of the northwest Gulf of Mexico is the Gulf Coast Geosyncline. This extends southwestward from Alabama toward northeastern Mexico and contains upward of 20,000 m of sediment. The geosyncline is underlain by varying thicknesses of salt, probably of latest Triassic-Jurassic age (Jux, 1961). The offshore area of the northwest Gulf, which includes the major portion of the geosyncline, is characterized by diapiric structures from the coastline to the Sigsbee Scarp. On the continental shelf most of these features are covered by sediments, whereas on the slope they are evident in the topography and form Gealy's "hummocky" zone (Gealy, 1955). It is emphasized by Antoine (1972) that the widespread salt deposit provides a dynamic structural agent acting throughout the entire northern Gulf region.

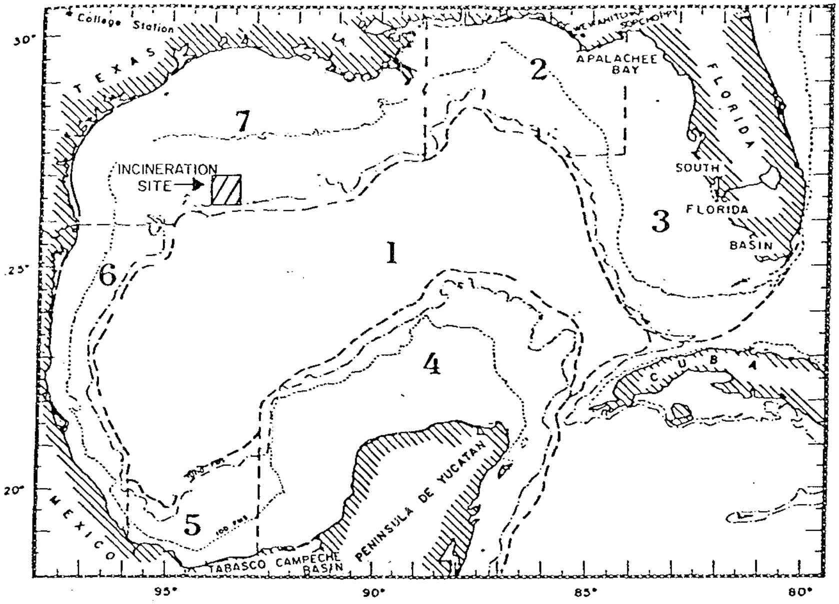


Fig. G-2. Geologic provinces in the Gulf of Mexico (from Antoine, 1972).

1. Gulf of Mexico Basin
2. Northeastern Gulf of Mexico
3. South Florida Continental Shelf and Slope
4. Campeche Bank
5. Bay of Campeche
6. East Mexico Continental Shelf and Slope
7. Northern Gulf of Mexico

TERRACE MORPHOLOGY

The origin of the continental terrace (shelf and slope) of the northwest Gulf of Mexico has been a topic for speculation since study of this basin began. Early investigators suggested that the Gulf basin resulted from massive Cretaceous or Pleistocene subsidence and faulting of continental type crust, resulting in the steep Florida, Campeche, and Sigsbee Escarpments (Suess, 1904; Schuchert, 1935; Dietz, 1952; Gealy, 1955; Greenman and LeBlanc, 1956). This line of thought led to the belief that the irregular nature of the bathymetry of the upper continental slope off Texas and Louisiana was caused by subaqueous erosion following subsidence (Dietz, 1952; Gealy, 1955). Pursuing another line of evidence, Shepard (1937) pointed out the existence of salt diapirs in the Mississippi Trough and Carsey (1950) speculated that the upper slope topography was a direct result of diapiric intrusion.

Ewing et al. (1960) and Antoine (1972) through geophysical studies of the Gulf Basin, have revealed the true oceanic nature of the crust under the deep Gulf, negating the fault postulate of Gulf origin. Continuous seismic profiling has also corroborated the existence and importance of salt diapirs in the formation of slope topography (Moore & Curray, 1963; Ewing & Antoine, 1966; Lehner, 1969). Ballard and Uchupi (1970), while acknowledging the importance of diapirs in producing the hummocky zone of the upper continental slope, point out that events related to Quaternary sea level fluctuations have left relict features, which also add to shelf and slope topography (see Fig. G-3).

SLOPE MORPHOLOGY

The continental slope of the northern Gulf of Mexico represents the seaward part, or the growing margin, of the Gulf Coast geosyncline, where geologic processes that helped to shape the basin are active today (Lehner, 1969). Beds that are buried deeply in the Gulf basin are at shallow depths on broad salt swells and uplifts of the continental slope. Sparker records (Moore & Curray, 1963; Ewing & Antoine, 1966;

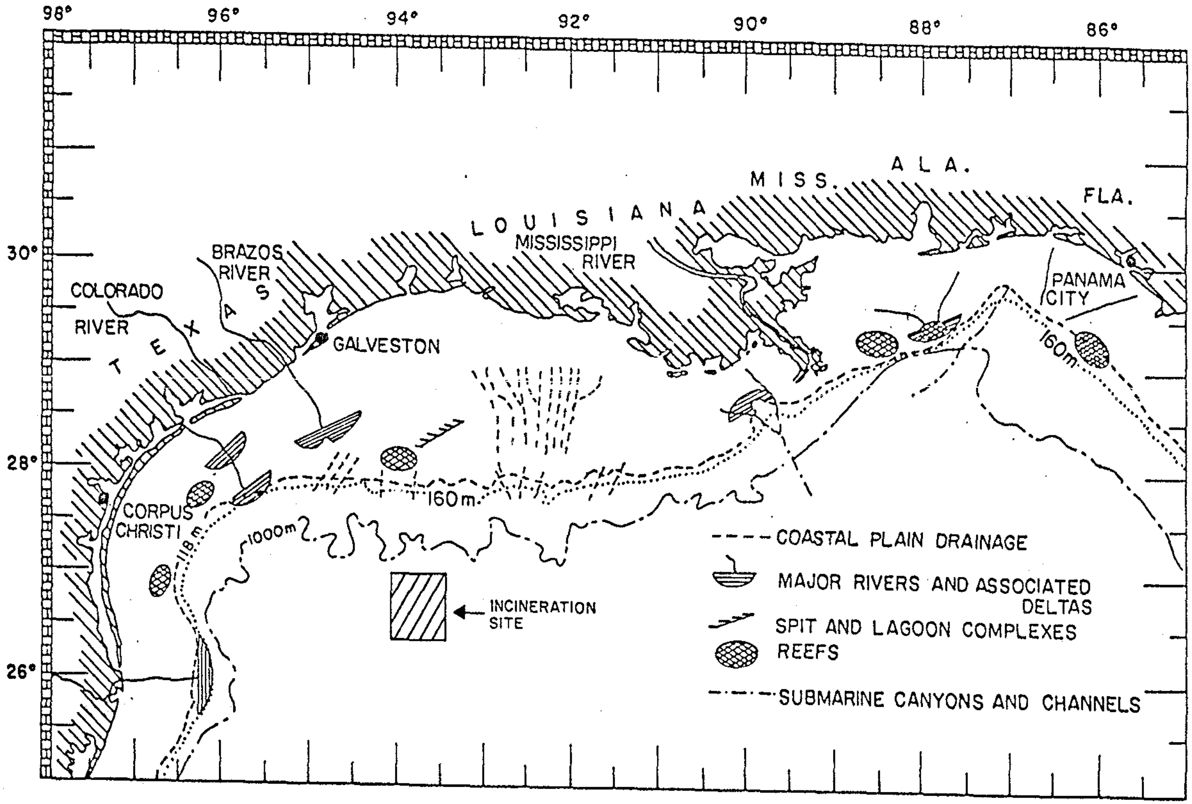


Fig. G-3. Relict features related to Quaternary sea level fluctuation (after Ballard and Uchupi, 1970).

Lehner, 1969) show that salt pillows and swells with diameters of 28-37 km are typical structures on the upper slope forming seaknolls or seamounts with elevations of as much as 1524 m. The flat tops of the salt pillows on the lower slope reach a common elevation and tend to create a terrace-like topography of broad sedimentary troughs. These synclinal basins are filled with slump deposits and turbidites, most of which are mud and clay, whose origin was related to the overloading of the shelf edge by prograding foreset beds, giving rise to extensive submarine slides on the upper slope. The lower slope terrace breaks off abruptly along the Sigsbee Scarp, which has the appearance of being the south edge of a large salt mass. Toward the Mississippi Delta, the upper slope, lower slope, and Sigsbee Scarp merge into a relatively smooth incline known as the Mississippi Cone.

TOPOGRAPHY OF NORTHERN GULF SLOPE

The slope is broken in many places by ridges, knobs, canyons, troughs and basins. In the northeastern section of the Gulf of Mexico it is interrupted by De Soto Canyon, a trough which heads near the 440 m contour and terminates near the 950 m isobath, with a maximum relief ranging from 185 meters (Jordan, 1951) to 250 m (Harbison, 1968). The continental slope off Texas and Louisiana consists of at least two segments: a relatively steep lower slope known as the Sigsbee Escarpment and an irregular upper segment identified by its hummocky topography (Uchupi, 1967) (see Fig G-4). The hummocky zone constitutes a major portion of the slope off the Texas-Louisiana shelf. Antoine (1972) associates the roughness and irregularity of the upper slope to underlying diapiric structures of Triassic-Jurassic salt and suggests that the Sigsbee Escarpment represents the present frontal edge of the salt migration. Other investigators, notably Shepard (1937), Carsey (1950), Moore and Curray (1963), Ewing and Antoine (1966), Wilhelm and Ewing (1972), have also interpreted the hilly topography of seaknolls and seamounts as developing from growth of salt domes. Others (Gealy, 1955 and Ewing et al., 1958) considered submarine slides, turbidity currents, and submarine creep to be very important in shaping the slope topo-

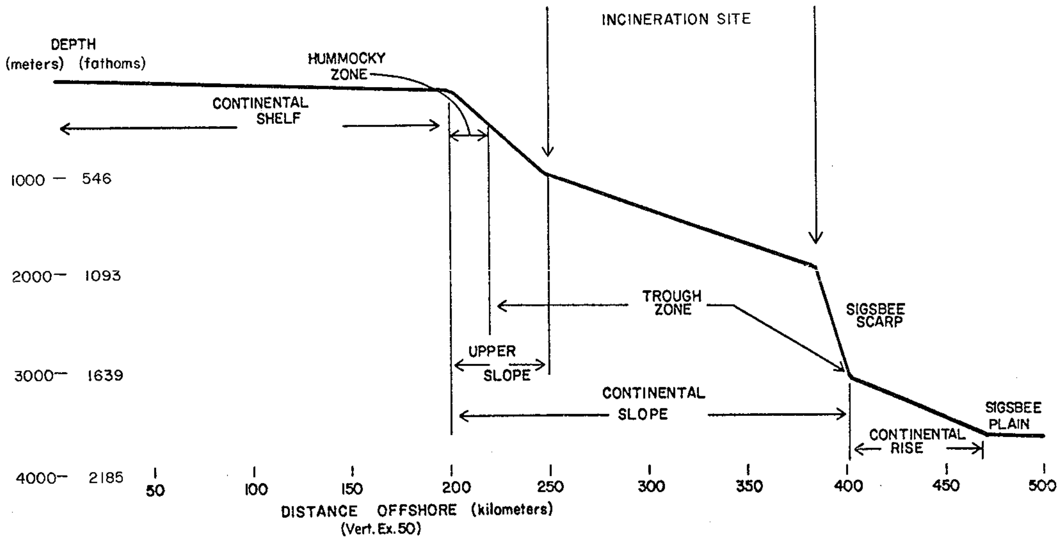


Figure G-4. Cross-section of the northern Gulf of Mexico. Bottom profile along the 94° meridian (western boundary of the incineration site); extracted from a map by Uchupi (1967).

graphy. To be sure, Gulf-floor relief was probably altered by erosion and deposition associated with lower stands of Pleistocene sea level (Watkins et al., 1975) and by the continuing process of submarine slumping but, as Ewing et al. (1958) suggest, the dominant source of sediments filling depressions on the upper slope enter the Gulf with Mississippi River flow.

A feature peculiar to the shelf break in the northwest Gulf is a series of prominent banks or topographic highs rising abruptly from the generally smooth, sediment-covered bottom (Parker & Curray, 1956). Several investigators have offered explanations for their origin, dating from Shepard (1937) who suggested that these banks may be related to salt-dome structures. Others have explained them on the basis of biothermal structures which have kept pace with changing sea levels (Stetson, 1953; Mathews, 1963). One of the more interesting and intensively studied of the banks is the West Flower Garden, a possible element of a discontinuous arc of reefal structures occupying the Gulf's southern and western continental shelves (Bright & Pequegnat, 1974; Edwards, 1971). It and the similar East Flower Garden Bank are capped by what are considered to be the northernmost thriving tropical shallow water coral reefs on the eastern coast of North America; however, they are located 133 km north of the proposed incineration site.

LOCATION OF THE GULF INCINERATION SITE

The location of the incineration site is centered 355 km east-northeast of the Texas-Mexico border, 315 km south-southeast of Galveston, Texas, and 350 km south of Cameron, Louisiana. The site occupies an area of approximately 4900 square kilometers in the western terrigenous province of the Gulf. Water depths within the perimeter of the site range from near 1100 m to more than 1835 m and the seafloor gradient for this portion of the outer continental slope is somewhat uniform and gradual. The site is seaward of Gealy's "hummocky zone" in an area of relatively low relief where the surface is cut by steep-sided troughs that extend down-slope. Alaminos Canyon and Ida Greene Canyon, probable extreme components of the trough zone, flank the area of the incineration site on the west and the east, respectively.

DETAILED DESCRIPTION OF GULF OF MEXICO BOTTOM SEDIMENTS

RECENT SEDIMENTOLOGY

The Recent and near-Recent sediments of the Gulf of Mexico have been extensively studied by Stetson (1953), Greenman and LeBlanc (1956), Ewing et al. (1958), Shepard et al. (1960) and other investigators. As a result of these studies Phleger (1967) implies that the distribution of surface sediments in this region is better known for any comparable marine area in the world. This is essentially true for the embayments, nearshore waters, and shallow shelf waters of the Gulf. In reality, however, the geology of the offshore area of Texas and Louisiana is perhaps better known at the subsurface level than at the surface due to the enormous amount of work with precision echo sounding and in refraction seismic, gravity, and magnetic surveying by such investigators as Antoine, Ewing, Bryant, Uchupi, Moore and Lehner (previously cited). Appelbaum (1972) found that comprehensive sedimentological studies in the northwestern Gulf have been restricted to the continental shelf and abyssal plain, with limited study on the upper continental slope.

One of the deeper-water studies was that of Curray's investigations of Holocene sediments of the northwest Gulf as a part of American Petroleum Institute Project 51 (Curray, 1960). While utilizing samples from depths shallower than 190 meters, he compiled most of what was known of the surficial sediments and history of Holocene deposition. Bouma (1972) has updated the subject of sediment distribution in the Gulf; however, his data were obtained from average content within the upper 7 m of the sediment column. He describes the sediments from the outer shelf and deeper environments as primarily clay with variable amounts of silt (i.e., pelite - a combination of all size fractions in the clay and silt range). To show variation in sediment types, a clayey pelite is defined as a pelite containing 75% or more clay and a silty pelite as one with 25% or more silt. In Fig. G-5, the 75% clay isopleth indicates clayey and silty pelites, while the numbers represent average clay percentage for the various stations.

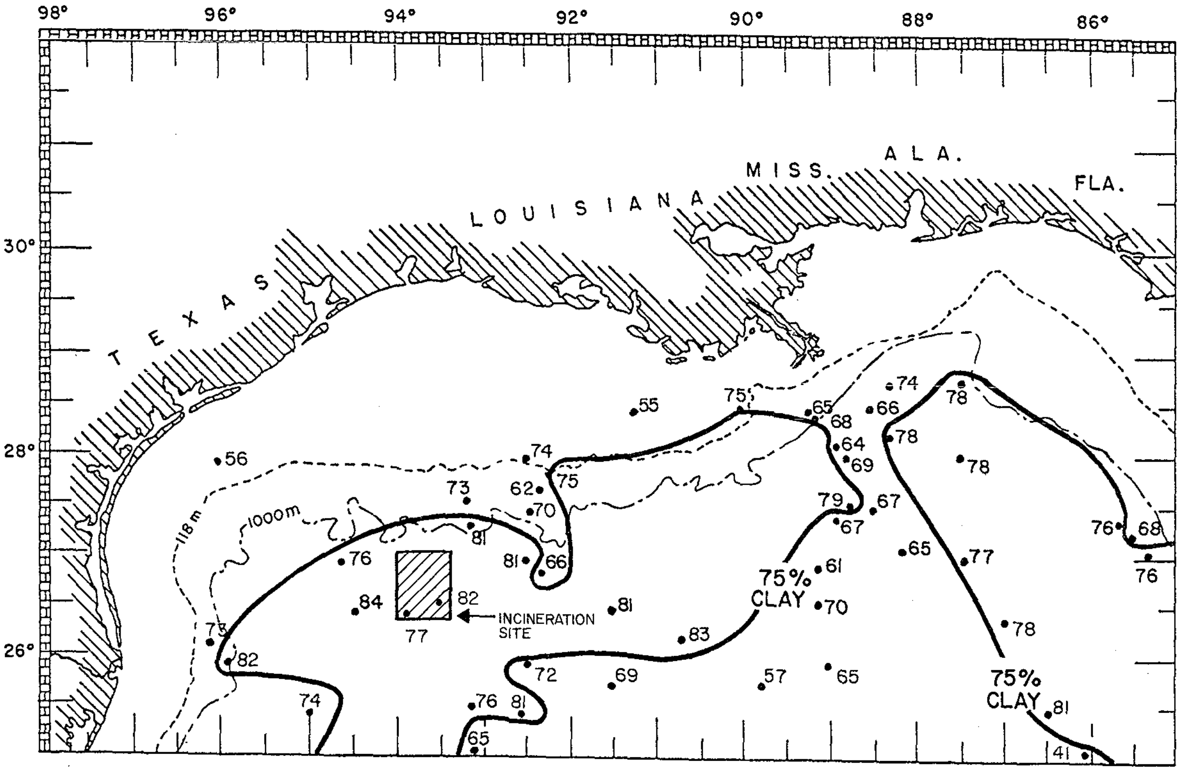


Fig. G-5. Clay content map of northern Gulf of Mexico (from Bouma, 1972).

There is essentially no deposition of detrital sediment from the continent in the relict areas at the present time. This can be shown on the basis of foraminifera ratios (Phleger, 1960) and by the presence of shallow water sediments at the surface. The fact that detrital sediments are being deposited on the inner continental shelf can be substantiated by the nature of the material, the presence of pure, indigenous faunas and foraminifera population ratios. This suggests that sediment being supplied to the Gulf does not reach the outer shelf (all sediment may be deposited on the inner shelf), or if it does, it is being deposited seaward from there. Off the Mississippi Delta, material coarser than fine silt is transported in small amounts across the entire width of the shelf but the sites of active deposition are almost impossible to distinguish. Phleger (1967) speculates that detrital sediments from the land are being deposited at the present time on the continental slope and in the basin (see Fig. G-6), but is not certain of such activity or the mechanics and amount of this supply. In general, it is felt that the major source of sediment for the western Gulf is Mississippi River discharge, which Drennan (1968) found to have an approximate average between 5000m^3/sec. (late fall) and 23,000m^3/sec. in the spring. The sedimentary products of weathering are also supplied by the Rio Grande and many medium and small streams in conjunction with some material being contributed by marine erosion of the coastal zone. During transport to and within the basin the materials are mixed and sorted by a variety of agents before final deposition.

Appelbaum (1972) concluded that the Brazos, Colorado and Mississippi Rivers were the main supplies of sand size sediment to his study area on the upper continental slope. This area is very proximal to the incineration site, being bounded on the east and west by 94° and 94°30'W longitude, and on the north and south by 28° and 27°30'N latitude. His evidence for a mixing of varied sources stemmed from heavy mineral grain counts when compared to previous patterns of northern Gulf assemblages (van Andel and Poole, 1960) with corroboration being afforded through clay mineral analyses.

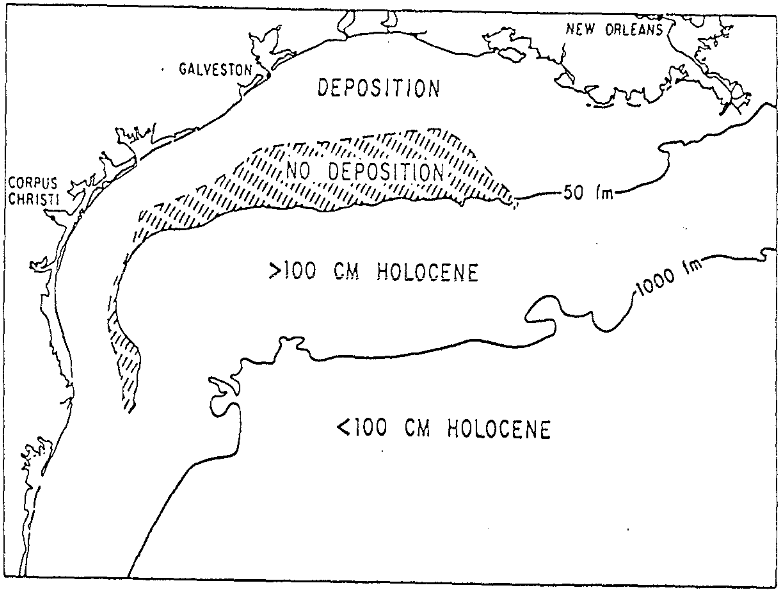


Fig. G-6. Generalized relative sedimentation rates in offshore Gulf of Mexico (from Phleger, 1967).

HEAVY MINERAL STUDIES

Work on the heavy minerals of the northwest Gulf began with Bullard's examination of the heavy mineral suites of Texas rivers and beach sands in order to determine their source areas (Bullard, 1942). He concluded that each of the principal Texas rivers carries a distinct suite of heavy minerals dependent upon the nature of the source rock of the various drainage basins. Goldstein (1942) divided the northern Gulf of Mexico into four distinct sedimentary provinces on the basis of heavy mineral suites. These divisions are the East Gulf province, the Mississippi province, the Western province and the Rio Grande province. In the northwest Gulf, the Mississippi and Western provinces are differentiated by a lower percentage of pyroxene and a higher percentage of leucoxene in the Western province. The Rio Grande province is distinguished from the Western by a higher percentage of pyroxene and the presence of basaltic hornblende.

van Andel (1960) pointed out that with the exception of the Colorado River sedimentary suite, the sediments of rivers emptying into the northwest Gulf are orthoquartzitic and are derived mainly from the Cretaceous and Tertiary margins of the Gulf Coast basin. He found modification of the sand in the basin only slight except for the removal of pyroxenes from Rio Grande and Mississippi sands exposed during the Pleistocene. van Andel and Poole (1960) examined the heavy minerals shoreward of the 110-meter contour in order to determine sand sources. In addition to Goldstein's provinces, these authors added a Texas coast province characterized by abundant tourmaline with zircon and some epidote. They attributed the Western province assemblage to mixing during the early Holocene transgression. In their study of the continental rise, slope, and abyssal plain, Davies and Facundus (1971) found no significant alteration of their heavy mineral assemblages taking place during basinward transport of the sediments. As a result, each assemblage enables investigators to trace the mineral province. The proposed site region receives heavy minerals from both the Central Texas Province and the Mississippi Province, the latter providing the greater quantity (see Fig. G -7).

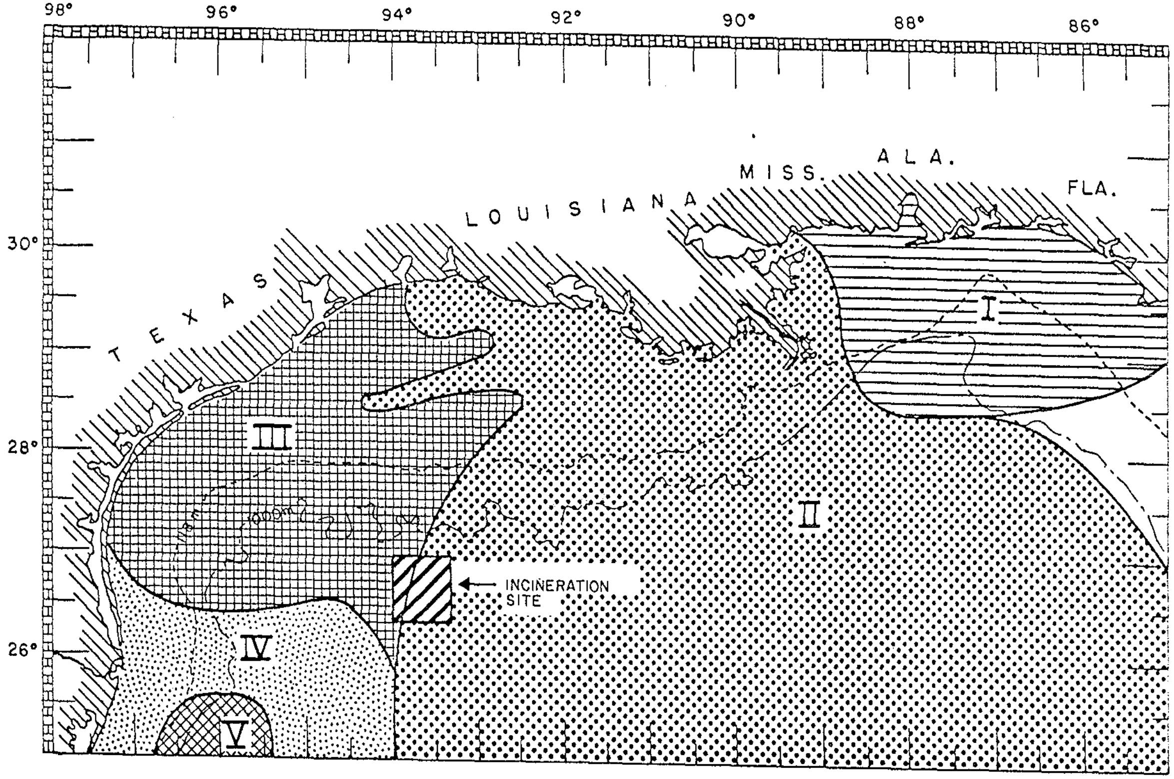


Fig. G-7. Areal distribution of heavy mineral provinces in the Gulf of Mexico, according to Davies and Facundus (1971). I - East Gulf Province; II - Mississippi Province; III - Central Texas Province; IV - Rio Grande Province; V - Mexican Province.

SEDIMENT CHARACTER AND DISTRIBUTION

Analyses of the sediment from recent core stations in the general slope region yielded data concerning grain size and percentage composition for the upper 5-7 cm of core section (TerEco, 1976). These determinations were obtained by means of wet sieve and settling velocity procedures. Sand was considered to be any material greater than 0.062 mm in size, regardless of being terrestrial or biogenous (i.e. foraminifera tests, mollusk shells or coral debris) in origin. Later microscopic examination revealed the presence of carbonate sand and almost complete absence of quartz sand in the coarse fraction obtained from the core samples. Only the material cored from one station yielded any quartz sand (very fine in size); however, approximately 99% of its sand-sized material was biogenically related, mainly coral debris. Figure G-8 shows the thickness of Globigerina ooze at the site and Figure G-9 is a carbonate percentage map. No authigenic grains, glauconite, were noted in any of the samples.

Sixteen core stations were occupied within or near the depth range of the site area. Those samples revealed almost equal distribution of the finer sediments - 38% of the cores were predominantly clay and 38% were predominantly silt. Sand, silt and clay undifferentiated accounted for 18% of the samples. These findings are consistent and agree with van Andel and Curray (1960) who described the recent facies of the Gulf continental slope as homogeneous clays and silty clays, some having a high percentage of planktonic foraminifera.

A map of sediment distribution in the northern Gulf was constructed by Grady (1970) for the National Marine Fisheries Service. In general, his chart shows sediment types from the shoreline to depths ranging between 100 and 1000 meters for that area north of the 24th parallel. It is notable that several of the above core stations are located within the limits of his map and that comparisons reveal almost total agreement with his general sediment type for that locale. With this is mind and using Grady's work as a base, a map of predominant sediment types has

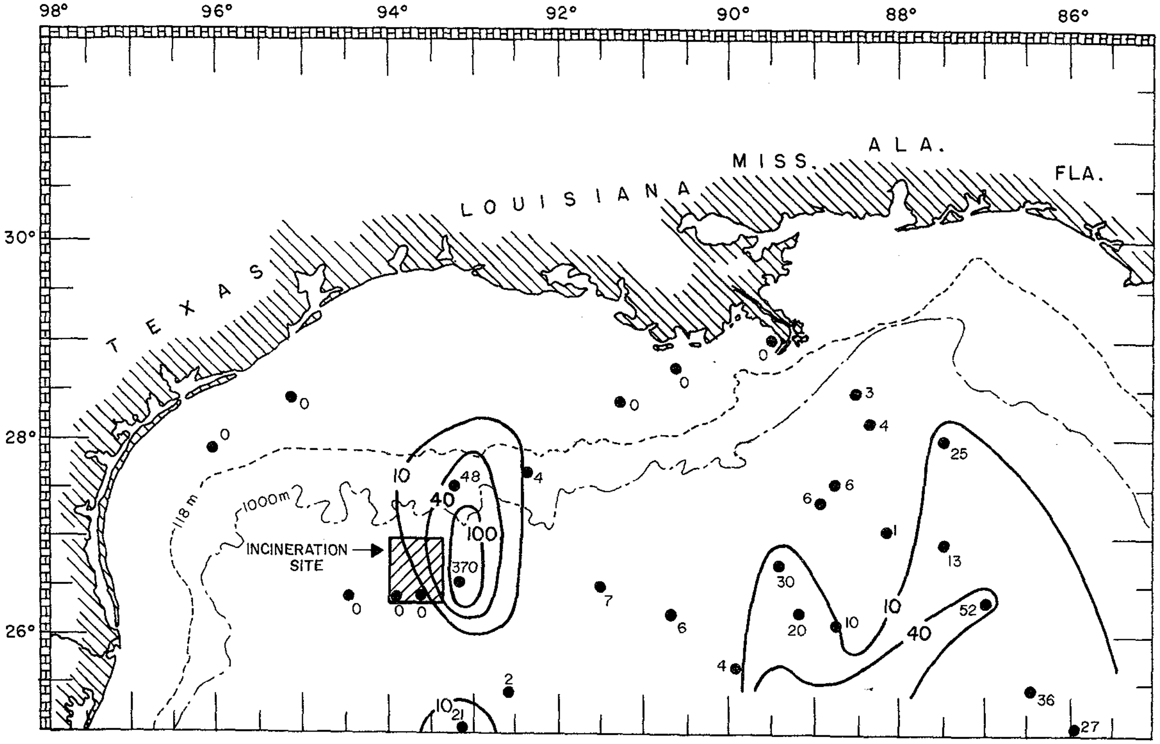


Fig. G-8. Top *Globigerina* ooze isopach map of the Gulf of Mexico (from Bouma, 1972). Contours indicate 10, 40, and 100 centimeters.

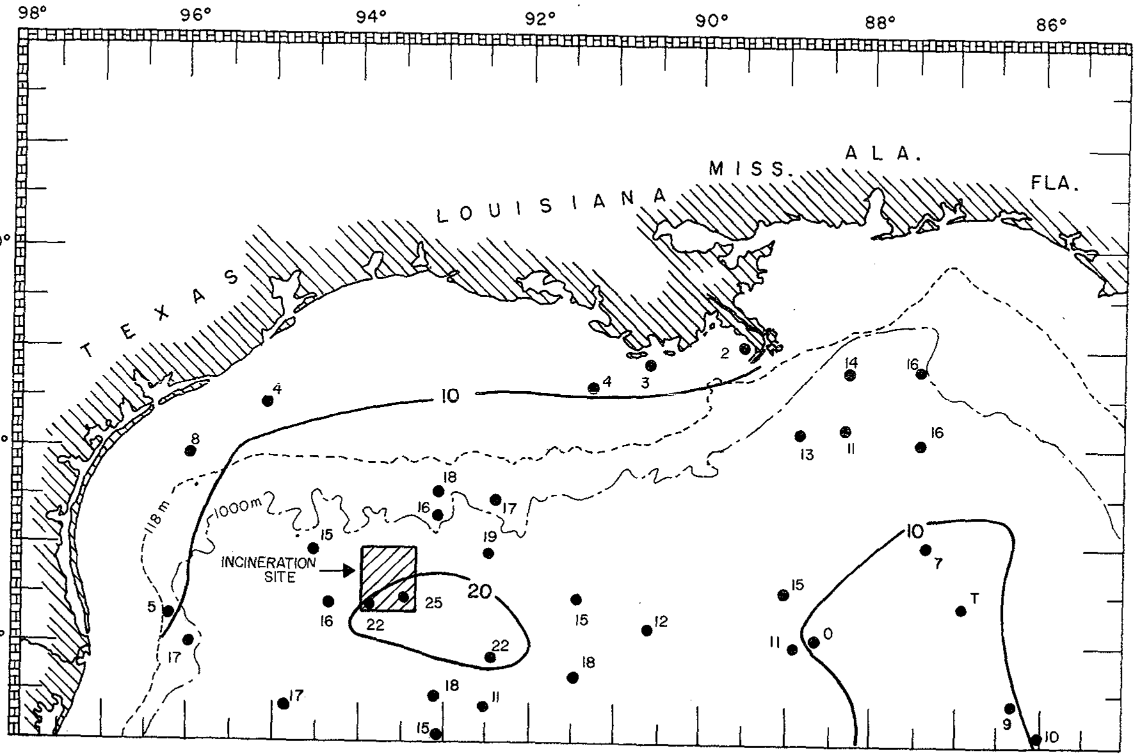


Fig. G-9. Carbonate percentage map of the Gulf of Mexico, excluding the top *Globigerina* ooze (from Bouma, 1972).

been constructed by means of interpolation from his control area seaward to the cited core stations. This compilation is designated as Fig. G-10. One should be aware that some extrapolation of data was required between 89° and 92° W longitudes; however, literature related to the Mississippi Cone (Huang and Goodell, 1970; Willhelm and Ewing, 1972) indicate the predominant sediment of that area to be foraminiferal clay.

BOTTOM SEDIMENTS AT THE INCINERATION SITE

Pelite covers most of the sea floor of the incineration site. More specifically, it would be considered as a clayey pelite since it contains 75% or more clay. A deviation from the pelite cover is found in the southwestern corner of the site where a patch of "clay-silt-sand undifferentiated" is situated. Larger sized sediment found there can possibly be accounted for by past influence of the Rio Grande River or by the fact that the Central Texas heavy mineral assemblage occupies that general region and abuts the more extensive Mississippi suite to the east. A major portion of the incineration site's bottom sediment contains heavy minerals from the Missippi Province and the remainder, approximately one-third of the total area, has those of the Central Texas Province.

Calcareous remains of pelagic foraminifera are mixed with the sediments and, for a major part of the deep Gulf, tend to mask other sediment types by means of a thin cover of <u>Globigerina</u> ooze. Within the perimeter of the incineration site, this cover ranges in thickness from less than 10 to more than 40 cm. The carbonate content of the sediment below the ooze cover averages between 14 and 25 percent.

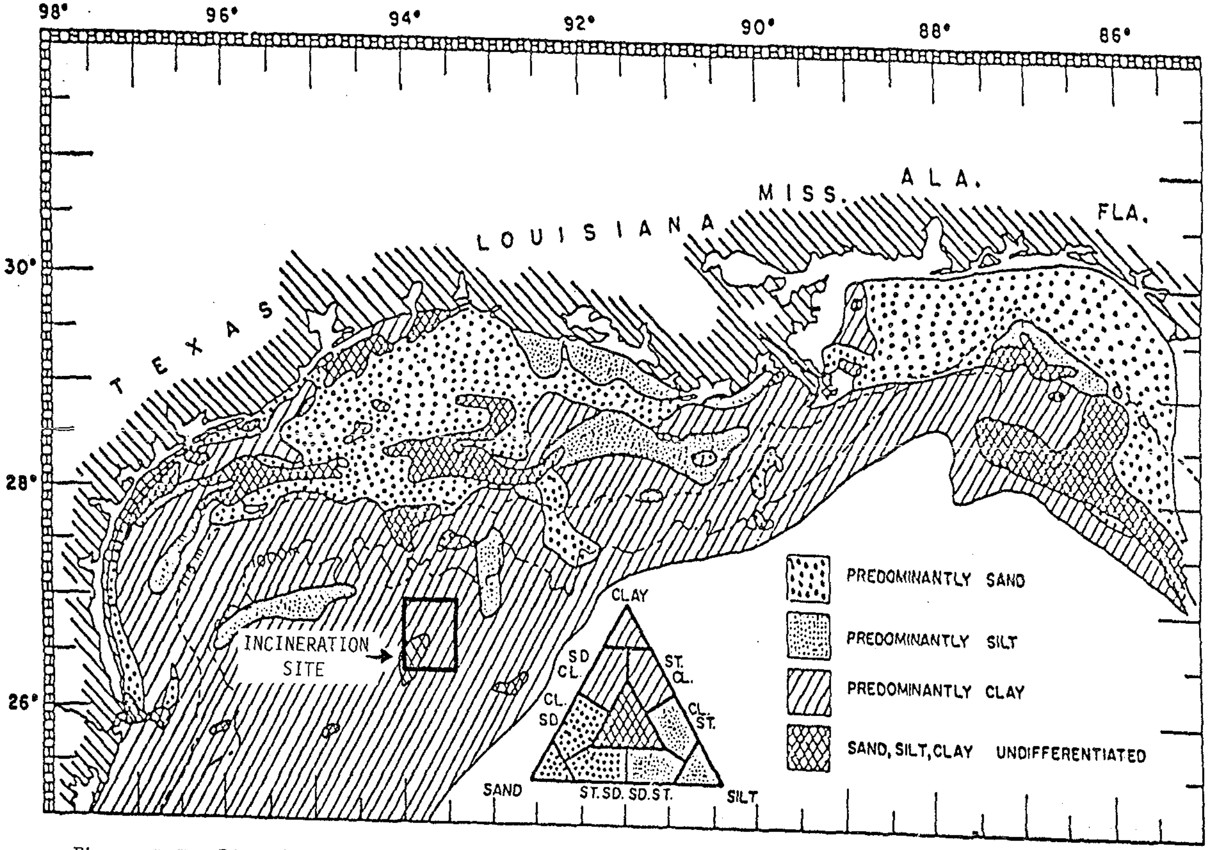


Figure G-10. Distribution of sediment types in the northern Gulf of Mexico (based in part on Grady, 1970; U.S.N.O.O., 1972; and unpublished data).

METEOROLOGIC ASPECTS

VISIBILITY

According to data received from the National Climatic Center for the two degree square bounded by 26°-28°N, 92°-94°W (Table G-1), the site has a very low frequency of poor visibility. The annual percent frequency of visibility less than 1 mile for the site is 0.23 compared with 1.0 for Corpus Christi, 0.9 for Galveston and 1.6 for Mobile (Brower et al., 1972). For visibility of less than 5 miles the annual percent frequency for the site is 2.6 compared with 3.7 for Corpus Christi, 3.4 for Galveston, and 4.7 for Mobile (Brower et al., 1972).

RELATIVE HUMIDITY

Relative humidity along the northern Gulf coast is high as a result of abundant rainfall and prevailing southeasterly winds, which have a long fetch over the warm waters of the Gulf of Mexico. This has been exemplified by Stone (1972) who shows that annual relative humidity is above 90% more than 50% of the time during the early morning hours at New Orleans. Further offshore, in the vicinity of the site, the relative humidity is much lower, i.e., relative humidity more than 90% occurs less than 15% of the time annually in the morning hours. Seasonally at the site, relative humidity tends to be higher during January-May and lowest during July-August. On a daily basis the site's relative humidity is lowest in the afternoon (Table G-2).

WINDS AND STORMS

Historically, winds at the incineration site are the calmest during July and August with average wind speeds of 7-10 knots (U.S. Navy Hydrographic Office, 1972). Wind speeds increase somewhat during September-October having average speeds of 10-12 knots. Wind speeds are highest in November-February averaging 13-15 knots. Winds tend to subside in March-June and by July-August they are back to their lowest average velocity.

Table G-1. Percent frequency of observations noting visibilities of <0.5, <1, and <5 miles for the 2° square bounded by 26°-28°N, 92°-94°W (from data furnished by NCC for square 62 of Marsden Square 82).

MONTH	VISIBILITY (% FREQUENCY)			OBS
	<0.5 MILE	<1 MILE	<5 MILE	
Jan.	0.5	0.5	4.5	441
Feb.	*	0.2	3.4	411
March	0.2	0.2	5.9	505
April	*	*	4.9	452
May	0.2	0.4	1.6	556
June	*	0.2	1.4	583
July	*	*	1.5	600
Aug.	*	*	1.3	688
Sept.	*	*	1.5	608
Oct.	0.6	0.6	1.8	622
Nov.	0.4	0.6	1.7	522
Dec.	*	*	1.6	561
ANN	0.16	0.23	2.6	

* Less than 0.05%

Table G-2. Percent frequency of relative humidity in the area of the site (from data furnished by the National Climatic Center, Asheville, N.C. for 5° square number 50 of Marsden Square 82).

MONTH	Hr,GMT	RELATIVE HUMIDITY CLASSES							OBS
		31-40	41-50	51-60	61-70	71-80	81-90	91-100	
JAN	00	.3	1.2	7.8	17.9	23.3	32.5	16.9	720
	06	.1	1.8	8.1	19.5	20.0	30.0	20.4	827
	12		2.2	8.1	16.8	21.5	35.2	16.3	731
	18	.2	2.9	12.0	16.0	20.0	34.6	14.1	865
FEB	00	.4	2.2	6.9	15.3	20.2	37.0	18.0	668
	06	.1	1.7	6.2	13.0	21.9	37.4	19.6	754
	12		.7	6.7	14.4	18.3	38.8	20.9	688
	18	.5	1.7	9.1	14.9	25.4	37.8	10.4	767
MAR	00	.1	3.9	10.0	15.0	17.3	35.8	17.7	693
	06	.5	3.1	7.9	13.7	15.2	34.4	25.2	834
	12	.4	4.4	8.4	13.8	18.2	33.3	21.3	726
	18	.5	4.1	13.2	15.7	22.5	34.3	9.4	848
APR	00	.3	1.6	7.9	14.5	19.9	43.1	12.7	692
	06	.3	1.0	6.6	11.6	13.1	42.7	24.5	773
	12	.1	1.2	6.2	13.2	15.1	42.4	21.8	682
	18		2.6	11.3	15.1	25.8	35.3	9.7	846
MAY	00	.2	1.4	7.2	12.9	33.1	32.8	12.5	650
	06	.1	.5	3.0	9.0	21.9	45.0	20.5	796
	12		.5	3.5	7.1	26.3	44.6	17.7	733
	18		1.8	7.1	18.6	35.9	28.1	8.4	835
JUN	00			1.5	19.7	49.3	23.6	5.9	785
	06		.1	.7	4.8	39.4	41.0	13.9	862
	12			.9	5.0	45.0	38.4	10.7	782
	18		.2	2.8	26.7	50.5	13.1	6.6	895
JUL	00		.2	2.0	35.9	46.6	12.6	2.7	889
	06			.3	10.0	61.4	21.2	7.1	901
	12			.3	11.4	62.5	20.1	5.4	902
	18		.4	3.8	47.8	36.6	7.7	3.8	1036

Table G-2 (continued)

MONTH	Hr,GMT	RELATIVE HUMIDITY CLASSES							OBS
		31-40	41-50	51-60	61-70	71-80	81-90	91-100	
AUG	00			3.2	30.7	45.9	15.3	4.9	874
	06		.1	.5	10.5	58.1	23.2	7.6	947
	12	.1	.1	.9	11.2	57.3	24.1	6.2	872
	18		.6	4.4	38.2	37.7	11.9	7.3	1019
SEP	00	.1	.5	2.8	20.5	47.2	21.5	7.4	811
	06		.1	2.2	10.0	46.5	29.6	11.4	909
	12	.1	.4	1.7	10.2	49.1	27.8	10.7	807
	18		.2	5.3	33.2	41.4	13.3	6.7	943
OCT	00	.1	1.2	9.0	20.1	38.2	24.2	7.2	752
	06	.1	.5	8.6	15.7	39.4	27.3	8.4	865
	12	.4	.8	8.6	16.7	36.1	28.0	9.3	830
	18	.4	2.7	13.9	25.3	32.4	18.3	6.9	925
NOV	00		.6	11.8	17.5	26.3	33.5	10.3	680
	06	.3	1.8	11.0	18.5	26.5	32.7	9.3	789
	12		1.3	8.8	17.7	24.4	35.2	12.5	753
	18	.5	3.5	12.0	22.3	27.3	26.3	8.1	849
DEC	00		2.8	12.1	20.5	23.2	30.8	10.6	708
	06	.1	2.5	11.0	19.7	22.5	31.7	12.3	836
	12	.3	2.3	9.8	21.9	22.4	28.8	14.5	732
	18	.6	4.0	15.2	20.0	22.2	28.1	9.8	877

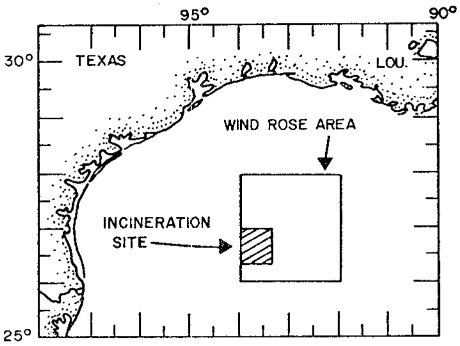
In addition to the average wind speeds the table below taken from Marcus (1973), gives percentile distribution of observed wind speed (in knots) by month for National Climatic Center Subregion 34; the incineration site is in the northwestern part of this Subregion. The table reflects only observed data; thus wind speeds reached in tropical storms and hurricanes are generally not reflected since mariners try to avoid these conditions. Tropical storms and hurricanes will be addressed later. This table is to be read as per the following example: 25% of the wind speed observations in January were equal to or less than 9 knots.

Observed Wind Speed in NCC Subregion 34

Extremes & Percentiles	J	F	M	A	M	J	J	A	S	O	N	D
Min.	0	0	0	0	0	0	0	0	0	0	0	0
01	0	0	0	0	0	0	0	0	0	0	0	0
05	4	4	5	5	3	1	0	0	3	4	4	4
25	9	9	9	9	7	5	5	4	7	8	8	8
50	14	14	13	11	10	10	9	11	12	13	13	13
75	20	19	18	18	16	14	13	12	17	18	18	18
95	27	25	25	24	21	19	17	16	24	25	25	25
99	35	35	30	27	25	25	21	22	40	40	31	33
Max.	40	46	37	35	30	40	28	30	60	37	45	40

In the region of the incineration site, winds throughtout the year prevail from the eastern quadrant; however, strong northerly components are evident from November through February (Figure G-11).

Abnormally high speed winds may occur in the incineration site during winter (as northers) or late summer (as tropical storms or hurricanes). A norther is a strong cold wind coming from the northeast-northwest that may extend into the Gulf area between November and April. This cold air mass is usually preceded by a warm and cloudy or rainy spell with southerly winds. From one to six northers are likely to be severe over the Gulf during individual years. Northers generally last about a day and a half, but severe storms may endure for three or four days (Brower et al., 1972).



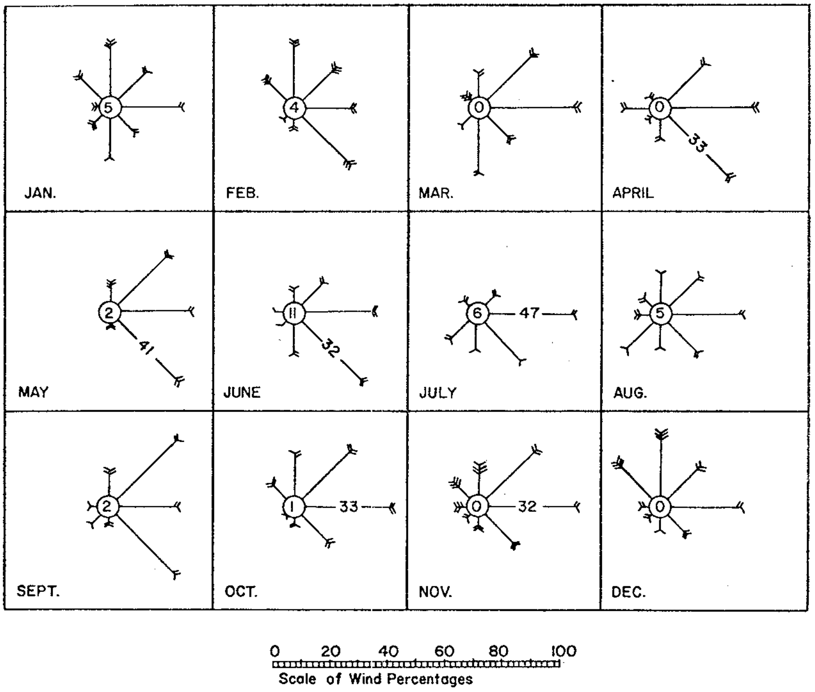


Fig. G-11. Wind roses illustrating wind speed and direction for the designated region. The arrows fly with the wind. Length of arrow represents the percentage of observations during the month that wind was from that direction. When arrow is too long to be shown, the percentage is indicated by numerals. The number of feathers shows the average Beaufort wind force. The number within the circle represents percentage of calm and variable winds (U.S. Navy Hydrographic Office, 1972).

Tropical storms (winds of 34 to 63 knots) and hurricanes (winds of 64 knots or higher) are more active in the Gulf during the months of August and September. The great majority of tropical storms and hurricanes in the area of the site come from the southeastern quadrant and move at a mean speed of approximately 10 knots.

The number of tropical storms and hurricanes expected to occur in a 100 year period within the 2 1/2° square subregion enclosing the incineration site is given by Marcus (1973). These data as well as the data on contiguous 2 1/2° square subregions are given in Table G-3; however, in summary, 43 tropical storms and 26 hurricanes are expected to occur within or very near the incineration site in a 100 year period.

Table G-3. Number of tropical storm (winds 34 to 63 kt) and hurricane (winds 64 kt) occurrences expected in a 100 year period for 2.5° squares in the Western Gulf of Mexico. The Gulf incineration site is within outlined area (from Marcus, 1973).

	97.5W to 95.0W		95.0W to 92.5W		92.5 to 90.0W	
	Trop.Stms	Hurrcns	Trop.Stms	Hurrcns	Trop.Stms	Hurrcns
30.0N to 27.5N						
Aug and Sept	10	10	18	15	28	15
Oct to July	18	5	14	6	23	8
Total	28	16	32	21	51	23
27.5N to 25.0N						
Aug and Sept	13	17	23	18	32	18
Oct to July	15	11	20	8	31	11
Total	28	28	43	26	63	29
25.0N to 22.5N						
Aug and Sept	21	11	24	11	27	15
Oct to July	17	8	18	10	25	8
Total	38	19	42	21	52	23

PHYSICAL AND CHEMICAL PROPERTIES OF THE WATER

The incineration site is located in oceanic waters and the physio-chemical parameters of the site's water column are typical of that found in the west central Gulf. The site's water column, as well as that of the west central Gulf, is vertically layered with five recognized water masses which are distinguishable by distinct values or gradients in specific parameters. Of these five layers the uppermost Surface Mixed Layer undergoes greater seasonal changes in physio-chemical parameters than do the deeper water masses. However, the seasonal changes in the site's Surface Mixed Layer are muted in comparison to waters closer to shore. Wind, waves, and currents prevail to the west northwest with the calmer period of the year being June-August.

CURRENT PATTERNS

GENERAL

Several attempts have been made from time to time to describe the general circulation of surface waters in the Gulf of Mexico (Nowlin 1971 and 1972; Leipper, 1970; Ichiye, 1962). From these studies it can be seen that the flow in the eastern Gulf is dominated, especially in late spring and summer by the Loop Current; water enters through Yucatan Strait as the Yucatan Current and flows in a clockwise loop which extends well north into the Gulf (varying considerably from year to year) and exits principally via the Florida Straits. In late summer or fall large rings of circulating water (an eddy) may separate from the Loop and generally move westward taking perhaps several months or a year before they lose their integrity (Leipper, 1970; Cochrane, 1972). So far as is known now, the flow of surface water in the western Gulf is somewhat less dynamic but is thought to be more predictable than that of the eastern Gulf (Nowlin, 1972). Essentially there are three sizable gyres from north to south in the western Gulf. Only the central and northern ones are of concern in this study. In winter a large clockwise (anti-cyclonic) cell is centered over the west-central Gulf. Obviously its southern limb will be flowing westward and its northern limb will flow northeastward where it veers into and reinforces the southern limb of a counter-clockwise cell. As it continues to move, it comes to be flanked by a southwestward current flowing along the outer Texas Louisiana shelf.

CURRENT PATTERNS OF THE INCINERATION SITE

The flow of surface water over the incineration site varies only a small amount seasonally (Fig. G-12). The prevailing current is to the west or northwest. Data of the U.S. Naval Oceanographic Office (1972) for the area around the site show that during January-March currents to the northeast quadrant occur with almost equal frequency as those to the western quadrant. Currents during the remainder of the year (April-December) show a strong affinity for westward flow. Current speed within the area is within a moderate range of 0.6-0.9 knots; seasonal as well as an annual current speed summaries are given in Table G-4.

Only a very small amount of data has been published on the Gulf's subsurface currents. Moore (1973) reported that currents ranging in speed from 0.1 to 0.6 knots move along or obliquely across the upper continental slope of the northwestern Gulf (Fig. G-12). His data show subsurface currents and countercurrents with shears at depths of approximately 120 m and 450 m. It is important to note that Moore (1973) believes that these over-the-slope currents are not regulated by tidal movements. In addition, Moore (1970) showed that submarine currents of velocities ranging from 0.1 to 0.6 knots are able to move medium to coarse sands (0.7 to 4.0 mm).

WATER MASSES

The principal inflow of water into the Gulf of Mexico is from the Caribbean Sea through the Yucatan Strait. These waters are a mixture of South Atlantic water (transported northwestward by the Guiana and Equatorial

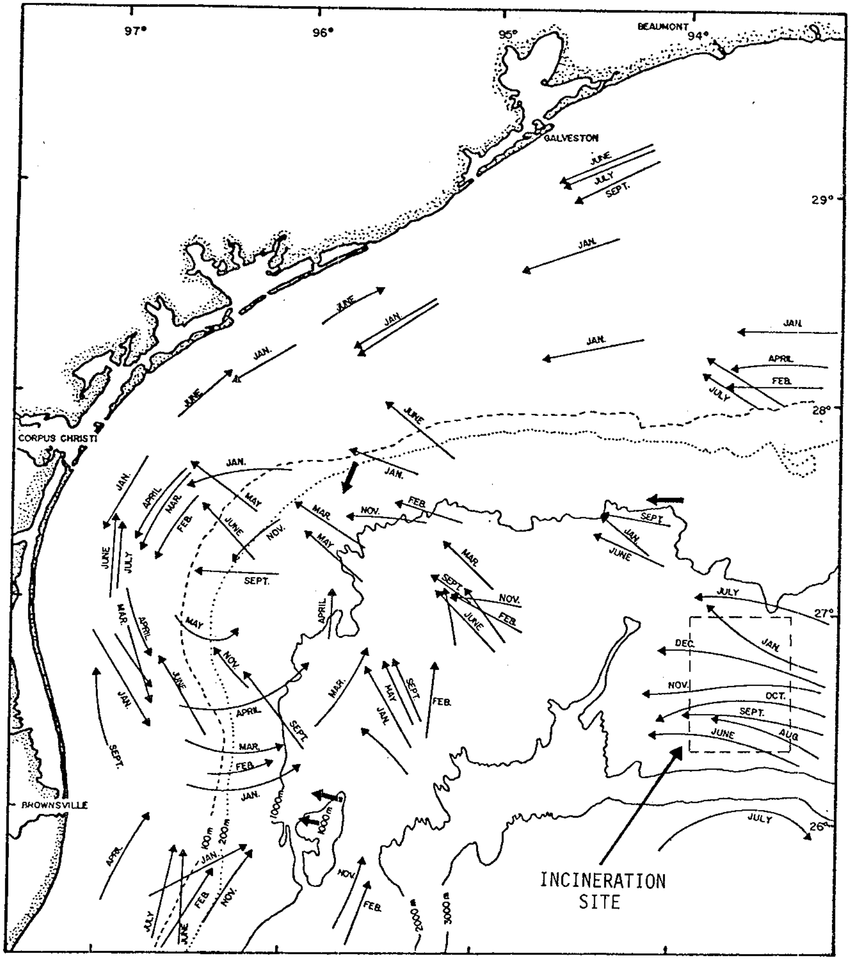


Fig. G-12. Possible patterns of flow of surface waters in the western part of the northern Gulf shown by fine arrows on a monthly basis. Heavy arrows show submarine flow (compiled from U.S. Hydrographic Office, 1972 and Moore, 1973).

Table G-4. Surface current speed and direction for the region of the incineration site (from U.S. Naval Oceanographic Office, 1972).

JAN - MAR

No. of Obs.-1896

Direction	Frequency (%)	Ave. Speed (kt)
N	12	0.6
NE	12	0.6
E	16	0.7
SE	9	0.6
S	7	0.6
SW	5	0.7
W	20	0.7
NW	14	0.7
Calm	5	

APR - JUNE

No. of Obs.-5151

Direction	Frequency (%)	Ave. Speed (kt)
N	6	0.6
NE	6	0.6
E	7	0.6
SE	5	0.6
S	4	0.5
SW	5	0.6
W	33	0.9
NW	28	0.9
Calm	9	

JULY - SEPT

No. of Obs.-4447

Direction	Frequency (%)	Ave. Speed (kt)
N	10	0.6
NE	7	0.6
E	11	0.6
SE	8	0.6
S	4	0.6
SW	7	0.6
W	27	0.8
NW	17	0.8
Calm	9	

OCT - DEC

No. of Obs.-8554

Direction	Frequency (%)	Ave. Speed (kt)
N	7	0.6
NE	6	0.6
E	8	0.6
SE	7	0.6
S	5	0.5
SW	6	0.6
W	31	0.8
NW	20	0.8
Calm	10	

Current Speed Summary-All Directions

No. of Obs.- 20048

Current Speed (kt)	Percent
Calm	8
0.1-0.9	65
1.0-1.9	23
2.0-2.9	4

current systems) with North Atlantic water (from the west Sargasso Sea). The ratio of South Atlantic to North Atlantic water has been estimated to be between 1:4 and 1:2 (Harding and Nowlin, 1966). Most of the outflowing water passes through the Florida Straits into the North Atlantic.

Five water masses are recognized in the Gulf and all occur within the site's water column. These water masses are vertically layered as follows: (1) Surface Mixed Layer, (2) Subtropical Underwater, (3) Oxygen Minimum Layer, (4) Subantarctic Intermediate Water, and (5) Gulf Basin Water. Each of these water masses can be distinguished in the Gulf by distinct values, gradients, or relative maxima or minima in specific parameters. In Fig. G-13 are plotted temperature, salinity, and oxygen as functions of depth for a March hydrographic station taken just south of the incineration site. Approximate water mass depth ranges for the five water masses are also shown in Fig. G-13. The distinguishing characteristics given below for each water mass were taken from various sources - Harding and Nowlin, 1966; Nowlin, 1971, 1972; Wüst, 1964.

Surface Mixed Layer (SML) - generally characterized as the upper isothermal layer with temperature depending on the heat budget and by a salinity distribution depending on evaporation minus precipitation, runoff, and the horizontal advection of currents. Depth of SML, shown in Fig. G-13 is approximately 75 meters.

Subtropical Underwater (SU) - characterized by an intermediate maximum of salinity in depths between 50-20 meters. Fig. G-14 gives the depth distribution of the core of the SU. The source of the SU in the Caribbean and Gulf is probably from the tropical North Atlantic at 20° - 25°N, 30° - 50°W.

Oxygen Minimum Layer (OML) - characterized by minimum oxygen values within depths of approximately 300-600 meters. The OML is not associated with salinity or temperature extremes. The Gulf OML is clearly continuous with that of the Caribbean. Fig. G-13 shows dissolved oxygen that is typical for the site.

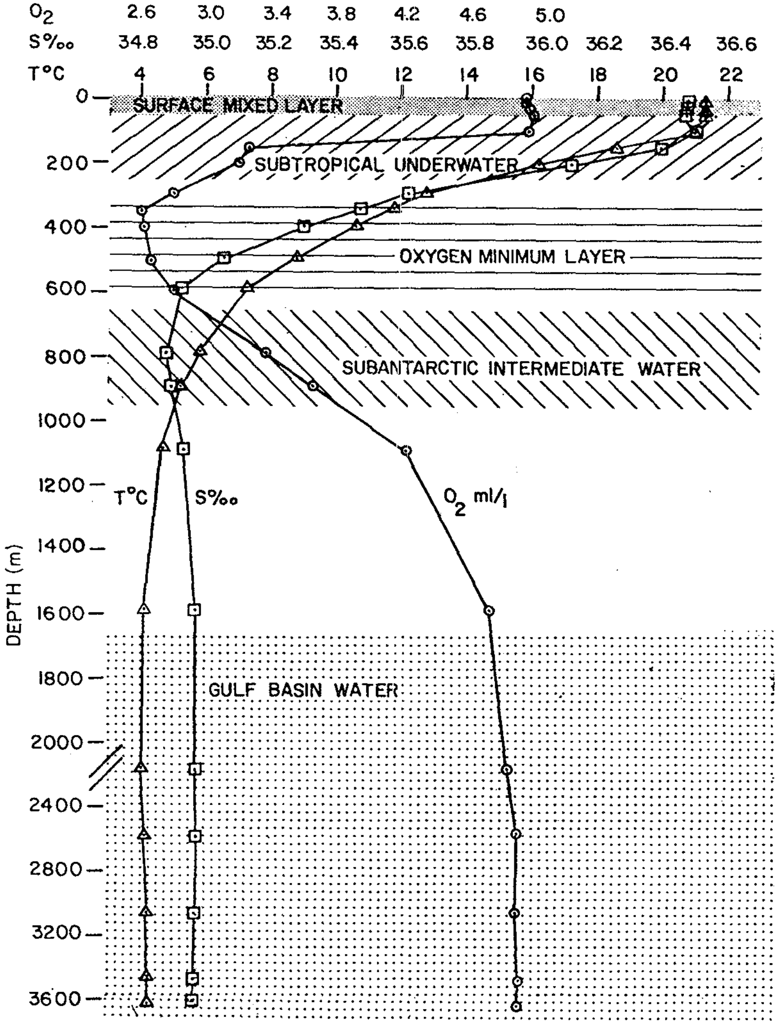


Fig. G-13. Physical characteristics and water mass designations from a west-central Gulf hydrographic station taken just south of the incineration site (25°09'N, 94°11'W; 15 March 1968).

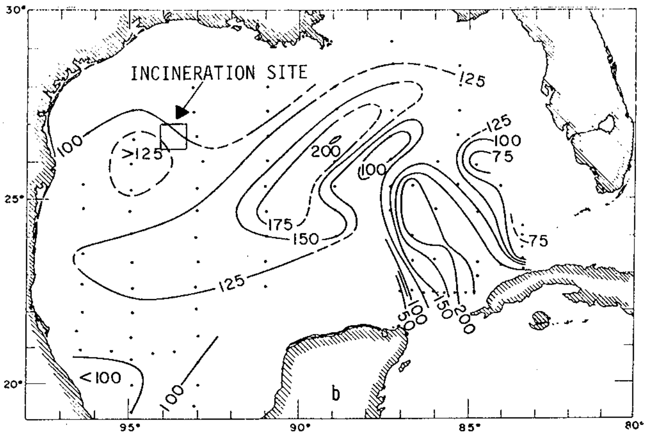


Fig. G-14. Core depth in meters of salinity maximum of the Subtropical under water (after Nowlin, 1972) .

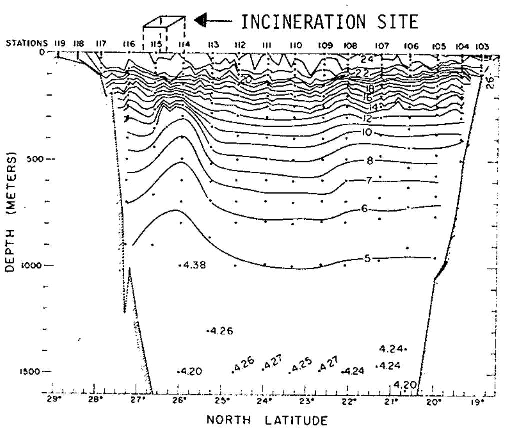


Fig. G-15. Temperature (°C) along the line shown in Fig. G-16. Note position of site next to station 115 (after Nowlin, 1972).

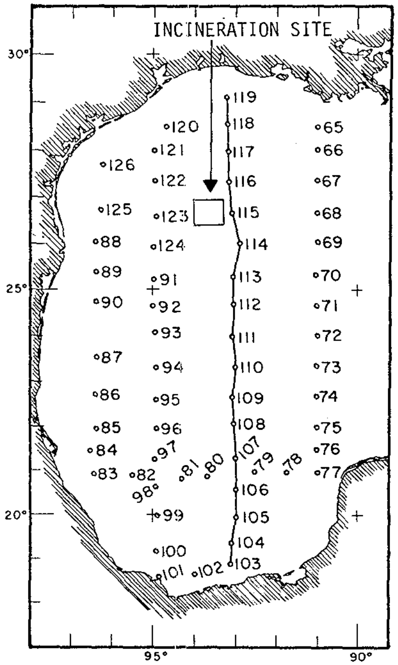


Fig. G-16. West Gulf stations occupied in February-March, 1962 by R.V. Hidalgo. Line indicates vertical section discussed in text (after Nowlin, 1972).

Subantarctic Intermediate Water (SIW) - characterized in the Gulf by a salinity minimum of 34.86-34.89 ppt at depths between 550-900 meters. This water mass has its origin at the Antarctic Convergence where cold, low salinity water sinks and spreads to the north. By the time it reaches the proposed site in the northwestern Gulf its salinity has increased to 34.88-34.89 ppt due to mixing that accompanies horizontal spreading. Calculations show the percentage composition of Subantarctic water in the core to be less than 5% at the Yucatan Strait and only some 1-2% in the western Gulf. A suggestion has been made to label this portion of the Gulf water mass "Remnant of the Subantarctic Intermediate Water."

Gulf Basin Water (GBW) - defined as those Gulf waters below 1650-1900 meters (estimate of Yucatan still depth). Since water depths at the incineration site range from near 1100 m to approximately 1835 m, the bottom is bathed by SIW-GBW transitional waters and GBW. Typical temperature, salinity, and oxygen values for these waters are shown in Fig. G-13.

SEA AND AIR TEMPERATURE

Throughout the year, variations in shelf surface temperature closely follow those of coastal air temperature; however, farther offshore in the vicinity of the site, surface temperature corresponds with air temperature in the spring and summer, but deviates somewhat in the fall and winter. This seasonal relationship between surface temperature and air temperature for the incineration site is given in Table G-5. Probable vertical distribution of isotherms during March for the incineration site is given in cross-section and is shown in Figures G-15 and G-16. From the table mentioned above it can be seen that the annual variation in average monthly surface temperature is some 10°C. Data of Etter and Cochrane (1975) and TerEco (1976) indicate that at a depth of 150 m the difference in annual temperature extremes is some ± 3°C. The difference in temperature extremes is approximately ± 1.5°C at 500 m, ± 1°C at 750 m, ± 0.5°C at 900 m, and less variation below the latter depth.

Table G-5. Average monthly sea surface and air temperatures for 5° square (25°-30°N, 90°-95°W) number 50 of Marsden Square number 82 (taken from data furnished by the National Climatic Center, Asheville, N.C.).

	Sea Surface	Air
Jan	20.8	18.4
Feb	20.6	19.0
Mar	20.9	19.8
Apr	22.2	22.0
May	25.3	25.3
Jun	28.1	27.9
Jul	29.6	29.0
Aug	29.8	29.1
Sep	29.0	28.0
Oct	27.3	25.3
Nov	24.4	21.3
Dec	22.2	19.3

SALINITY

Over the site the salinity of the surface waters is generally within the range of 36.0 - 36.4 ppt (Nowlin and McLellan, 1967). Surface salinities may depart from this range since lower values (river influenced) have been detected in the Gulf as far south as the site; however, their influence is limited only to the upper part of the Mixed Layer (Abbott and Bright, 1975). In the vicinity of the site, vertical difference in salinity is only about 1.5 ppt from the surface to the bottom (Fig. G-17).

Approximately 80 surface samples were collected at the site during the October-December, 1974 incinerations of organochlorine wastes. Except for one sample, 37.0 ppt, all were in the range of 35.9 - 36.4 ppt.

DISSOLVED OXYGEN

In the Surface Mixed Layer, dissolved oxygen concentrations are fairly uniform and tend to be at saturation values. If the upper part of the water column is relatively stable (little mixing), a subsurface maximum

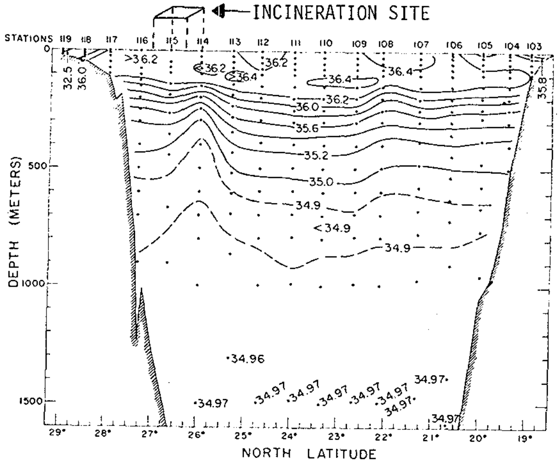


Fig. G-17. Salinity (ppt) along line shown in Fig. G-16. Note position of site next to station 115 (after Nowlin, 1972).

in dissolved oxygen concentration is frequently present somewhere in the first 50 m as a result of oxygen production by photosynthesis. Below the photosynthetic zone, oxidation and respiration tend to reduce the dissolved oxygen content. This process contributes to the formation of the oxygen minimum layer. The degree to which this core of low dissolved oxygen is depleted depends mainly on (1) its original dissolved oxygen content at formation, (2) the amount of oxidizable matter within the layer, and (3) its residence time. The Gulf's Oxygen Minimum Layer is derived primarily from the outside and enters the Gulf via the Yucatan Strait (Wüst, 1964). This entering layer, with a dissolved oxygen content of approximately 2.6 ml/l, spreads northward and becomes contiguous with the sediment along the slope. According to Nowlin (1972) the core of the oxygen minimum layer in the vicinity of the site is at a depth of around 250 m and has a dissolved oxygen content of slightly less than 2.6 ml/l (see Figs. G-13, G-18 and G-19).

ACIDITY AND ALKALINITY

The definition of pH is given by the following equation: $pH = -\log (H^+)$. The term alkalinity, as used by oceanographers, is defined as the number of milli-equivalents of hydrogen ion necessary to titrate the anions of weak acids in one liter of seawater. Unfortunately this usage of the term alkalinity is confusing because chemists have long used the same term to describe the hydroxyl ion concentration. Since the hydrogen ion concentration in sea water is involved in numerous equilibria, local, seasonal, and diurnal variations are often found. For example, one of the many factors on which pH is dependent is the amount of dissolved CO_2, which in turn depends on photosynthetic activity and thus on the amount of solar radiation. Therefore, in the assessment of environmental perturbations using pH measurements, it is necessary to have controls.

During the October-December 1974 monitoring of the incineration of organochlorine waste approximately 185 pH samples and controls were analyzed from the incineration site. Except for one sample (pH 8.05) all were within the range of pH 8.2-8.4. In addition, diurnal varia-

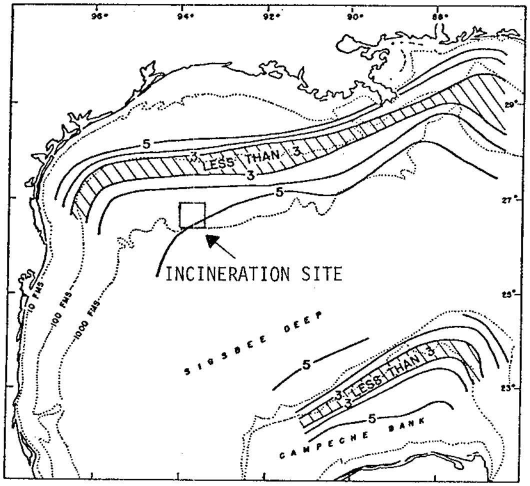


Fig. G-18. Dissolved oxygen content (ml/l) of waters contiguous with the bottom (after Richards, 1957).

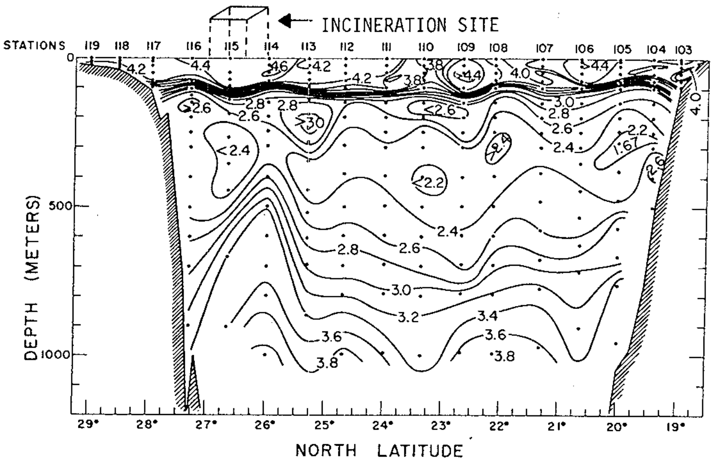


Fig. G-19. Dissolved oxygen concentration along the line shown in Fig. G-16. Note position of site next to station 115 (after Nowlin, 1972).

tions were noted in the pH values. Alkalinity values determined from 23 samples collected at the site during December 1974 ranged from 2.46-2.54 meq (H^+)/1. Statistical treatment of the data showed no significant differences between in-plume test and up-wind control values (TerEco, 1975).

CONTAMINANT LOADING

DDT contamination of the marine environment must be examined in light of DDT uses which have led to existing contamination levels if the assessment of direct release into the environment is to be meaningful. The National Academy of Sciences (1971) estimated that approximately 0.1% of the annual production of DDT reaches the oceans by surface runoff. Estimates of United States riverine input of DDT to the oceans during the 1960's placed this burden at 100 tons (90,718 kg) per year. These estimates were based on measured DDT concentrations in principal rivers. The U.S. production of DDT for this same period varied between 4.8×10^4 and 8.3×10^4 tons (4.3×10^7 kg and 7.5×10^7 kg, respectively) per year while world-wide production during that period was estimated at 1×10^5 tons (9.07×10^7 kg) (National Academy of Sciences, 1971; Goldberg, 1975).

Application of the aforementioned quantities of DDT and its subsequent deposition in the marine environment have resulted in the documented accumulation of DDT residues in marine organisms. However, information is exceedingly sparse on DDT concentrations in seawater, and in particular the open ocean. Reliable measurements of DDT in the open ocean are hard to find even with detection limits in excess of 1 ng/l (one part per trillion). Several studies have shown that chlorinated hydrocarbons are in elevated concentration at the air/sea interface relative to the underlying water (Bidleman et al., 1976). The interface is of too small a volume to be considered a significant reservoir of organohalogens; however, their enrichment in this layer impacts ecological significance to those organisms associated with the interface, e.g. neuston. Typically chlorinated hydrocarbons are removed from the water column by adsorption onto particulate matter (Harvey et al., 1976). DDT concentrations in the "surface microlayer" and subsurface waters for coastal and open waters of various oceans are summarized in Table G-6. Values for DDT concentrations in the Gulf of Mexico are given for comparison in Table G-7. The concentrations of DDT in the water (0.06 ng/l) are similar to those reported for the Sargasso Sea (Giam et al., 1976).

Atmospheric concentrations of DDT in marine air of the Atlantic Ocean and the Gulf of Mexico are presented in Tables G-8 and G-9 respectively. For the Gulf of Mexico, the mean concentration of DDT in the air is 0.04 ng/m^3 (Table G-7), and, like the water, is similar to those reported for the Sargasso Sea (0.03 ng/m^3) (Giam et al., 1976; Bidleman and Olney, 1974).

Table G-6. DDT concentrations in the surface microlayer (SM) and subsurface water (SS) in the world oceans (adapted from Bidleman et al., 1976).

Location	Sampling Dates	DDT (10^{-9} g/l) SM	DDT (10^{-9} g/l) SS
Coastal			
Biscayne Bay, Fla	1968	185-12,700	<1
Florida Current	1968	80	<1
California Current	1971		2-6
California Current	1971	0.4	0.1
California Current	1973		0.3-1.3
California Coastal	1971	12-15	
Gulf of Santa Catalina, California	1974		0.2-1.8
California Harbors	1974		0.6-6.5
Chesapeake Bay	1973	0.6-1.9	0.08-0.11
Swedish Fjords	1972	3.8x10^7	
Irish Sea	1974		0.1-0.2
Newfoundland-Portugal	1972		<1
Portugal-Norwegian Sea	1972		<1
U.S.-Bermuda	1972		<1
Sargasso Sea	1973	0.3-2.1	<0.15
Bermuda-U.S.	1973	0.2-0.5	<0.05
South Atlantic	1975		<0.1-0.4
North Central Pacific Gyre	1972	<0.02	<0.03

Table G-7. DDT concentrations in the marine environment of the Gulf of Mexico (adapted from Giam et al., 1976).

Number of Stations	Samples (year)	Total DDT
44	Biota (71-72)	49.00 (ng/g)
24	Biota (73-74)	2.30 (ng/g)
36	Sediment (73-75)	0.20 (ng/g)
34	Water (73-74)	0.60 (ng/l)
8	Air (73-75)	0.04 (ng/m^3)

Table G-8. DDT concentrations in marine air (adapted from Bidleman et al., 1976).

Location and Date	No. of Samples	10^{-9} g/m^3 p.p' -DDT
Bermuda, 1973	4	0.017-0.053 (total DDT)
Bermuda, 1973	7	0.009-0.022
Bermuda, 1974	25	<0.003-0.062
Cruises, Bermuda-U.S., 1973-74	17	<0.001-0.058
Chesapeake Bay, 1973	3	0.014-0.037
Grand Banks, 1973	5	<0.001 (total DDT)

Table G-9. DDT concentrations in the air from the Gulf of Mexico (adapted from Giam et al., 1976).

Date Obtained	Location	10^{-9} g/m^3 DDT
2/75	28° 36.7' 96° 45.2'	0.05
2/75	28° 54.1' 28° 53.3' 89° 29.4' 89° 31.8'	0.03
2/75	28° 59' 29° 3.4' 89° 13.8' 89° 12.3'	0.09
2/75	29° 13' 89° 18.5'	<0.03
2/75	29° 13' 91° 47.5' Galveston	0.1
3/75	27° 51' 91° 4'	0.02
2/74	27° 55.7' 93° 36'	<0.02
2/74	27° 58.8' 93° 39.5'	<0.04

WAVE HEIGHT AND DIRECTION

There has been no long term study of wave heights specifically within the incineration site; however, the site is within National Climatic Center subregion 34 and adjacent to the northwest of miniregion 341 (Marcus, 1973). Wave heights are generally greater during December-February and reach their low during June-July. From Table G-10 (taken from Marcus, 1973, for miniregion 341) it can be seen that during December-February wave heights $\geq$ 8 ft. occur 8-13% of the time. In June-July the occurrence of $\geq$ 8 ft. waves is less than 0.5% of the time.

Wave direction in the incineration site corresponds closely to wind direction. According to the U.S. Naval Oceanographic Office (1963), throughout the year generally less than 10% of the waves have a westerly component. In April-September waves come mainly from the southeast quadrant. Waves from the southeastern quadrant continue throughout the year; however, during October-March there is also an appreciable amount from the northeastern quadrant (Marcus, 1973).

Table G-10. Wave height by month for miniregion 341 (25-26°N, 92-93°W).

	Med. Wave Height	% Freq. ≥ 5 ft.	% Freq. ≥ 8 ft.	% Freq. ≥ 12 ft.	No. of Obs
Jan	4.9	53.4	13.1	1.9	206
Feb	3.3	49.5	11.2	2.1	180
Mar	3.3	43.8	9.4	1.0	203
Apr	3.3	41.1	6.8	.0	192
May	3.3	36.7	6.3	.5	207
June	3.3	16.5	.5	.0	212
July	1.6	12.2	.0	.0	180
Aug	3.3	17.5	2.1	1.3	234
Sept	3.3	37.2	7.0	2.8	215
Oct	3.3	37.7	7.9	3.9	228
Nov	3.3	41.7	7.0	1.5	199
Dec	3.3	45.1	8.3	1.0	193

THE BIOLOGIC COMPONENT

In the broadest sense the marine biota frequenting the vicinity of the Gulf incineration site may be divided into two groups: the pelagial (living free in the water column) and benthos (living in, on, or in close association with the bottom), each with their respective subgroupings. Because incineration produces emissions to the atmosphere, another group, the marine and migratory avifauna, must also be considered.

THE PELAGIAL

The pelagial may be divided into the plankton (without the capability for significant lateral movement) and the nekton (free swimming and capable of sustained lateral movement independent of water mass movement). In addition to the basic locomotive differences, trophic and regenerative differences characterize the groups. Plankton tend to occupy the lower trophic levels as primary producers (phytoplankton) and consumers (zooplankton). The role of the phytoplankton (the only plants of the open ocean) is the formation of organic matter through the process of photosynthesis. The role of the zooplankton is consumption of the phytoplankton (herbivores) or other zooplankton (carnivores), thereby making the organic matter (energy in the form of food) more readily available as food for organisms of higher trophic levels (fish). By the very nature of their existence the life span of plankters is very short (days to weeks) and the regenerative ability of planktonic populations is very high. The natural range of abundance for plankton populations will vary through several orders of magnitude over a seasonal cycle.

The nektonic organisms, e.g., swimming fish, invertebrates, and mammals, occupy higher trophic levels and generally exhibit much longer life spans than the plankton. With reproductive cycles approximating an annual cycle, the regenerative powers of the nektonic population through reproduction are much less than those of the plankton.

PHYTOPLANKTON

The phytoplankton is made up of hundreds of different microscopic, single-celled plants which usually fall into one of three classes: diatoms, dinoflagellates, and coccolithophorids. The abundance and species composition exhibit considerable variation with season, depth, and lateral distance from land. This variation is so great that attempts to quantify impacts on phytoplankton populations through composition and abundance analyses defy all but the most rigorous treatments and even then still require years to complete.

The phytoplankton, being in practicality confined to the upper 100 meters or so of ocean and unable to make active migrations in avoidance of contaminants, is likely to be susceptible to the effect of surface-originated contaminants, i.e. incineration emissions. However, its resilience, or ability to recover rapidly from temporary stress, is probably greater than any other component of the biota. Phytoplankton populations regularly go through drastic fluctuations in abundance and composition as the result of natural phenomena such as grazing pressure, nutrient depletion, and light limitations on photosynthesis. One has only to consider phytoplankton populations of polar regions, which undergo months of darkness under ice and still rebound to as great an abundance and diversity as is found anywhere, to realize the tremendous ability of the phytoplankton populations to recover from stress.

Biomass

Abundance of Phytoplankton Cells

Mean phytoplankton cell numbers in oceanic regions of the Gulf of Mexico approximate 10^2 cells/liter (Fukase, 1967; Steidinger, 1973). Similar results were found in oceanic waters immediately south of the northern Gulf slope where cell numbers ranged from 1.30 - 4.88 x 10^2 cells/liter (excluding Oscillatoria sp.) with Oscillatoria sp. values of 0.35 - 48.8 x 10^2 cells/liter (TerEco Corporation, 1974). At stations close to the

200 m contour along the continental shelf break in the northern Gulf of Mexico, phytoplankton cell numbers of 0.15 - 1.27 x 10^3 cells/liter were found while values of 3.9 x 10^4 cells/liter were recorded near the mouth of the Mississippi River (Hulbert and Corwin, 1972). By way of comparison with the more productive areas toward shore, in shelf waters near the Mississippi Delta, values ranging from 0.237 - 3.056 x 10^6 cells/liter and as high as 6.0 - 9.0 x 10^6 cells/liter were recorded by Thomas and Simmons (1960) and Fucik (1974), respectively.

Chlorophyll-a and Total Plankton

Numerous phytoplankton standing crop values (measured as chlorophyll-a concentration) have been collected over a period of nine years, covering virtually the entire Gulf of Mexico (El-Sayed, 1972). Average Gulf of Mexico chlorophyll-a concentrations at the surface and integrated to the bottom of the euphotic zone are 0.20 mg/m^3 and 12.42 mg/m^2, respectively (El-Sayed, 1972). Additional measurements obtained during four summer and autumn cruises revealed similar surface and integrated averages of 0.23 mg/m^3 and 11.50 mg/m^2 (El-Sayed and Turner, 1974).

Chlorophyll-a averages from intermittent sampling without respect to season for 2° squares of latitude and longitude for the areas which cover the northern Gulf continental slope are presented in Figure G-20. When compared with the whole Gulf, northern Gulf averages were moderate with surface and integrated values of 0.20 mg/m^3 and 12.70 - 15.02 mg/m^2, respectively, with highest values just east of the Mississippi Delta (El-Sayed, 1972). Surface values in the area of concern equal the average (0.20 mg/m^3) for the Gulf of Mexico, and integrated values are greater than the average.

Soviet investigations in the Gulf of Mexico for total plankton biomass (measured as mg/m^3 wet weight) reveal geographical patterns similar to those of chlorophyll-a with the most productive regions being found along the northwestern coast of Florida (Khromov, 1965). Plankton biomass in the open Gulf was low, with values of 100-150 mg/m^3, compared

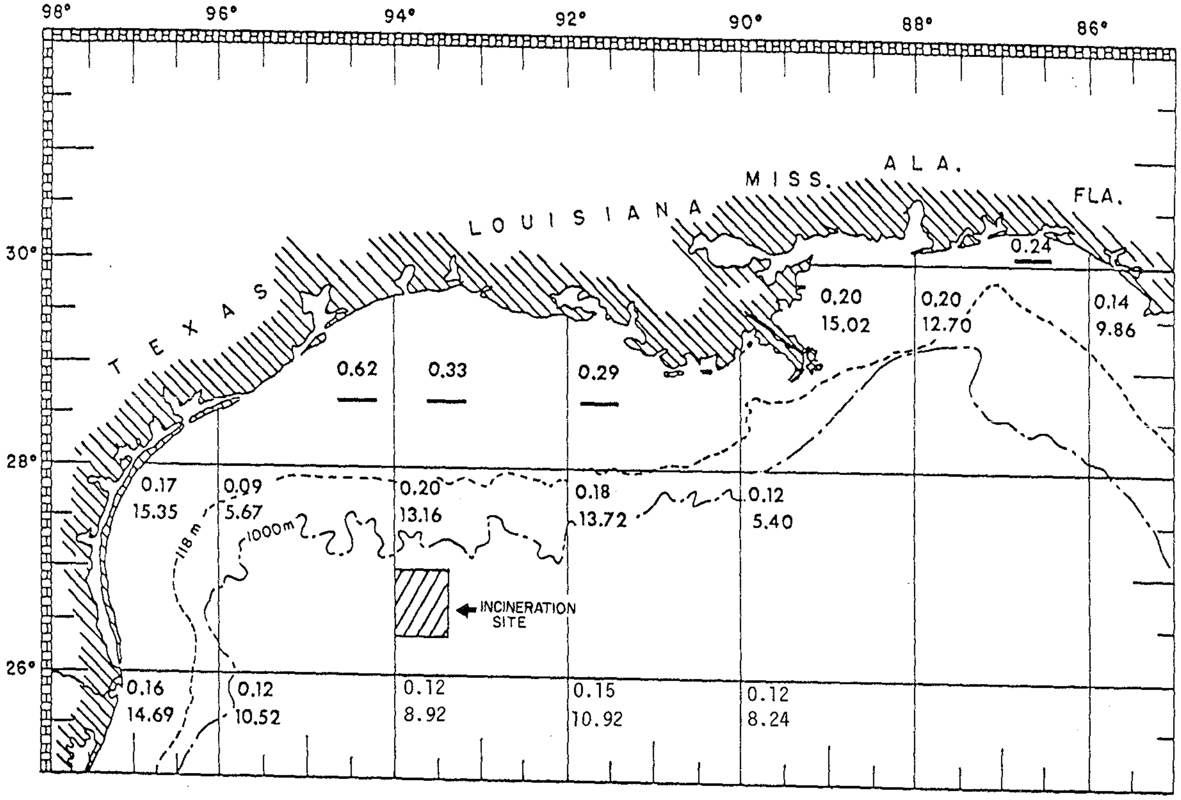


Fig. G-20. Surface and integrated chlorophyll-a averages in the region of the incineration site. Upper values are for the surface (mg chl-a/m^3) and lower values are integrated to the bottom of the euphotic zone (mg chl-a/m^2) (redrawn from El-Sayed, 1972).

to 200-1000 mg/m^3 in the region near the Mississippi Delta (Khromov, 1967; Bogdanov et al., 1968). Upwelling in the northern Gulf along the bottom of the continental slope and over the outer edge of the continental shelf was suggested as the reason for the high productivity (Bogdanov et al., 1968).

Typical profiles of vertical chlorophyll-a distributions in the Gulf of Mexico reveal low values near the surface. Maximum concentrations in many cases coincide with the bottom of the euphotic zone (El-Sayed, 1972; El-Sayed and Turner, 1974) or pycnoclines (Hobson and Lorenzen, 1972) at depths of 50-100 m. This pattern appears to be a typical feature in other oceanic areas as well (Anderson, 1969; Goering et al., 1970; Venrick et al., 1973).

Primary Production

Geographic Distribution

Primary production averages for 2° squares of latitude and longitude for the area over the northern Gulf continental slope were low (Figure G-21) with surface and integrated values ranging from 0.08 - 0.26 mgC/m^3/hr and 2.02 - 4.00 mgC/m^2/hr., respectively. Maximum values over the continental slope were found off Panama City, Florida, with surface and integrated averages of 0.43 mgC/m^3/hr and 5.0 mgC/m^2/hr, respectively (El-Sayed, 1972). The designated incineration site occurs within an area of low productivity.

Although the geographic region (2° latitude by 2° longitude) is relatively high for overall Gulf production, onshore/offshore gradients in production are apparent. A comparison of oceanic values with Fucik's (1974) data from the adjacent continental shelf waters reveals the low primary production values of the continental slope and oceanic waters.

Vertical Distribution

In a pattern similar to the vertical chlorophyll-a distributions previously discussed, maximum primary production values in the Gulf

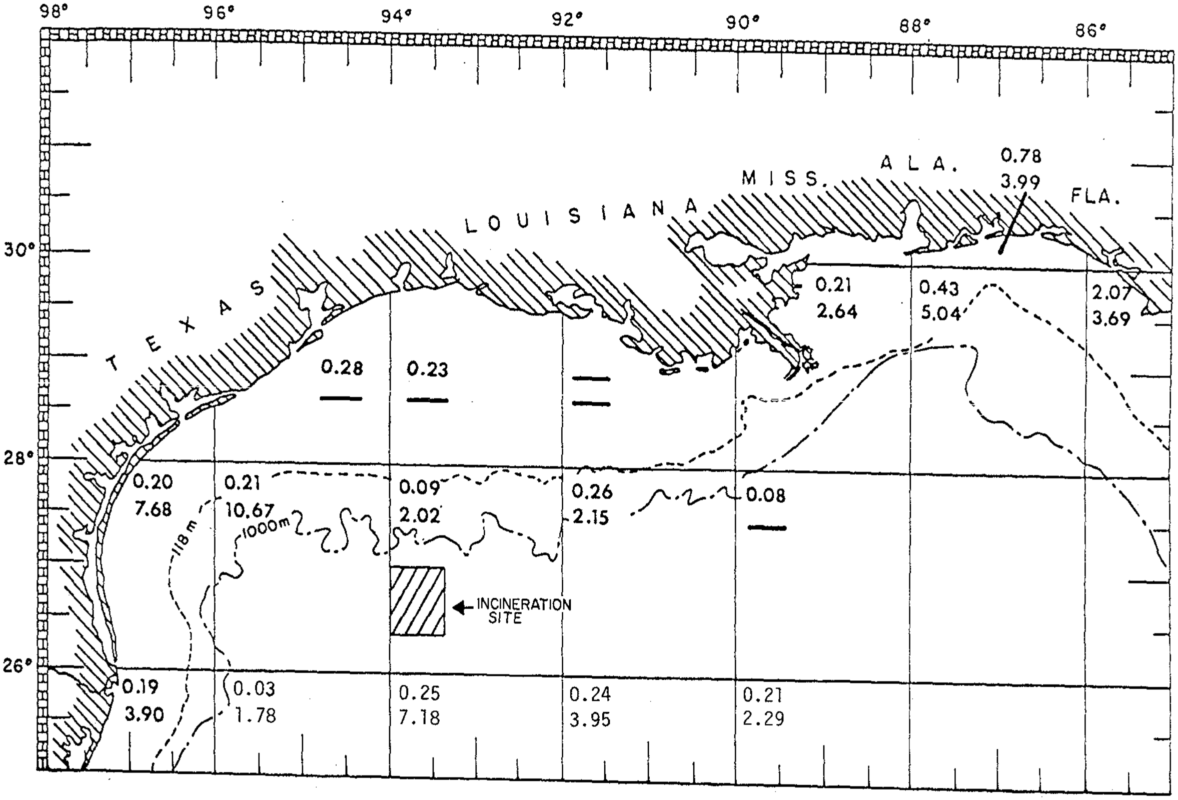


Fig. G-21. Surface and integrated primary production averages in the region of the incineration site. Upper values are for the surface (mgC/m^3/hr) and lower values are integrated to the bottom of the euphotic zone (mgC/m^2/hr) (redrawn from El-Sayed, 1972).

Diatoms

Conger et al. (1972) listed 939 diatom species which have been reported from the Gulf of Mexico. Of all the species in their list, *Rhizosolenia alata* is the one most frequently recorded from Gulf waters throughout the year (Balech, 1967; Saunders and Fryxell, 1972). This species is also cited as the most important diatom in Apalachee Bay and in the northeastern Gulf of Mexico (Curl, 1959). *Ceratulina pelagica* is present in most estuarine waters of the Gulf but is occasionally found in continental shelf waters. *Asterionella japonica* and *Skeletonema costatum* occur over the entire continental shelf, but occasionally are found in oceanic regions (Steidinger, 1973). Although abundant in the northern and northeastern Gulf of Mexico, *Biddulphia chinensis* is replaced by *B. regia* in coastal waters south of Cedar Key, Florida. Other diatom species found throughout the Gulf of Mexico in most months include: *Guinardia flaccida*, *Chaetoceros compressum*, *C. peruvianum*, *Hemiaulus membranaceus*, *H. hauckii*, and *Rhizosolenia stolterfothii* (Saunders and Fryxell, 1972).

The geographic ranges of the predominant species recorded from net samples by Balech (1967) were plotted by Saunders and Fryxell (1972). Species they plotted in the region of the site include: *Biddulphia chinensis*, *B. regia*, *Ceratulina pelagica*, *Chaetoceros coarchtatum*, *C. compressum*, *Guinardia flaccida*, *Hemiaulus membranaceus*, *H. sinensis*, *Rhizosolenia alata*, *R. stolterfothii*, and *Thalassionema nitzschoides*.

In oceanic waters within the incineration site between 26°26'N-26°52'N and 93°48'W - 93°55'W, 29 diatom species were recorded in October 1974 (TerEco, 1974). The most abundant diatom species included *Bacteriastrum delicatulum*, *Chaetoceros affinis*, *C. atlanticum*, *Navicula* sp., *Nitzschia seriata*, *Rhizosolenia calcar-avis*, *R. hebetata*, *R. styliformis*, and *Synedra* sp.

Dinoflagellates

Steidinger (1972b) listed 405 dinoflagellate species which have been recorded for the Gulf of Mexico. In addition she found that Ceratium furca, C. fusus, C. massiliense, and C. trichoceros are widespread species in both coastal and oceanic waters, while Ceratium teres, Ceratocorys horrida, and Pyrocystis pseudonoctiluca are generally present in oceanic waters (Steidinger, 1972a).

Other Phytoplankters

The cyanophyte, Trichodesmium sp. (Oscillatoria, probably T. erythraeum) has been reported to be the most abundant phytoplankter during certain periods at various locations throughout the Gulf of Mexico (Ivanov, 1966; TerEco Corporation, 1974; Fucik, 1974; El-Sayed and Turner, 1974).

Thirty-two coccolithophorid species were collected in qualitative samples from the Gulf of Mexico (Gaarder and Hasle, 1971), of which Coccolithus huxleyi and Gephyrocapsa oceanica were the most frequently recorded. In addition, quantitative samples revealed that C. huxleyi may become the most numerous phytoplankton species in offshore waters of the Gulf of Mexico in late autumn (Hulburt and Corwin, 1972).

Seasonal Cycles

Species Distributions and Abundance

The only available data for the northern Gulf of Mexico come from the studies of Thomas and Simmons (1960) and Fucik (1974), east and west of the Mississippi Delta, respectively. In both studies, phytoplankton numbers were highest in spring and lowest in fall in inshore waters, but Thomas and Simmons (1960) found no significant differences at their most seaward stations. In addition, Fucik found that diatoms comprised 72-90% of the cell numbers while dinoflagellates accounted for only 10-28% of the phytoplankters present.

Biomass and Primary Production

Maximum surface chlorophyll-a values for the Gulf of Mexico as a whole increase during summer and fall. The mean integrated chlorophylla-a values for summer and winter were identical, and only slightly higher than those for spring and autumn (El-Sayed, 1972).

Seasonal primary production patterns for the Gulf of Mexico as a whole, generally parallel those of chlorophyll-a with maximum values in winter (El-Sayed, 1972). The amplitude of seasonal changes in primary production and chlorophyll-a concentrations in the oceanic regions of the Gulf is small (El-Sayed, 1972).

ZOOPLANKTON

Practically every major animal phylum makes some contribution to the zooplankton. Although most zooplankters remain planktonic throughout their existence, many animals occur in the plankton during only part of their lives. Those organisms which spend only part of their lives as plankton are known as meroplankton in contrast to the holoplankton, which remain in the plankton throughout their life cycle. Meroplankton includes the larvae of benthonic invertebrates (viz., trochophores and veligers of mollusks, nauplii of barnacles, various larval stages of crabs and shrimp, larvae of echinoderms, etc.) as well as eggs and larval stages of many fish species. Included in the holoplankton are siphonophores, ctenophores, pteropods, euphausiids, and most copepods and chaetognaths.

Acute impacts on the holoplankton are of relatively little consequence when compared to the significance of the same impacts on the meroplankton. With normal life spans on the order of days to weeks, and a broad geographic distribution, holoplankton on the other hand constitutes a far more vulnerable niche in the marine ecosystem. By the very nature of its condition (larval or juvenile stages), it would tend to be more susceptible to environmental perturbations. Of greater direct importance to man is the fact that losses in the meroplankton not only affect the food supply for higher trophic levels, but also the higher trophic levels themselves through diminished recruitment.

Another component of the zooplankton particularly sensitive to ocean incineration is the neuston. The neuston is that component of the zooplankton (both holo- and mero- forms) which lives at the air/sea interface. By virtue of its habitat, it seems particularly vulnerable to the effects of incineration emissions.

In neritic waters of the Gulf of Mexico (i.e. extending seaward to a depth of about 200 m) the meroplankton reaches its greatest abundance and often exceeds the holoplankton. In the oceanic zone (seaward of the neritic zone) holoplankton species predominate. Zooplankton of the Gulf incineration site has a large holoplankton component.

Distribution of Biomass

Although the zooplankters are incapable of sustained lateral migration, they do exhibit a well-developed capacity for vertical migration. They rise to near the surface at night and move down to or below the thermocline by day. It is generally accepted that diurnal vertical migration among the zooplankton organisms is a mechanism to aid survival through the avoidance of predators and the hunt for food. Thus it may be proposed that these plankters also have some potential capacity for avoiding unfavorable waters (i.e. the surface) should contamination accumulate.

On the shelf in the northern part of the Gulf of Mexico, plankton develops intensively to the west and especially to the east of the Mississippi River. These two areas, rich in plankton, are due in part to the effect of the river's drainage, which is greatest to the east of the mouth. Opposite the river mouth there is very little plankton (Khromov, 1965).

The principal comprehensive zooplankton biomass studies encompassing the Gulf incineration site have come from the U.S. Fish and Wildlife Service (Arnold, 1958) and the Soviet-Cuban expeditions of 1962-66 (Khromov, 1965; and Bogdanov et al., 1969). Distributions of food plankton biomass (net plankton less the detritus) for winter and summer months are shown in Figures G-22 and G-23. From these studies, as well as specialized

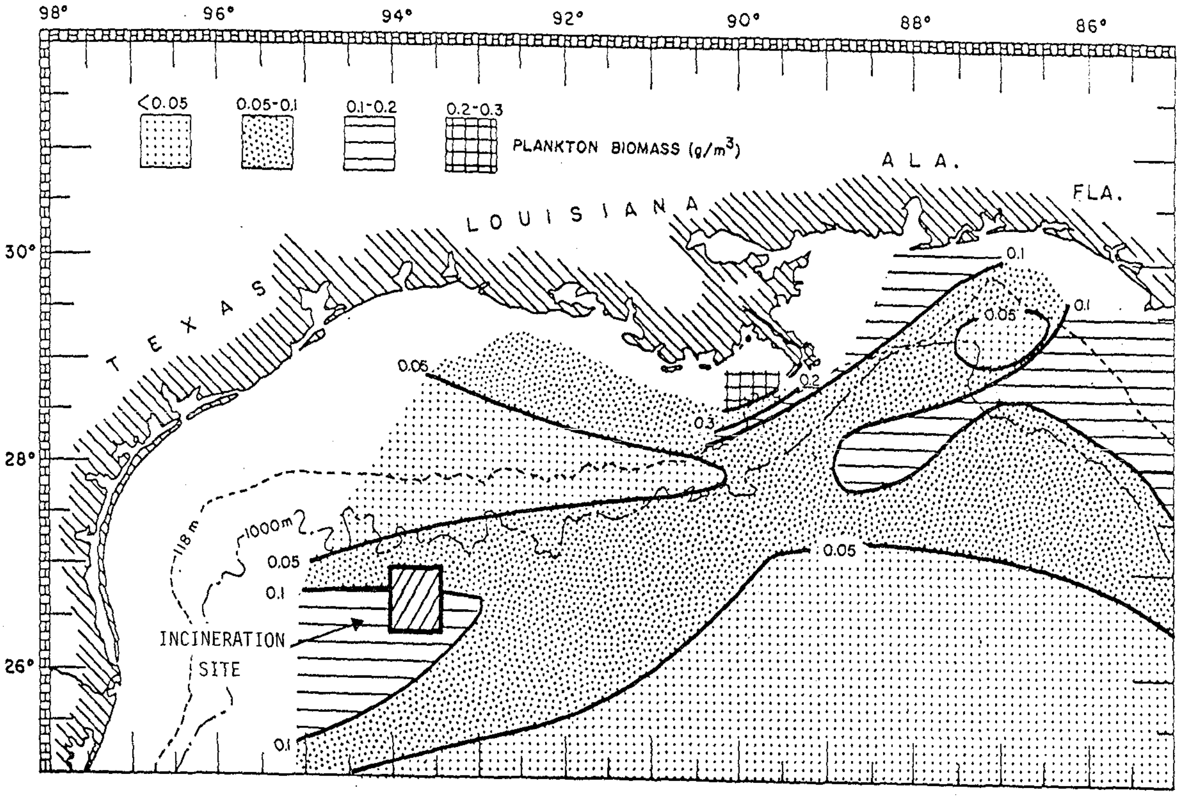


Figure G-22. Distribution of food plankton in the northern Gulf of Mexico during August-October 1964 (after Khromov, 1965).

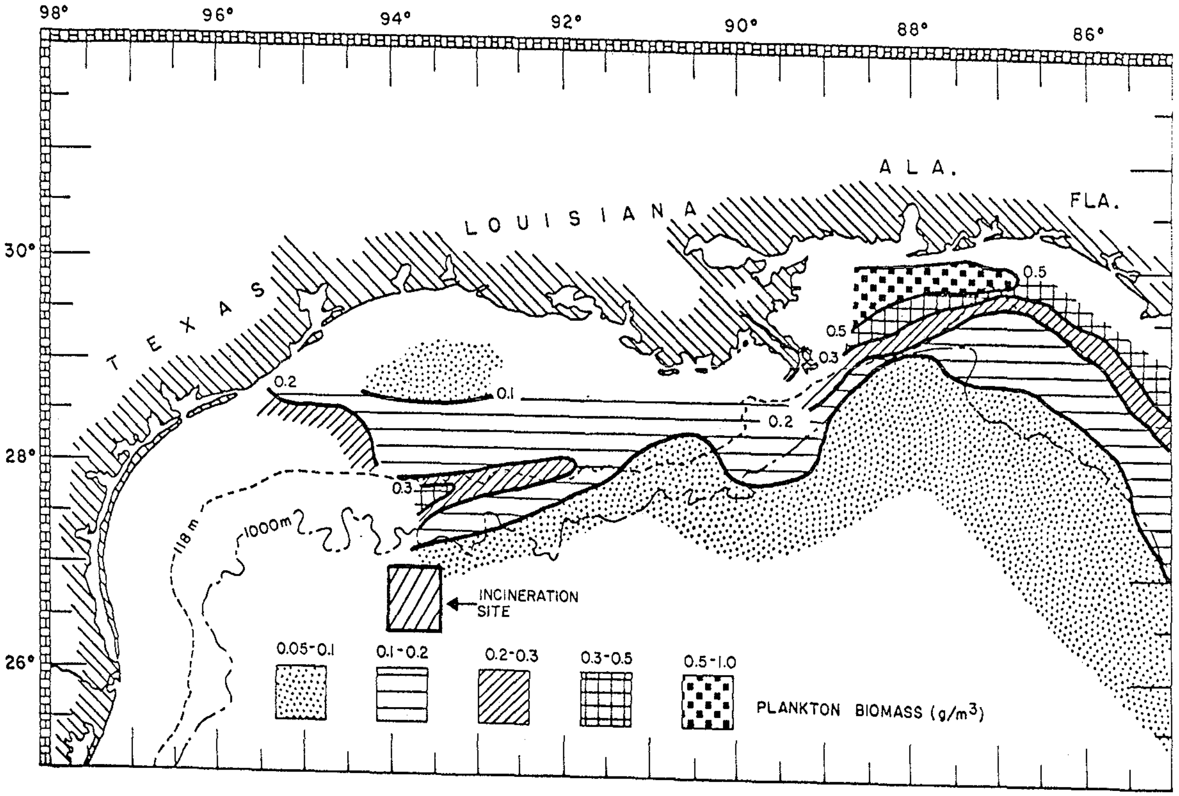


Figure G-23. Distribution of food plankton along the northern coast of the Gulf of Mexico during February-March 1964 (after Khromov, 1965).

studies on specific zooplankton components the following general trends are evident. The western half of the Gulf of Mexico supports a lower zooplankton biomass than does the eastern half. The standing crop in the upper layers decreases with increasing distance from shore or increasing water depth.

Seasonal Variation

Zooplankton populations are higher during the cooler months than during other months of the year. Khromov (1969) believes that the decrease in the plankton population in spring may be related to the beginning of intensive warming which causes stratification and prevents upwelling of nutrient-rich deeper water. Zooplankton abundances in the site environs are at their lowest levels during warmer months. However, during the cooler months, the concentrations are 2-6 times greater and would constitute an important food supply for higher trophic levels.

According to data from the Soviet-Cuban research cruises in the Gulf and Caribbean (Khromov, 1969), the high zooplankton biomass in fall and winter is dominated by *Eucalanus monachus*, *Temora turbinata*, *Nannocalanus minor*, *Paracalanus parvus*, various species of *Oncaea*, *Oithona*, and *Conchoecia*, decapod larvae, and a large number of *Oikopleura*. SUSIO (1976) found a great abundance of *Paracalanus* sp. in winter 1976 near the incineration site. During the summer months Khromov found the following species to be dominant: *Nannocalanus minor*, *Undinula vulgaris*, *Clausocalanus furcatus*, *Clausocalanus arcuicornis*, *Paracalanus parvus*, *Temora stylifera*, *Temora turbinata*, *Acartia*, and various Cyclopoida. *Eucalanus monachus*, ever so conspicuous in the winter population, was drastically reduced in abundance.

Composition

Copepods. Copepods are small crustaceans, most ranging from less than one millimeter to several millimeters in length. Marine copepods exist in enormous numbers. Indeed, they may be the most abundant metazoans on the earth. It is their enormous number that delegates their importance in the marine food web. Fleminger (1959) studied the geographic distribution of calanoid copepods in Gulf waters from approximately 500 samples and found the majority of the Gulf species to be tropical forms inhabiting equatorial waters around the world. Some neritic species (such as Centropages hamatus, Acartia tonsa, Pseudodiaptomus coronatus, and Labidocera aestiva) with temperate North Atlantic affinities vary in their adaptation to tropical conditions. These species are numerous in coastal and estuarine waters with winter minimum temperatures of 10°C and summer maximum temperatures of 28°C. When the lowest temperature in winter is 8°C, they diminish in quantity.

In relation to onshore-offshore gradients Fleminger (1959) found five modes of spatial distribution for copepod species, in successive bands with overlapping boundaries parallel to the shoreline:

1. Estuarine facies - in estuaries, lagoons, and contiguous coastal waters: Acartia tonsa and Paracalanus crassirostris.
2. Coastal-Neritic facies - inshore to midcontinental shelf waters: Centropages furcatus and Temora turbinata.
3. Neritic-Shelf facies - roughly between the 20 m and 200 m isobaths: Eucalanus pileatus and Paracalanus parvus.
4. Shelf-Oceanic facies - the outermost shelf and slope: Clausocalanus furcatus and Undinula vulgaris.
5. Oceanic facies - oceanic waters: Centropages violaceus and Pontellina plumata.

Park (1970) reported a systematic study of the vertical distribution of calanoid copepods from the oceanic Gulf. Although emphasis was placed on species occurring at depths greater than 200 meters, his list of epipelagic species would be applicable to the study area.

Epipelagic Species of Calanoid Copepods in the Gulf of Mexico (from Park, 1970)

Calocalanus pavoninus
C. styliremis
Paracalanus parvus
Clausocalanus furcatus
C. paululus
Heterorhabdus spinifera
Ctenocalanus vanus
Euaetideus acutus
E. giesbrechti
Scolecithricella vittata
Lucicutia paraclausi
L. favicornis

Chaetognaths. The phylum Chaetognatha is a group of exclusively marine invertebrates. With the exception of the benthonic genus Spadella, all chaetognaths are holoplanktonic. These organisms are voracious carnivores, feeding heavily on crustaceans and larval fishes. This, coupled with their being among the most common plankters, warrants their importance to the marine food web.

Studies by Pierce (1951, 1954, 1962), Adelmann (1967) and Every (1968) have delineated the Gulf's chaetognath fauna. Pierce's (1951, 1962) and Adelmann's (1967) studies were confined to the neritic Gulf while Every's (1968) study concentrated on the oceanic waters of the Gulf. No obvious east-west geographical affinities have been found. However, definite neritic-oceanic distributions are present. Below, the common Chaetognatha found in the Gulf are listed along with their neritic or oceanic affinities. Sagitta enflata, a cosmopolitan species, has been reported to the most abundant chaetognath species in neritic as well as oceanic waters. The remaining species listed should be considered expatriates when found outside their designated zones.

List of Common Neritic and Oceanic Chaetognaths Reported from the Gulf of Mexico

Species	Designation
Sagitta enflata	Cosmopolitan
Sagitta hexaptera	Oceanic
Sagitta serratodentata	Oceanic
Sagitta bipunctata	Oceanic
Sagitta decipiens	Oceanic
Sagitta helenae	Neritic
Sagitta hispida	Neritic
Sagitta tenuis	Neritic
Krohnitta pacifica	Neritic
Pterosagitta draco	Oceanic

The majority of Every's (1968) samples were taken with open nets; thus, specific vertical distribution data were not obtained. However, upon examination of data from his opening-closing nets combined with data of depth of tow versus species collected from open nets, certain distributional trends appear. From these, data were derived denoting those chaetognaths found in the Gulf and designating their probable vertical distributions as epipelagic, mesopelagic, or bathpelagic.

Epipelagic Chaetognaths from the Gulf of Mexico
(from Every, 1968)

Pterosagitta draco
Sagitta enflata
Sagitta hexaptera
Sagitta helenae
Sagitta hispida
Sagitta bipunctata
Sagitta serratodentata
Sagitta tenuis
Krohnitta pacifica

Euphausiacea. The euphausiacean fauna of the Gulf is typical of that of the tropical western Atlantic (James, 1971). Investigations by James (1970) and Schroeder (1971) showed that 33 species occur in the Gulf. Dividing the northern Gulf into east and west sectors at 90°W longitude, Schroeder (1971) listed the species by abundance for the northwest and northeast Gulf. Listed below are the 10 most abundant species found by Schroeder (1971) in each of the areas. Cognizance of sampling technique limitations and lack of seasonal data prompted James (1970, 1971) and Schroeder (1971) not to speculate on euphausiacean geographical affinities which may exist for the Gulf of Mexico.

The Ten Most Abundant Euphausiids, Arranged in Decreasing Order of Abundance, Found in the Northwest and Northeast Gulf (from Schroeder, 1971)

Northwest	Northeast
Stylocheiron submii	*Nematoscelis microps-atlantica*
Euphausia tenera	*Stylocheiron carinatum*
Stylocheiron carinatum	*Euphausia tenera*
Euphausia mutica	*Stylocheiron abbreviatum*
Euphausia americana	*Stylocheiron suhmii*
Stylocheiron affine	*Euphausia americana*
Stylocheiron abbreviatum	*Euphausia pseudogibba*
Nematoscelis microps-atlantica	*Stylocheiron longicorne*
Stylocheiron longicorne	*Euphausia hemigibba*
Euphausia hemigibba	*Stylocheiron affine*

James (1971) generalized the vertical distribution of Gulf euphausiids as (1) Epipelagic - adults common above 100 m, (2) Mesopelagic - adults from 100-700 m, (3) Bathypelagic - adults below 700 m. Species belonging to the epipelagic categories are listed below.

Epipelagic Euphausiaceans from the Gulf of Mexico
Asterisk (*) Denotes Those Species Reported by
Schroeder (1971) as Diurnal Vertical Migrators

Euphausia americana*
E. brevis*
E. gibboides*
E. hemigibba*
E. mutica*
E. pseudogibba*
E. tenera*
Nematoscelis atlantica

Neumatoscelis microps
Stylocheiron abbreviatum
S. affine
S. carinatum
S. suhmii
Thysanopoda monacantha
T. subequalis*
T. tricuspidata*

Pteropod Mollusks. Pteropods, which are holoplanktonic mollusks, are important contributors to the plankton of oceanic waters, but are of little importance to the inshore or coastal plankton. As emphasized by Bjornberg (1971) an abundance of pteropod species usually indicates offshore waters. Their direct importance to man as indicator organisms may soon be more fully exploited. Austin (1971) has shown that water masses of the eastern Gulf can be recognized and differentiated by occurrence of certain pteropods.

On the northern Gulf shelf, the most abundant pteropod species reported by Snyder (1975) were juveniles of Limacina inflata, L. trachiformis, Creseis acicula acicula, and C. virgula conica.

Of the pteropod species reported by Snyder (1975), from the slope and oceanic waters of the Gulf, Limacina inflata was the most common species, occurring in 90% of the samples, and frequently was the most abundant. She reported abundance for L. inflata up to 12,400/100 m^3 for samples taken in the central Gulf. Listed below are pteropod species which occurred in at least 80% of Snyder's samples from Gulf slope and oceanic waters.

Limacina inflata
Creseis acicula acicula
C. virgula conica

Styliola subula
Hyalocylis striata
Diacria quadridentata
Cavolina inflexa

The vertical distributions of pteropods are somewhat obscured by their diurnal vertical migrations, but considering only daytime collections, Snyder separated the Gulf species into the following two groups:

Group I 0-100 m	Group II >100 m
Limacina trochiformis	*Limacina inflata*
Creseis acicula acicula	*L. lesuerii*
C. virgula virgula	*L. bulimoides*
C. virgula conica	*Hyalocylis striata*
Cavolina inflexa	*Styliola subula*
Diacria quadridentata	*Clio pyramidata*
Peraclis reticulata	*C. cuspidata*
	Peraclis bispinosa
	Cavolina uncinata

NEUSTON

Neuston generally refers to the group of organisms that lives on, in, or just below the surface film of water bodies. In addition to the biological component of the neuston, one also finds various abiotic substances, some of which are related to human pollution, such as floating tar balls, plastic, DDT, PCBs, and miscellaneous debris.

The environment of the surface film places its inhabitants in a very vulnerable position. Mechanical action of wave and spray subject them to much physical motion. Temperature is quite variable. Direct exposure to the sunlight produces very high levels of light and especially to ultraviolet radiation that is often damaging to living protoplasm. The surface tension of the water film and foam may entrap very small organisms that lack the size and force to break away. In addition, much organic material (driftwood, etc.) and fine wind-borne inorganic matter may be found floating at the surface. Perhaps the greatest hazard the neustonic organisms face is from petroleum hydrocarbons and other pollutants (pelagic tar balls, DDT, PCBs, etc.) derived from the activities of civilization. Thus, the organisms that live at the surface must possess special adaptations to survive in this zone of stress. It should be pointed out, however, that some components of the neuston can undergo vertical migration, as noted below.

Neuston organisms are frequently indistinguishable from the underlying epipelagic plankton species, except for some of the larger pleuston, i.e., those organisms living in or above the air-water interface, partially in air and partially in water, often possessing some type of gas flotation device, and mainly distributed by the direct action of the wind. Examples of larger pleuston are the coelenterates, Physalia (Portugese man-of-war), Velella (By-the-wind sailor), the sea-snail, Janthina (purple storm snail), and sargassum weed. Associated with the sargassum is a variety of small fishes, shrimp, crabs, and other organisms. The sargassum and its faunal community are widely distributed in tropical and subtropical seas, and it is especially abundant in the Gulf Stream system of the western Atlantic, including the Gulf of Mexico.

The hyponeuston refers to organisms living in the surface layer, but below the interface. It is often composed of the same species that are found in the underlying plankton (usually dominated by copepods), but in different relative abundances.

The composition of the neuston varies greatly throughout the 24-hour period, because many epipelagic plankton species and larval forms found lower in the water column during the day migrate to the surface film at night. Compositional differences between the neuston and the epipelagic plankton are less pronounced in boreal waters than they are in waters of the lower latitudes (Hempel and Weikert, 1972). Neuston composition also varies seasonally and with distance from the shore.

Neuston studies in the Gulf of Mexico, especially in the northern Gulf, are sparse. Berkowitz (1976) compared neuston and near-surface zooplankton in an area of the northwestern Gulf of Mexico over the lower continental slope in an oceanic environment differing from that of the incineration platform area. He found the neuston above the 1000-fathom bottom contour to be relatively impoverished compared to plankton concentrations one meter below the surface. Continental shelf areas tend to have a greater abundance of neuston than oceanic areas, and the night neuston of shelf areas is enhanced by migration of the benthic species (Morris, 1975). Copepods are generally the dominant organisms in continental shelf neuston.

Particularly distinctive of the continental shelf neuston are the larval forms of benthic animals, especially the decapod crustacean larvae, which have strong diurnal and seasonal fluctuations in numerical abundance and biomass in the surface waters. Pequegnat et al. (1977) and Wormuth et al. (1979) report consistently higher numbers of decapod larvae in night samples versus day samples at stations in the Gulf of Mexico on the South Texas outer continental shelf and higher numbers in spring-summer (April-May-June) than in any of the other monthly samples during a 1976-77 study. The dominant decapod larvae were portunid crab zoeas and megalopas. Larvae of other invertebrates, i.e., mollusks, echinoderms, barnacles, etc., as well as fish eggs and larvae are present in varying amounts in continental shelf neuston. The latter are especially important constituents of continental shelf neuston, particularly in view of the fact that most of the commercially important species of fish on the continental shelf pass the egg and larval stages of their development in the continental shelf plankton and/or neuston.

THE NEKTON

Nekton is generally defined as that component of marine life capable of swimming with force and purpose, independent of ocean currents. As such, this group is able to search actively for food, avoid predators, and migrate extensively. Their capacity to avoid nets and to range over broad areas of the ocean has resulted in a paucity of knowledge concerning the distributions and life history of nektonic organisms. Yet these same capacities may allow components of the nekton to avoid areas of the ocean impacted by man's activities. Included in the nekton are a few invertebrates such as squid (Cephalopods) and shrimp (Crustaceans), many fishes, marine reptiles, and marine mammals.

CEPHALOPODS

Many invertebrate species are capable of sustained horizontal migration and thus could be considered as nekton (e.g., shrimp and crabs).

However, many of these invertebrates are usually dependent on the sea bottom for their food and more properly should be considered as part of the benthos. Two groups of invertebrates that are more characteristic of and more abundant in deeper oceanic waters make a significant contribution to the nekton near the incineration site. These are the pelagic cephalopods (squid) and some of the pelagic shrimp.

Lipka (1975) reported 66 species of pelagic cephalopods (Phylum Mollusca) from the Gulf of Mexico. Few locations yielded collections composed of abundant adult forms. Clearcut faunal distributional patterns could not be established, though *Doryteuthis plei*, *Loligo pealei*, and *Lolliguncula brevis* were typical of the neritic zone. *L. brevis* was ubiquitous in nearshore regions, inhabiting estuaries and bays with salinities as low as 17 ppt. *D. plei* and *L. pealei* were generally found in more saline waters on the shelf.

The majority of Lipka's pelagic cephalopod samples were collected during descent or ascent of bottom dredges and trawls. Thus, precise bathymetric distributional limits were impossible to determine. However, Lipka determined the probable vertical distributions of certain species based upon morphological indicators described by Voss (1967). The probable bathymetric distribution patterns of Lipka's pelagic cephalopods in the Gulf of Mexico are given in Table G-11.

CRUSTACEANS

Decapod and mysidacean shrimps are conspicuous components of the midwater fauna. Pequegnat (1972) noted that of the 23 species of penaeid shrimps known to occur from depths below 200 m, only six are pelagic, and only two of these (*Gennadas valens* and *Bentheogennema intermedia*) can be considered "common." Of the 63 species of caridean shrimps occurring below 200 m, 22 species are pelagic, and only three of these (*Acanthephyra purpurea*, *Acanthephyra stylorostrata*, and *Systellaspis debilis*) may be called "common." Ten species of deep-sea mysidacean shrimps are known from the open Gulf, and only three of these (*Gnathophausia ingens*, *Eucopia australis*, and *Eucopia sculpticauda*) are considered "common."

Table G-11. Vertical distribution of Gulf cephalopods (from Lipka, 1975).

Epipelagic (0-200 m)

- *Onykia carriboea*
- *Onychoteuthis banksi*
- *Ommastrephes pteropus*
- *Ommastrephes bartramii*
- *Thysanoteuthis rhombus*
- *Liocranchia reinhardti*
- *Leachia cyclura*
- *Cranchia scabra*
- *Heteroteuthis hawaiiensis*
- *Tremoctopus violaceous*
- *Argonauta argo*

Mesopelagic (200-700 m)

- *Enoploteuthis leptura*
- *Enoploteuthis anapsis*
- *Abralia veranyi*
- *Abralia grimpei*
- *Pyroteuthis margaritifera*
- *Pterygioteuthis giardi*
- *Pterygioteuthis gemmata*
- *Lycoteuthis diadema*
- *Oregoniateuthis springeri*
- *Selenoteuthis scintillans*
- *Histioteuthis corona corona*
- *Histioteuthis dofleini*

Bathypelagic (700-2000 m)

- *Chiroteuthis lacertosa*
- *Bathyteuthis abyssicola*
- *Mastigoteuthis glaucopsis*
- *Mastigoteuthis grimaldi*
- *Joubiniteuthis portieri*
- *Cycloteuthis sirventi*
- *Japetella diaphana*
- *Eledonella pygamaea*
- *Grimalditeuthis bomplandii*
- *Sandalops ecthambus*
- *Corynomma speculator*
- *Egea inermis*
- *Phasmatopsis oceanica*
- *Bathothauma lyromma*
- *Helicocranchia pfefferi*
- *Helicocranchia papillata*
- *Megalocranchia megalops*
- *Vampyroteuthis infernalis*

Pequegnat (based upon unpublished research still in progress) has provided information concerning approximate depth ranges, areas of occurrence, and relative abundance of the meso-and bathypelagic species of penaeid, caridean, and mysidacean shrimps of the Gulf of Mexico (Table G-12).

Table G-12. Meso-and bathypelagic shrimps and their distribution and relative abundance in the Gulf of Mexico listed in order of relative abundance within each group.

MESOPELAGIC (200-700 m)

	Relative Abundance	Area of Gulf in Order of Abundance
PENAEIDAE		
*Gennadas valens (Smith, 1884)	Abundant	NE,NW,SE,SW
*Bentheogennema intermedia Bate, 1888	Common	SW,NE,NW,SE
*Gennadas capensis Calman, 1925	Sparse	SE,NE,NW,SW
Gennadas scutatus Bouvier, 1906	Sparse	SE, NE
*Gennadas bouvieri Kemp, 1909	Sparse	SE,NE,SW
Gennadas talismani Bouvier, 1906	Rare	NE,SE
CARIDEA		
*Acanthephyra purpurea A. Milne-Edwards, 1881	Common	SW,NW,NE,SE
*Systellaspis debilis (A. Milne-Edwards, 1881)	Common	SW,NW,NE,SE
*Oplophorus gracilirostris A. Milne-Edwards, 1881	Sparse	SW,SE,NE,NW
*Oplophorus spinicauda A. Milne-Edwards, 1881	Sparse	SW,SE,NE,NW
*Parapandalus richardi (Courtière, 1905)	Sparse	SW,SE,NE
Psathyrocaris infirma Alcock & Anderson, 1894	Rare	SW
MYSIDACEA		
*Gnathophausia ingens (Dohrn, 1870)	Common	NE,SE,NW,SW
*Gnathophausia zoea Willemoes-Suhm, 1875	Common	SE,SW,NE,NW

Table G-12. Continued

BATHYPELAGIC (700-2000 m)

	Relative Abundance	Area of Gulf in Order of Abundance
Acanthephyra stylorostrata (Bate, 1888)	Common	SW,NE,NW
*_Acanthephyra acanthitelsonis_ Bate, 1888	Sparse	NE,SW,NW
*_Acanthephyra curtirostris_ Wood-Mason, 1891	Sparse	SW,NE,NW,SE
*_Acanthephyra acutifrons_ Bate, 1888	Sparse	SW,NE,NW,SE
*_Notostromus gibbosus_ A. Milne-EdwardS 1881	Sparse	NE,NW,SW,SE
*_Acanthephyra brevirostris_ Smith, 1885	Sparse	NW,SW,NE
Oplophorus spinosus (Brulle, 1835)	Rare	SW,NE
Ephyrina benedicti Smith, 1885	Rare	SW,NW
Meningodora mollis Smith, 1882	Rare	SW,NE
*_Parapasiphai cristata_ Smith, 1884	Rare	SW,NE
*_Ephyrina hoskynii_ Wood-Mason, 1891	Rare	SW,NE
Acanthephyra pelagica (Risso, 1816)	Rare	SW
Notostomus longirostris (Bate, 1888)	Rare	SW
Hymenodora sp.	Rare	SW
Hymenodora glacialis (Buchholtz, 1874)	Rare	SW
Parapasiphae sulcatifrons Smith, 1884	Rare	NW

MYSIDACEA

*_Eucopia sculpticauda_ Faxon, 1893	Common	SE,SW,NE,NW
*_Eucopia australis_ Dana, 1852	Sparse	NE,SE
*_Gnathophausia gracilis_ Willemoes-Suhm 1873	Rare	NE,SE
Gnathophausia gigas Willemoes-Suhm 1873	Rare	SW

*Known to occur over the continental slope in the northern Gulf of Mexico.

FISH

Fishes are the most important component of the nekton. The pelagic forms often represent the higher levels of the oceanic food chain. Many of these feed primarily on plankton, and several groups form dense schools in the near surface waters. Demersal fishes feed on the bottom and also support a major foodfish and bottomfish industry in the northern Gulf of Mexico.

Thorson (1971) noted that about 50% of all the fish caught for human consumption (represented by the years 1966-67) belonged to the herring family Clupeidae. The herring, a pelagic fish, represents a major food source for the larger pelagic predators such as mackerel and tunney, which in turn constitute another 10% of the human consumption totals.

According to Sal'nikov (1965), deepwater fishes of the Gulf of Mexico are mainly from the families Macrouridae (grenadiers or rattails), Gadidae (codfishes), Myctophidae (lanternfishes), Alepisauridae (lancetfishes) and Chimaeridae (chimaeras). However, certain sportfishes, including the billfishes, occur in the blue waters found offshore. Table G-13 lists some of these fast-swimming nektonic species.

Table G-13. Common "blue water" fish species found off the Texas coast (adapted from A. D. Little, 1973).

Species	Common Name	Habitat/Remarks
Pomatomus sattatrix	Bluefish	Offshore; in schools
Sarda sarda	Atlantic bonito	Offshore; bluewater
Coryphaena hippurus	Dolphin	Open water near floating seaweed and driftwood
Caranx hippos	Crevalle jack	Offshore; young in bays, around bridges, pilings
Scomberomorus cavalla	King mackerel	Reefs; deep clearwater
Makaira nigricans	Blue marlin	Deep blue water; solitary
Istiophorus platypterus	Sailfish	Far offshore; deep water
Thunnus atlanticus	Blackfin tuna	Offshore; in schools
T. thynnus	Bluefin tuna	Offshore; in schools
T. albacares	Yellowfin tuna	Offshore; in schools
Aconthocybium solanderi	Wahoo	Open ocean and Gulf Stream, deep reefs

The fish groups which predominate in the mid-water areas of the Gulf of Mexico include the hatchetfishes (Sternoptychidae), lanternfishes (Myctophidae), lightfishes (Gonostomatidae), viperfishes (Chauliodontidae), and scaleless dragonfishes (Melanostomiatidae). Very little is known of the distribution of any of these groups in the northern Gulf of Mexico except the hatchetfishes. Baird (1971) noted the general world-wide depth distribution patterns for the following three sternoptychid genera:

Argyropelecus - high seas, pelagic; upper 600 m
Polyipnus - close to shore
Sternoptyx - high seas, pelagic; 500-1500 m

Bright and Pequegnat (1969) reported that of the 10 species of hatchetfishes known from the Gulf of Mexico, 8 are distributed Gulf-wide and are probably residents, and 2 species (Argyropelecus amabalis and Polyipnus laternatus) appear to be transients which are transported into and out of the eastern Gulf by the Loop Current. Within the Gulf, hatchetfishes occur chiefly between the depths of 250 and 1500 m. They are apparently not associated with the sound-scattering layers above 200 m in the Gulf (which are apparently caused by invertebrates rather than by fishes). The data of Bright and Pequegnat suggest ascent at night and descent during the day for Argyropelecus aculeatus and most other members of the family. However, the reverse migration is suggested for Sternoptyx diaphana and possibly Argyropelecus hemigymnus, both of which tend to inhabit the deeper layers. Information concerning species of hatchetfishes taken with opening-closing midwater trawls at three depth levels in the Gulf of Mexico is given in Table G-14.

In order to obtain information on the other group of midwater fishes not previously reported upon in the literature, data were compiled on those midwater fishes fortuitously collected during descent and ascent of the benthic trawls and dredges within the depth limits of this study. Generally the fishes collected were small, since the larger, more mobile forms could more easily avoid capture. Also, mesopelagic and bathypelagic fishes, as a whole, tend to be smaller than epipelagic or benthonic representatives. The most commonly collected species (Table G-15) are from families Sternoptychidae (hatchetfish), Chauliodontidae (viperfishes), Gonostomatidae (lightfishes) and Myctophidae (lanternfishes).

Table G-14. Numbers of hatchetfish caught per hour using opening-closing device (from Bright and Pequegnat, 1969).

Depth range (meters)		0-175	175-500	500-900
Hours trawling time	D	4.8	3.0	0.8
	N	1.9	4.4	2.4
Argyropelecus affinis	D	-	-	-
	N	-	0.2	-
Argyropelecus gigas	D	-	-	1.2
	N	-	-	-
Argyropelecus hemigymnus	D	-	1.0	-
	N	-	1.1	-
Argyropelecus aculeatus	D	-	3.3	2.4
	N	0.5	1.8	-
Argyropelecus olfersi	D	-	-	-
	N	-	0.5	-
Argyropelecus lynchus lynchus	D	-	-	-
	N	1.0	1.8	-
Sternoptyx diaphana	D	-	2.0	8.4
	N	-	0.2	6.8
Polyipnus asteroides	D	-	0.3	-
	N	-	0.2	-
All species	D	-	5.7	12.0
	N	1.6	6.0	6.8

D-Day
N-Night

Most of the midwater pelagic fishes collected are well adapted to deep sea pelagic life. Besides luminescent organs along the body which are possessed by many of these fishes, some have luminescent organs on their barbels which may act as lures for attracting prey. Since food is relatively scarce in the mesopelagic and bathypelagic zones, the principle of large predator-small prey breaks down. A good example of this is *Chauliodus sloanei* which can engulf prey larger than it is by the means of opening its mouth and extending its stomach. Various other degrees of specialization are encompassed among the pelagic fishes collected during this investigation. Table G-16 lists the most commonly collected Gulf pelagic fish species, along with their respective families, collected within the depth limits of this study.

Table G-15. Most commonly collected pelagic fishes in descending rank of occurrence.

Species	Family
Sternoptyx diaphana	Sternoptychidae
Chauliodus sloanei	Chauliodontidae
Gonostoma elongatum	Gonostomatidae
Yarella blackfordi	Gonostomatidae
Cyclothone sp.	Gonostomatidae
Neoscopelus macrolepidotus	Myctophidae

Table G-16. Alphabetized list of Gulf pelagic fish collected within those depth limits of the incineration site.

SPECIES	FAMILY	COMMON NAMES
Antennarius radiosus Garman, 1896	ANTENNARIIDAE	Frogfishes
Apogon sp.	APOGONIDAE	Cardinalfishes
Argyropelecus gigas Norman, 1930	STERNOPTYCHIDAE	Hatchetfishes
Argyropelecus lynchus Garman, 1899	STERNOPTYCHIDAE	Hatchetfishes
Argyropelecus sp.	STERNOPTYCHIDAE	Hatchetfishes
Aristostomias grimaldii Zugmayer, 1913	MALACOSTEIDAE	
Avocettina infans (Gunther, 1878)	NEMICHTHYIDAE	Snipe eels
Balistes capriscus Gmelin, 1788	BALISTIDAE	Triggerfishes
Bathophilus pawneei Parr, 1927	MELANOSTOMIATIDAE	Scaleless dragonfishes
Bathyclupea argentea Goode & Bean, 1895	BATHYCLUPEIDAE	
Bregmaceros atlanticus Goode & Bean, 1886	BREGMACEROTIDAE	Codlets
Bregmaceros cayorum Nichols, 1952	BREGMACEROTIDAE	Codlets
Chauliodus sloanei Bloch & Schneider, 1801	CHAULIODONTIDAE	Viperfishes
Chloroscombrus chrysurus (Linnaeus, 1766)	CARANGIDAE	Jacks & Pompanos
Cyclothone sp.	GONOSTOMATIDAE	Lightfishes
Diaphus metopoclampus Cocco, 1829	MYCTOPHIDAE	Lanternfishes
Diplophos taenia Gunther, 1878	GONOSTOMATIDAE	Lightfishes
Epigonus occidentalis Goode & Bean, 1895	APOGONIDAE	Cardinalfishes
Epigonus pandionis (Goode & Bean, 1881)	APOGONIDAE	Cardinalfishes
Epinnula magistralis Poey, 1851	GEMPYLIDAE	Snake mackerals
Equetus acuminatus (Bloch & Schneider, 1801)	SCIAENIDAE	Drums
Evermannella sp.	EVERMANNELLIDAE	
Gonostoma elongatum Gunther, 1878	GONOSTOMATIDAE	Lightfishes
Hygophum macrochir (Gunther, 1864)	MYCTOPHIDAE	Lanternfishes
Lagocephalus laevigatus (L., 1766)	TETRAODONTIDAE	Puffers
Macdonaldia sp.	NOTACANTHIDAE	Spiny eels
Macrorhamphosus scolopax (Linnaeus, 1758)	CENTRISCIDAE	Snipefishes
Malacosteus niger Ayres, 1848	MALACOSTEIDAE	
Melamphaes beanii Gunther, 1887	MELAMPHAEIDAE	
Melamphaes sp.	MELAMPHAEIDAE	
Melanostomias biseratus Regan & Trewavas, 1930	MELANOSTOMIATIDAE	Scaleless dragonfishes
Mullus auratus Jordan & Gilbert, 1882	MULLIDAE	Goatfishes
Neoscopelus macrolepidotus Johnson, 1863	MYCTOPHIDAE	Lanternfishes
Notacanthus analis Gill, 1883	NOTACANTHIDAE	Spiny eels
Oxyodon sp.	APOGONIDAE	Cardinalfishes
Peprilus burti Fowler	STROMATEIDAE	Butterflyfishes
Photostomias sp.	MALACOSTEIDAE	
Polymixia lowei Gunther, 1859	POLYMIXIIDAE	Beardfishes
Selar crumenophthalmus (Bloch, 1793)	CARANGIDAE	Jacks & Pompanos
Sphoeroides parvus Shipp & Yerger	TETRAODONTIDAE	Puffers
Sphoeroides splengeri (Bloch, 1782)	TETRAODONTIDAE	Puffers

Table G-16. (Continued)

SPECIES	FAMILY	COMMON NAMES
Stenotomus caprinus Bean, 1882	SPARIDAE	Porgies
Sternoptyx diaphana Herman, 1781	STERNOPTYCHIDAE	Hatchetfishes
Stomias ferox Reinhardt, 1842	STOMIATIDAE	
Stomias sp.	STOMIATIDAE	
Synagrops bella (Goode & Bean, 1895)	APOGONIDAE	Cardinalfishes
Synagrops spinosa Schultz	APOGONIDAE	Cardinalfishes
Trachurus lathami Nichols	CARANGIDAE	Jacks & Pompanos
Trichiurus lepturus l., 1758	TRICHIURIDAE	Cutlassfishes (Atlantic)
Upeneus parvus Poey, 1851	MULLIDAE	Goatfishes
Yarella blackfordi Goode & Bean, 1895	GONOSTOMATIDAE	Lightfishes

MARINE REPTILES

Several species of marine turtles are known to occur in the Gulf of Mexico. According to the U.S. Department of Interior, BLM (1978) the Atlantic ridley (Lepidochelys kempii), the hawksbill (Eretmochelys imbricata) and the leatherback (Dermochelys coriacea) turtles are endangered species. The loggerhead (Caretta caretta) and green (Chelonia mydas) turtles are considered threatened species.

Green turtles have been reported to nest in the vicinity of Sanibel Island on the west coast of Florida (U. S. Department of Interior, BLM, 1978), and tagged specimens have been found in the Florida Keys (Carr, 1965). The Atlantic ridley nests in abundance in Tamaulipas, Mexico, and uses the northern Gulf of Mexico coastal area for feeding. Loggerhead turtles nest on beaches in the Gulf during the summer months, and according to the 1978 BLM publication have been observed on several islands off Mississippi, Alabama, and Florida. Leatherback turtles range widely throughout the Gulf and have been reported nesting on several northwestern Florida beaches. Observations have been made of these turtles feeding in large numbers on jellyfish in inshore waters during summer.

MARINE MAMMALS

More than 20 species of marine mammals have been reported from the Gulf of Mexico. Of the species reported, none are restricted to the study area. The majority are wide-ranging and some exhibit world-wide distribution. The fauna consists almost entirely of cetaceans (whales and propoises), but pinnipeds (seals and sea lions) and sirenians (manatees) are represented (Caldwell, 1973). According to the U.S. Department of Interior, BLM (1978), six species of whales occurring in the Gulf are endangered. These are:

Black right - *Balaena glacialis*
Humpback - *Megaptera novaeangliae*
Fin - *Balaenoptera physalus*
Sperm - *Physeter catodon*
Sei - *Balaenoptera borealis*
Blue - *Balaenoptera musculus*

The bottlenose (*Tursiops truncatus*) and spotted (*Stenella plagiodon*) dolphins and the sperm and short-finned pilot (*Globicephala macrorhynchus*) whales are the most common cetaceans sighted in the eastern Gulf. Cetaceans feed on copepods, euphausiids, and fishes.

THE ZOOBENTHOS

The aggregate of animals living on (and in) the bottom and those substantially dependent upon bottom organisms as food constitute the *zoobenthos* (in the photic zone there may be a well-developed phytobenthos). The composition and structure of the substratum is the key to the fundamental nature of the benthic faunal assmblages found in a local area of the marine environment. Hard bottoms support groupings of organisms that are almost wholly categorized as *epifaunal* species; those species on the other hand that inhabit soft bottoms and live within the unconsolidated sediments are called *infaunal* species. These broad definitions leave decisions to be made as to how the following kinds of organisms should be fitted into these major categories:

> Species, generally quite mobile, that live on the surface of soft bottoms (often called level bottoms) and do not burrow into them (so far as is known), e.g., the giant red crab, *Geryon quinquedens*, are related to the epifauna (soft-bottom type).

> Species that are quite mobile and move over soft bottoms but that burrow in largely for refuge and possibly for protection of newly hatched individuals and emerge to feed on the sediment surface, e.g., the caridean Glyphocrangon nobilis and possibly the giant isopod Bathynomus giganteus, even though they burrow into the sediments, should be treated as epifaunal species.

Demersal fishes might seem to present a special problem, but it seems best to let them remain in this category. Some prefer to set apart those species that have a very intimate physical relationship with the bottom, even burrowing into sediments, such as benthic fishes. In any case if one should assign these demersal fishes to one or another of the above categories, it is apparent that they bear greater functional relationships with the epifauna than with the infauna.

This leaves, then as infaunal those species that are intimately bound with the soft bottom substratum, usually burrowing into it, having limited mobility, if any, as adults, except perhaps within burrows, and that feed wholly within the sediments by either drawing water into their burrows or moving through the sediments. Typical infaunal species dealt with here are most (but not all) of the bivalve mollusks, some holothurians, some echinoids, some polychaete annelids, etc.

The numbers of species of organisms living on hard substrata have been estimated by Thorson (1957) to far exceed those living on level bottoms. This is probably true in deep water, and it certainly applies if the macrofauna only is considered. However, in the depth range of this report major areas of hard bottoms are scarce. Secondary hard bottoms (Remane, 1940) such as mollusk shells and small rocks are about the only developments that are observed. These serve as the substratum for small brachiopods (e.g. Pelagodiscus atlanticus), such bivalves as Bentharca, some barnacles (Verruca and Scalpellum), a few ecotoprocts, and an occasional gorgonian, horny coral (Chrysogorgia).

Numerous benthic stations have been sampled in the near vicinity of the incineration site by personnel of TerEco Corporation; however, none were within its perimeter. Those samples have been worked, i.e., species identified and enumerated, but these data have not been presented in published form. These collections, obtained by means of either dredging or trawling, are presented in Table G-17.

BENTHIC FAUNAL ASSEMBLAGES

The concept of benthic animal communities seems to have been formulated first in the late 19th century by Karl Mobius as an outgrowth of his observation of oyster reefs. Other biological scientists of a similar interest (Fager, 1963; Mills, 1969; Krebs, 1972) have offered definitions concerning marine benthic communities. No matter which definition seems preferable, one should be willing to agree that in a community one is dealing with (1) populations of organisms that together make up (2) assemblages of coincidental species that (3) exhibit sufficient degrees of recurrence in prescribed areas as to (4) repudiate the notion that they are simply ramdomly assembled collections of species.

The acceptability of the above definitions is heightened by the fact that none of them puts any limit on the size of communities nor does any one require that attempts be made to include every species that lives in the habitat. This is especially important to marine benthic studies where specie diversity can be high and the availability of species-level taxonomic expertise may be low. Moreover, the shift from pelagic to benthic environments, the large range of size and motility of the constituent species, and changes in substratum type demand that several sampling techniques be employed if any reasonable approximation of a "complete" representation of the constituents of a marine community is to be achieved. For these reasons, the discussion and description of communities in the following pages is limited to large benthic organisms that can be captured by means of dredges and/or trawls. Even here sampling problems in deep water could easily dissuade one from attempting to discuss deep-benthic communities except for one thing, viz., that after gaining a backlog of experience one cannot but be impressed by the observation that when the catch of a trawl or dredge from a particular isobath of habitat is laid out on the deck it is similar to but not identical with recurrent groups of species taken previously by the same gear.

Table G-17. Benthic species collected from stations near the incineration site.

BENTHIC SPECIES	STATION DEPTHS (fm)											
	515	530	550	580	670	765	800	970	1124	1135	1785	1796
CARIDEAN SHRIMP												
Nematocarcinus rotundus	1	45	21	21	22	11	10					
Glyphocrangon aculeata	1	5	35	60	23	3	4	1				
Heterocarpus oryx			3	3	17	3						
Glyphocrangon nobilis			14	6	26	20	23	1		1		
Bathypalaemonella serratipalma							1					
Bathypalaemonella texana							1					
Nematocarcinus ensifer								7	18	14		
Glyphocrangon longirostris									6			
Glyphocrangon sculpta									1			
Pontophilus gracilis			1									
Glyphocrangon alispina		130		29								
Psalidopus barbouri		2										
Acanthephyra eximia						1						
PENAEID SHRIMP												
Benthesicymus bartletti	1	2				6	1		1			
Benthesicymus cereus							1				4	
Hymenopenaeus aphoticus						1	1					
Plesiopenaeus armatus									2			
Hemipenaeus carpenteri									1			
Nematocarcinus acanthitelsonis											1	
Aristeus antillensis		1										

Table G-17. (Continued)

BENTHIC SPECIES	STATION DEPTHS (fm)											
	515	530	550	580	670	765	800	970	1124	1135	1785	1796
Hepomadus tener						1						
BRACHYURAN CRABS												
Rochinia umbonata		1										
Geryon quinquedens			1	1	17		1	1	2			
Homolodromia paradoxa		1		1	1							
Bathyplax typhla		54										
GALATHEID CRABS												
Uroptychus nitidus			1		8							
Munidopsis sigsbei	1		1		13	2	10					
Munidopsis nitida									1			
Munidopsis sundi											1	
Munidopsis gulfensis						1						
Munidopsis simplex						3						
Munidopsis abreviata				2								
Munidopsis spinosa		1		6								
Munida valida		2										
PAGURID CRABS												
Parapagurus pilosimanus			3			2	1					
POLYCHELID CRUSTACEAN												
Stereomastis sculpta				39	44		9	7	1			
Polycheles validus								1	3			
Polycheles typhlops											1	

Table G-17. (Continued)

BENTHIC SPECIES	STATION DEPTHS (fm)											
	515	530	550	580	670	765	800	970	1124	1135	1785	1796
NEPHROPID CRUSTACEANS												
Nephropsis aculeata		1										
Nephropsis agassizi	1			1								
Polycheles lidae			3									
ISOPOD CRUSTACEANS												
Bathynomus giganteus					1							
HOLOTHUROIDS (SEA CUCUMBERS)												
Benthodytes sanguinolenta							1					
Benthodytes lingua									3	5	2	
Benthodytes typica (?)												21
Molpadia musculus	4											
Molpadia barbouri	3	3										
Mesothuria lactea						1						
ASTEROIDS (STARFISH)												
Goniopecten demonstrans		1										
Nymphaster arenatus				1					4	3		2
Dytaster insignis									3	2	13	
Litonotaster intermedius									3	3		1
Benthopecten simplex									2			18
Drachmaster sp.									2			
Marsipaster sp.									1	2		
Ceramaster sp.									1			

Table G-17. (Continued)

BENTHIC SPECIES	STATION DEPTHS (fm)											
	515	530	550	580	670	765	800	970	1124	1135	1785	1796
Astropecten americanus				7								
Astropecten sp.				1								
Poranisca lepida				1								
Doraster constellatus				6								
BIVALVE MOLLUSKS												
Tindaria amabilis	2					1	9					
CEPHACOPOD MOLLUSKS												
Japetella diaphana								2				
Bathothauma lyromma								1				
Eledonella pygamaea								1				
Histioteuthis dofleini										1		
Grimalditeuthis bomplandii										1		
Octopoteuthis megaptera											1	
Grimpoteuthis sp. A											3	
DEMERSAL FISH												
Dicrolene intronigra			11	24	6	1	1					
Monomitopus agassizi				36	5							
Stephanoberyx monae			1	1	6							
Malacosteus niger					1							
Bathypterois quadrifilis		1	1	2	1				2	1		
Gadomus arcuatus					1							
Bathygadus favosus					1							

Table G-17. (Continued)

BENTHIC SPECIES	STATION DEPTHS (fm)											
	515	530	550	580	670	765	800	970	1124	1135	1785	1796
Cariburus zaniophorus			1	3	3							
Venefica procera			1	1	1					1		
Dibranchus atlanticus		1		9	1							
Synaphobranchus oregoni			8		10							
Aldrovandia gracilis							2					
Cariburus mexicanus				6			1					
Hemipterois sp.										1	3	
Cataetyx sp.										1		
Photostomias sp.											1	
Barathronus bicolor				1							1	
Bassozetus normalis											4	1
Bathytroctes sp.			2								1	
Ilyophis brunneus											2	
Bathypterois longipes												1
Conocara mcdonaldi			1									
Nezumia hildebrandi			7	12								
Aldrovandia affinis						18						
Gadomus longifilis				21								
Bathygadus vaillanti				16								
Oxygadus occa				2								
Trachonuras sulcatus				1								
Malacocephalus occidentalis				1								

Table G-17. (Continued)

BENTHIC SPECIES	STATION DEPTHS (fm)											
	515	530	550	580	670	765	800	970	1124	1135	1785	1796
Grenurus grenadae				4								
Halosarus guntheri				12								
Raja fuliginea				4								
Scylliorhinus profundorum				3								
Bathytroctis melanocephalus				2								
Alepocephalus agassizii				1								

Benthic communities are somewhat easier to define than pelagic communities, due to the fact that the bottom represents a barrier to many organisms, a surface of action (feeding, reproduction) for others, and a haven of protection for the burrowing forms. Communities still range over broad areas, however, due to extensive areas of similar environmental conditions. Collard and D'Asaro (1973), quoting several other authors, state that, while abiotic factors such as temperature, salinity, turbidity, sediment depositional rates, currents, physico-chemical and geographic barriers are important modifiers of community structure and distribution, substrate remains as the single key abiotic factor influencing communities. Biotic modifiers and determinants of community structure include predation, competition, physiological tolerances, and population characters (fecundity, longevity, mortality, etc.).

The approach to describing the faunal assemblages of the slope within the depth range of the incineration site will be to list under the proper assemblage name those species that are essentially limited to the bathymetric limits stipulated for the assemblage as a whole. However, a study of the two proposed assemblages revealed that several species occupied the entire depth range of the incineration site area. These components of the zoobenthos include: Glyphocrangon nobilis (Caridean shrimp), Geryon quinquedens (Brachyuran crab), Stereomastis sculpta (Macruran decapod), Numphaster arenatus (Starfish), Bathypterois quadrifilis (Demersal fish), and Venefica procera (Demersal fish).

The constituent species of what one can consider as a true lower slope assemblage are broken down into the following two zones.

Lower Slope Assemblage

Upper Zone (550 to >800 fm)

Nematocarcinus rotundus	Caridean shrimp
Glyphocrangon aculeata	Caridean shrimp
Heterocarpus oryx	Caridean shrimp
Glyphocrangon alispina	Caridean shrimp
Benthesicymus bartletti	Penaeid shrimp
Bathyplax typhla	Brachyuran crab
Homolodromia paradoxa	Brachyuran crab

Upper Zone (Continued)

Munidopsis sigsbei	Galatheid crab
Munidopsis spinosa	Galatheid crab
Munida valida	Galatheid crab
Uroptychus nitidus	Galatheid crab
Parapagurus pilosimanus	Pagurid crab
Nephropsis agassizi	Macruran decapod
Bathynomus giganteus	Giant isopod
Benthodytes sanguinolenta	Holothuroid
Mesothuria lactea	Holothuroid
Goniopecten demonstrans	Starfish
Astropecten americanus	Starfish
Doraster constellatus	Starfish
Tindaria amabilis	Bivalve mollusk
Dicrolene intronigra	Demersal fish
Monomitopus agassizi	Demersal fish
Stephanoberyx monae	Demersal fish
Dibranchus atlanticus	Demersal fish
Synaphobrachus oregoni	Demersal fish
Nezumia hildebrandi	Demersal fish
Cariburus zaniophorus	Demersal fish
Cariburus mexicanus	Demersal fish

Middle Zone (>950 to 1350 fm)

Nematocarcinus ensifer	Caridean shrimp
Glyphocrangon longirostris	Caridean shrimp
Benthesicymus cereus	Penaeid shrimp
Munidopsis nitida	Galatheid crab
Polycheles validus	Macruran decapod
Benthodytes lingua	Holothuroid
Litonotaster intermedius	Starfish
Dytaster isignis	Starfish
Hemipterois sp.	Demersal fish
Cataetyx sp.	Demersal fish

DENDROGRAM SHOWING FAUNAL RELATIONSHIPS

The diagram in Fig. G-24 is based upon unpublished data obtained from numerous dredge and trawl stations within the deep aspects of the Gulf of Mexico. Instead of pooling the results of sampling around each isobath, in constructing the dendrogram, station data have been used and then reflected on the isobath in an attempt to delineate faunal assemblages. The dendrogram seems to point to important faunal breaks around 550 fm, between 800 and 950 fm, and near 1350 fm.

This dendrogram is based upon the index of similarity I, which is calculated by using the value

$$\frac{2j}{2ab-(a+b)j}$$

where a and b are the respective number of species in two samples and j is the number of species common to both samples. Mountford (1962) derived the index, based on logarithmic-series distribution, and showed it to be less dependent on sample size than earlier ones. This method tends to classify stations into groups of similar stations on the basis of the fauna collected at each and makes use not only of the index of similarity between a pair of single stations, but also of an index of similarity between two groups of stations.

MARINE AND MIGRATORY AVIFAUNA

Around 400 species of birds have been identified over the Gulf of Mexico (Woolfender and Schreiber, 1973). They include pelagic, nearshore, and migratory species. The pelagic and migratory species are of primary interest here.

Pelagic birds enter the Gulf from the Atlantic between breeding seasons. Their movements correspond to weather and availability of food (Lincoln, 1979). Other than Sooty Terns and Brown Noddies, Wilson's Storm Petrel

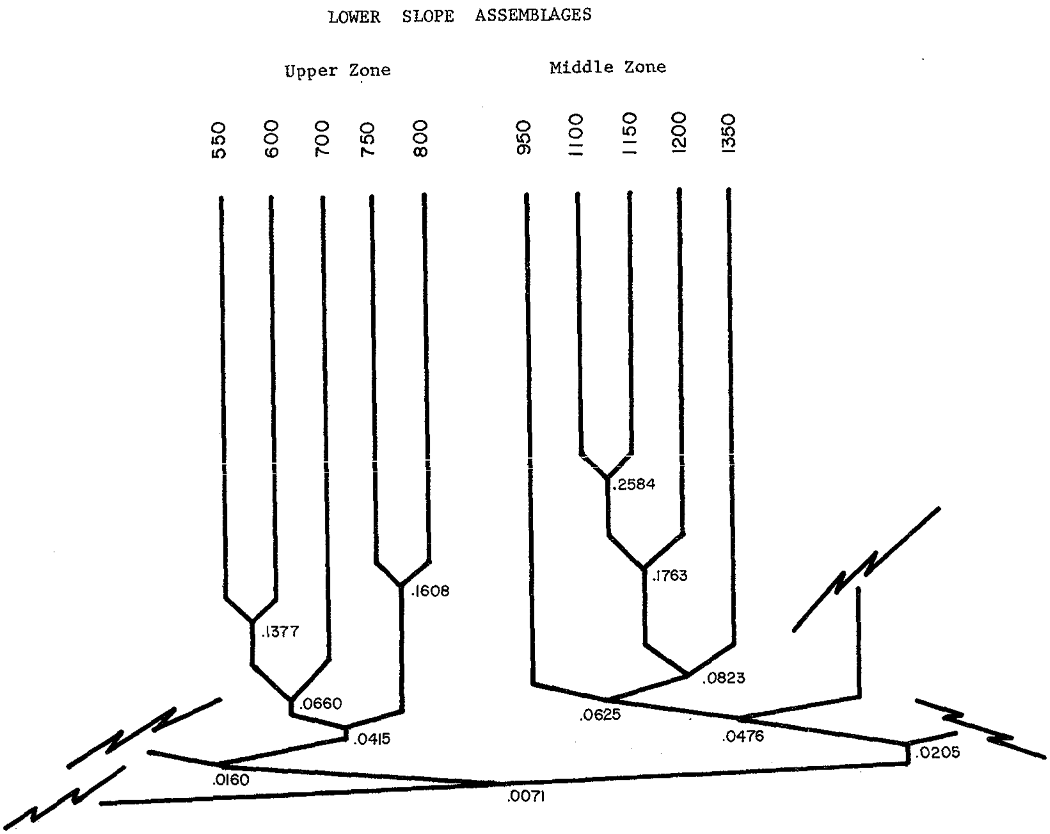


Fig. G-24. Faunal similarity dendrogram (that portion applicable to the present study). Compiled from data on similarity of species collected from stations near the designated isobaths. (Upper numbers represent depth in fathoms while those within the diagram are indices of similarity.)

Oceanites oceanus is the only seabird that regularly occurs in large numbers. Others sighted in the Gulf have been Audubon's Shearwater Puffinus lherminieri, Sooty Shearwater P. griseus, Blue-faced Booby Sula dactylatra, Brown Booby S. leucogaster (Woolfender and Schreiber, 1972), Gannet Morus bassanus and Magnificent Frigatebird Fregata magnificens (Gaillard, 1971).

The existence of trans-Gulf migration of birds is now an established fact. Apparently irrefutable evidence for this phenomenon did not surface until Lowery's works were published in 1945 and 1946. Even so this type of migration was not accepted by all ornithologists, notably Williams (1945, 1947, 1950). The negative argument was based on the supposition that small birds (Fringillidae, for example) did not have sufficient fat deposits to make a non-stop flight. Odum et al. (1961) established that if small birds have fat deposits of 25 percent of their body weight, they have a flight range of 1200 kilometers. The distance from the Yucatan Peninsula to the northern Gulf coast is approximately 1000 kilometers.

Many land birds that winter in Central and South America migrate across the Gulf in fall and spring (Wallace and Mahan, 1975). Fall migrants begin passing through the Gulf states as early as mid-August, attaining significant numbers in mid-September. The largest numbers of migrants have been observed at the end of September and on the first few nights of October, after which numbers decline markedly (Newman and Lowery, 1964).

In one study of fall migration, birds heading toward the Gulf accounted for 48% of all sightings at Pensacola Bay, 66% at St. George Island, 88% at Pilottown, Louisiana and 75% at Grand Isle, Louisiana. Birds migrated south in broad bands toward Yucatan, the nearest land on their path. The 560-mile flight should take 19 hours under ideal conditions (Imhof, 1971).

Spring migration begins in mid-March, and most passerines have reached breeding grounds in the Gulf states by mid-April (Robbins et al., 1966), via the same general routes they use in the fall (Lincoln, 1979). Stevenson (1957) lists 76 bird species that have been observed crossing the Gulf during the spring migration in parts of March, April and May or the fall period during parts of August, September, and October. In Louisiana the earliest migrants appear in the fourth week of March and peak during early May when as many as 50,000 birds per mile of front per day have been observed. It is questionable that these birds would pass near the incineration site.

There are apparently three routes that trans-Gulf migrants follow: (1) Lowery (1946) shows one route to be from Progreso (Yucatan) to the Delta region; (2) Lowery and Neuman (1954) indicate a second route is from Yucatan to a region between Corpus Christi and Freeport, Texas; and (3) Stevenson (1957) believes that some birds winter in the Caribbean area then cross the West Indies and the Gulf on a more or less northwesterly route in the spring. Some of the birds following paths 2 and 3 could pass near or over the incineration site. However, as Gusey (1974) has pointed out, most of the migrating birds fly at elevations between 310 meters and 1530 meters where concentrations of any stack emissions would be very low or non-existent.

ENDANGERED AND THREATENED SPECIES

Several federally designated endangered species occur, either on a permanent or on a transitional basis, within the Gulf of Mexico and possibly within the geographic area of the incineration site. With many of these, no definitive range is identified; thus it is difficult to portray the species accurately for environmental assessment. For the purpose of this report, only those that might possibly occur within the perimeter of the incineration site, i.e., whales and sea turtles will be addressed. For additional information one should consult the Federal Register (Feb. 22, 1977).

WHALES

The population status and migration patterns for these species in the Gulf of Mexico is unknown. The following species are known to occur in the Gulf on an at least transitory basis:

Common Name	Scientific Name
Blue whale	*Balaenoptera musculus*
Finback whale	*Balaenoptera physalus*
Humpback whale	*Megaptera novaeangliae*
Right whale	*Eubalaena* spp. (all species)
Sei whale	*Balaenoptera borealis*
Sperm whale	*Physeter catodon*

SEA TURTLES

The areas of concern relative to these reptiles are the high energy beaches occurring along the Gulf coast which the turtles use for nesting. During their migration to these area, the following species might pass through the region of the incineration site:

Common Name	Scientific Name
Atlantic ridley turtle	*Lepidochelys kemaii*
Hawksbill turtle	*Eretmochelys coriacea*
Loggerhead turtle	*Dermochelys coriacea*
Loggerhead turtle	*Caretta caretta*
Green sea turtle	*Chelonia mydas*

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