MEMORANDUM

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SUBJECT: **Chlorinated Hydrocarbon Manufacturing Segment Description**

This memorandum describes the Chlorine and Chlorinated Hydrocarbon (CCH) manufacturing segment and provides the rationale for the chlorinated hydrocarbon chemical list included in the industry questionnaire.

Project Background

In the 2004 Effluent Guidelines Plan (69 FR 53712), EPA found that, despite existing regulations, significant amounts of dioxins and other toxic pollutants are discharged from facilities manufacturing chlorine using the chlor-alkali process, ethylene dichloride (EDC), vinyl chloride monomer (VCM), and polyvinyl chloride (PVC). EDC is produced by direct chlorination and/or oxychlorination, VCM is produced by dehydrochlorination, and PVC by the polymerization of VCM. Based on this information, EPA identified chlor-alkali, EDC, VCM, and PVC manufacturing operations as possible candidates for effluent limitations guidelines and standards (ELG) revision.

During 2005, EPA identified other manufacturing processes that operate under similar conditions to the chlor-alkali, EDC, and VCM processes, and therefore have potential to discharge dioxins. EPA decided to expand the manufacturing operations considered for revised ELGs to include all chlorine manufacturing processes. The CCH manufacturing segment will also include manufacturing of additional chlorinated hydrocarbons manufactured by direct chlorination, oxychlorination, dehydrochlorination, or hydrochlorination. Chlorinated hydrocarbons that are regulated under the Pesticide Chemicals Point Source Category (40 CFR Part 455) or under the Pharmaceuticals Manufacturing Point Source Category (40 CFR 439) are not included in the CCH manufacturing segment.

The CCH manufacturing segment is defined to include facilities that manufacture chlorine or chlorinated hydrocarbons as a primary product. Below is EPA's definition of "primary product" for the CCH rulemaking:

> **Primary Product –** A primary product may be an intermediate, co-product, or final product. By-products and impurities are not considered primary products. The primary product is the targeted chemical or chemicals in a reactor and purification processing step. For example, the primary products in the chlor-alkali process are chlorine, caustic,

and hydrogen. EDC is the primary product of the direct chlorination or oxychlorination of ethylene.

By-Product – A chemical substance that is produced from a side reaction(s) and is without a separate commercial intent.

Co-Product – A chemical substance that is produced for sale or use in subsequent processes during the manufacture of another chemical substance.

Impurity – A chemical substance which is unintentionally present with another chemical substance.

Chlorinated Hydrocarbon Intermediate – A chlorinated hydrocarbon intermediate is a chlorinated hydrocarbon, which is produced and consumed onsite in another chlorinated hydrocarbon process (e.g. EDC is an intermediate in the production of VCM).

Chlorinated Hydrocarbon Product – A chlorinated hydrocarbon product is a chlorinated hydrocarbon, which is either sold or shipped off site or is consumed in a non-chlorinated hydrocarbon process (e.g. VCM is a chlorinated hydrocarbon product that is consumed onsite for the production of PVC).

Chlorine Manufacturing

The chlor-alkali process accounts for more than 95 percent of the world chlorine production. Other processes that can produce chlorine as a co-product of manufacturing include the downs sodium process, magnesium process, Uhde HCl decomposition process, and nitric acid/salt process. The CCH manufacturing segment includes all chlorine manufacturers. EPA identified five facilities that manufacture chlorine using processes other than chlor-alkali:

- Bayer Corporation in Baytown, TX operates an Uhde HCl decomposition process and a mercury cell chlor-alkali process;
- DuPont in Niagara Falls, NY operates a downs sodium process;
- Oregon Metallurgical in Albany, OR operates a magnesium process;
- Titanium Metals Corporation in Henderson, NV operates a magnesium process; and
- US Magnesium in Rowley, UT operates a magnesium process.

Chlorinated Hydrocarbon Manufacturing

Chlorinated hydrocarbon manufacturing processes include direct chlorination, oxychlorination, dehydrochlorination, and hydrochlorination. In addition, EPA includes the polymerization of VCM to produce PVC in the CCH manufacturing segment. The remainder of this memorandum summarizes ERG's review of chlorinated hydrocarbon manufacturing processes, including the potential for dioxin formation and ERG's methodology to develop the list of CCH products and facilities in the manufacturing segment.

Potential Sources of Dioxins in Chlorinated Hydrocarbon Manufacturing

The potential for dioxin formation in chlorinated hydrocarbon manufacturing processes was a factor in EPA's decision to expand the list of chlorinated hydrocarbons for potential ELG revision. This section provides background information on dioxin formation in chemical manufacturing processes and presents evidence of dioxins in wastewaters from chlorinated hydrocarbon processes.

Theory of Dioxin Formation

Dioxins are formed as unintentional by-products in a wide range of processes. They are widely dispersed in the environment and may be present in manufacturing processes as raw materials or products. Consequently, releases or transfers of dioxins can occur even if dioxins are not formed in the process [1]. Research of dioxin formation in combustion sources suggests that dioxins may be formed by a *de novo* synthesis [2]. The following factors are necessary for the *de novo* synthesis of dioxins and furans from carbon:

- Carbon consisting of imperfect and degenerated layers of graphite;
- Presence of oxygen;
- Presence of chlorine;
- Copper chloride or another transition metal catalyst; and
- Temperatures in the range of 200 to 350°C [2].

In addition, for chemical manufacturing processes, the following conditions are favorable for generation of dioxins and furans:

- High temperature (>150°C);
- Alkaline conditions (especially during purification); and
- UV radiation or other radical starters [1].

The oxychlorination of ethylene to produce EDC is the most favorable process step for the formation of dioxins in the chemical industry [1]. The process has a carbon source, a chlorine source, oxygen, a copper chloride catalyst, and temperatures in the range for dioxin formation. VCM production by thermal dehydrochlorination of EDC is unlikely to form dioxins due to the low concentration of oxygen. Chemical conditions in PVC polymerization are not favorable for dioxin formation. Other sources of dioxins include streams from liquid/gas or vent gas combustors. Dioxins may also be present on catalyst support. [1]

Chlorinated aliphatic processes are not likely to produce high levels of dioxins. Most processes are expected to produce little to no dioxins. Dioxin formation is most probable in chlorinated aliphatic processes that use mixed residues as feedstock. For example, heavy ends from EDC production can be fed to an oxychlorination reactor to make perchloroethylene and trichloroethylene. [1]

In the manufacture of chlorobenzenes, dioxin formation was a concern for one process that produces trichlorobenzene. This process is no longer used. However, other processes to produce mono- and dichlorobenzenes may form dioxins during purification steps where alkaline conditions exist. [1]

Other chemical products, for which manufacturing processes have been characterized for their potential to form dioxins include:

- Chlorophenols and derivatives – U.S. production of chlorophenols is limited to 2,4-dichlorophenol and pentachlorophenol. Pentachlorophenol is a pesticide. [2]

- Polychlorinated byphenyls (PCB's) – There is no production of PCB's in the U.S.

- 2,4,6-Trichlorophenyl-4'-nitrophenyl ether (CNP) – This chemical is an herbicide.

- Chloranil – There is no domestic production of chloranil in the U.S. [1] However, large quantities of choranil are imported to the U.S. for use in the manufacture of diazo dyes. In May 1993, EPA proposed a significant new use rule (SNUR) under Section 5 of TSCA that requires industry to notify EPA at least 90 days prior to the manufacture, import, or processing, or any use, of chloranil containing total CDD/CDFs at a concentration greater than 20 μg/kg. [2]

Evidence of Dioxin Formation – Office of Solid Waste (OSW) Dioxin Data (3)

As part of its rule development, the Office of Solid Waste (OSW) sampled wastewater streams from chlorinated aliphatic production. Table 1 summarizes the wastewater streams sampled. Note that descriptions of the sample points are often not publicly available due to CBI considerations. OSW detected dioxins in wastewater from the production of the following chlorinated aliphatics:

- EDC/VCM;
- Chlorinated methanes;
- Vinylidene chloride;
- [CBI Redacted];
- [CBI Redacted];
- Allyl chloride;
- Hexachlorocyclopentadiene; and
- Perchloroethylene/Trichloroethylene.

Table 2 describes the typical characteristics of each process for the chemicals listed above. In addition, OSW identified the following chlorinated aliphatics during the industry study and determined that the chemical processes did not generate wastewater:

- 1,1,2-Trichloroethane (Vinyl trichloride);
- Ethyl chloride;
- Trans-1,2-dichloroethene;

- 1,1-dichloroethane;
- 1,1,2,2-tetrachloroethane;
- Pentachloroethane; and
- Beta-Trichloroethane.

Table 1. Wastewater Streams Sampled During Chlorinated Aliphatics Listing Determination

Facility Name	Stream Name	Dioxin
Borden – Geismar, LA	Combined stripper bottoms from VCM process	Detected
Dow – Freeport, Texas	Unit V Oxychlorination Quench	Detected
	Unit I Oxychlorination Quench	Detected
	Trichloroethylene wastewater	Not detected
	Wastewater treatment headworks – specialty train	Detected
	Wastewater treatment headworks – chlorohydrin train	Detected
	Vinylidene chloride wastewater	Detected
	Chlorinated methanes (CMP) wastewater from quench/stripping operation	Detected
	Chlorinated methanes wastewater from cooling/drying/neutralization	Not detected
Dow Corning – Carrollton, KY (site makes methyl chloride as intermediate for siloxane products (2 production lines)	Spent vent scrubber water from production line 1	Not detected
	Wastewater treatment headworks	Not detected
DuPont Dow Elastomers – Louisville, KY (Information on specific chemicals manufactured is CBI)	Scrubber water from the Process 1	Detected
	Scrubber water from the Process 2	Not detected
	Stripper and decanter water from the Process 3	Detected
	Combined headworks to WWT	Detected
DuPont Dow Elastomers, LaPlace, LA (site manufactures 1,4-dichloro-2-butene and 3,4-dichloro-1-butene as intermediates in chloroprene production, report does not list definitions for DCB and CD)	DCB isomerization scrubber water	Not detected
	WW from HCl recovery	Detected
	CD brine from steam stripping	Detected
Geon – LaPorte, TX	Wastewater from EDC/VCM processes after stripping	Detected
Occidental -- Convent, LA	EDC stripper bottoms	Not detected
Oxymar – Ingleside, TX	EDC/VCM steam stripper bottoms	Detected
	EDC steam stripper bottoms	Detected
PPG – Lake Charles, LA	OHC stripper bottoms	Detected
	Perc/Tri stripper bottoms	Detected
Shell – Norco, LA (manufactures allyl chloride)	HCl scrubber water	Not detected
	Caustic scrubber water	Not detected
	Equalization effluent	Detected
Velsicol – Memphis, TN (manufactures hexachloropentadiene from chlorination/dehydrochlorination of cyclopentadiene for sale and for production of heptachlor and chlrendic)	Combined caustic scrubber water	Detected
	Incinerator caustic scrubber	Detected
	Incinerator quench	Detected
	Combined headworks to pretreatment	Detected

Table 1 (Continued)

Facility Name	Stream Name	Dioxin
Vulcan -- Geismar, LA	EDC steam stripper bottoms effluent	Detected
	Chloromethane steam stripper bottoms	Not detected
	Wastewater treatment headworks – air stripper feed	Detected
	Combined wastewater feed to neutralization	Detected

Table 2. Process Descriptions for Chlorinated Aliphatics with Detectible Levels of Dioxins in Wastewater

Chlorinated Aliphatic	Process	Reaction	Reactor Temperature	Catalyst	Oxygen Present?
EDC	Direct chlorination	Liquid or vapor phase reaction of ethylene and chlorine to produce EDC	40–50°C (Liquid phase only)	Ferric chloride, aluminum chloride, antimony pentachloride, or cupric chloride	No Oxygen is an inhibitor
EDC	Oxychlorination	Vapor phase reaction of ethylene and HCl to produce EDC and water	250–300°C	Cupric chloride	Oxygen or air present
VCM	Dehydrochlorination	Thermal cracking of EDC to produce VCM and HCl	425-550°C	None	No oxygen
Chlorinated methanes	Direct chlorination	Thermal chlorination of methyl chloride to form methylene chloride, chloroform, and carbon tetrachloride	No information	No information	No oxygen
Allyl chloride	Direct chlorination	Thermal chlorination of propylene and chlorine to form allyl chloride and HCl Allyl chloride is an intermediate for epichlorohydrin production	No information	No information	No oxygen
Vinylidene chloride	Dehydrochlorination	Caustic dehydrochlorination of 1,1,2-Trichloroethane using NaOH to form vinylidene chloride, NaCl, and water	Aqueous phase reaction Low temperatures	Phase transfer catalysts can be used	Oxygen is present in NaOH
Perchloroethylene/ Trichloroethylene	Oxychlorination	Oxychlorination reaction forms perchloroethylene and trichloroethylene	250–300°C	Cupric chloride	Oxygen or air present
Hexachlorocyclopentadiene	Chlorination Dehydrochlorination	Chlorination/dehydrochlorination of cyclopentadiene	No information	No information	No information

Development of Chlorinated Hydrocarbons List

The following sections of this memorandum describe the methodology ERG used to develop a recommended list of chlorinated hydrocarbons for the CCH manufacturing segment. The final recommended list is shown in Table 4 at the end of this memorandum.

Definitions

During initial discussions with industry trade organizations, industry personnel raised questions about the definitions used to describe the CCH manufacturing segment. Based on the key industry terms and definitions below, ERG proposes defining chlorinated hydrocarbons as organic compounds containing only carbon, hydrogen, and chlorine (including chlorinated paraffins), and excluding pesticides and pharmaceuticals.

Hydrocarbons:

Chemical compounds that consist entirely of carbon and hydrogen. [4]

Aliphatic: One of the major groups of organic compounds, characterized by straight- or branched- chain arrangement of the constituent carbon atoms. Aliphatic hydrocarbons comprise three subgroups:

1. Alkane (paraffin) – A class of aliphatic hydrocarbons characterized by a straight or branched carbon chain; generic formula C_nH_{2n+2}.

2. Alkene (olefin) – A class of unsaturated aliphatic hydrocarbons having one or more double bonds.

3. Alkyne (acetylene hydrocarbon) – One of a class of unsaturated hydrocarbons of the homologous series having the generic formula C_nH_{2n-2} and a structural formula containing a triple bond. [4]

Aromatic: A major group of unsaturated cyclic hydrocarbons containing one or more rings, typified by benzene, which has a 6-carbon ring containing three double bonds. [4]

Chlorinated hydrocarbon:

1. Chemicals containing only chlorine, carbon, and hydrogen. These include a class of persistent, broad-spectrum insecticides that linger in the environment and accumulate in the food chain. Among them are DDT, aldrin, dieldrin, heptachlor, chlordane, lindane, endrin, Mirex, hexachloride, and toxaphene. Other examples include TCE, used as an industrial solvent.

2. Any chlorinated organic compounds including chlorinated solvents such as dichloromethane, trichloromethylene, chloroform. [5]

Chlorinated aromatics: Collective term for chlorinated derivatives of benzene, toluene, phenol, naphthalene and bi-phenyl and other compounds containing at least one benzene ring. Chlorinated aromatics are widely used as intermediates in the manufacture of medicines, agricultural chemicals and paints. [6]

Chlorinated solvents: Trichloroethylene, tetrachloroethylene (also known as perchloroethylene), and methylene chloride (also known as dichloromethane), are the main solvents in this group. Due to their non-flammability, these compounds have been widely used for cleaning metals in the electronics industry and for dry cleaning of clothes. The use of 1,1,1-trichloroethane was phased out at the end of 1995 under the Montreal Protocol. [6]

Chlorinated Paraffins: Chemicals manufactured by chlorination of liquid n-paraffin or paraffin wax. The largest application for chlorinated paraffins is as a plasticizer and flame-retardant in flexible PVC. They are also used as plasticizers in paint, sealants and adhesives. Higher chlorine content grades are used as flame-retardants in a wide range of rubbers and polymer systems. Another major outlet for chlorinated paraffins is in the formulation of metalworking lubricants where they have long been recognized as one of the most effective additives for lubricants used in a wide range of machining and engineering operations. Finally, they are used in leather formulations. [6]

Chlorocarbon: A compound of carbon and chlorine or carbon, hydrogen, and chlorine. [6]

Organic chlorine compounds:

A group of more than 2,000 substances which are based on organic compounds (i.e. carbon-containing) with one or more chlorine atoms. Organic chlorine compounds are important synthetic building blocks in the chemical industry, and they are also formed in nature in large quantities. [6]

Manufacturing Processes

ERG reviewed the manufacture of chlorocarbons and chlorohydrocarbons in the Kirk-Othmer Encyclopedia of Chemical Technology [7]. According to Kirk-Othmer, processes have evolved over the years to obtain high yields of the desired chlorinated hydrocarbon. Byproducts are used as raw materials to form other products. Figure 1 shows the integration of the different chlorinated hydrocarbon manufacturing processes (Kirk-Othmer).

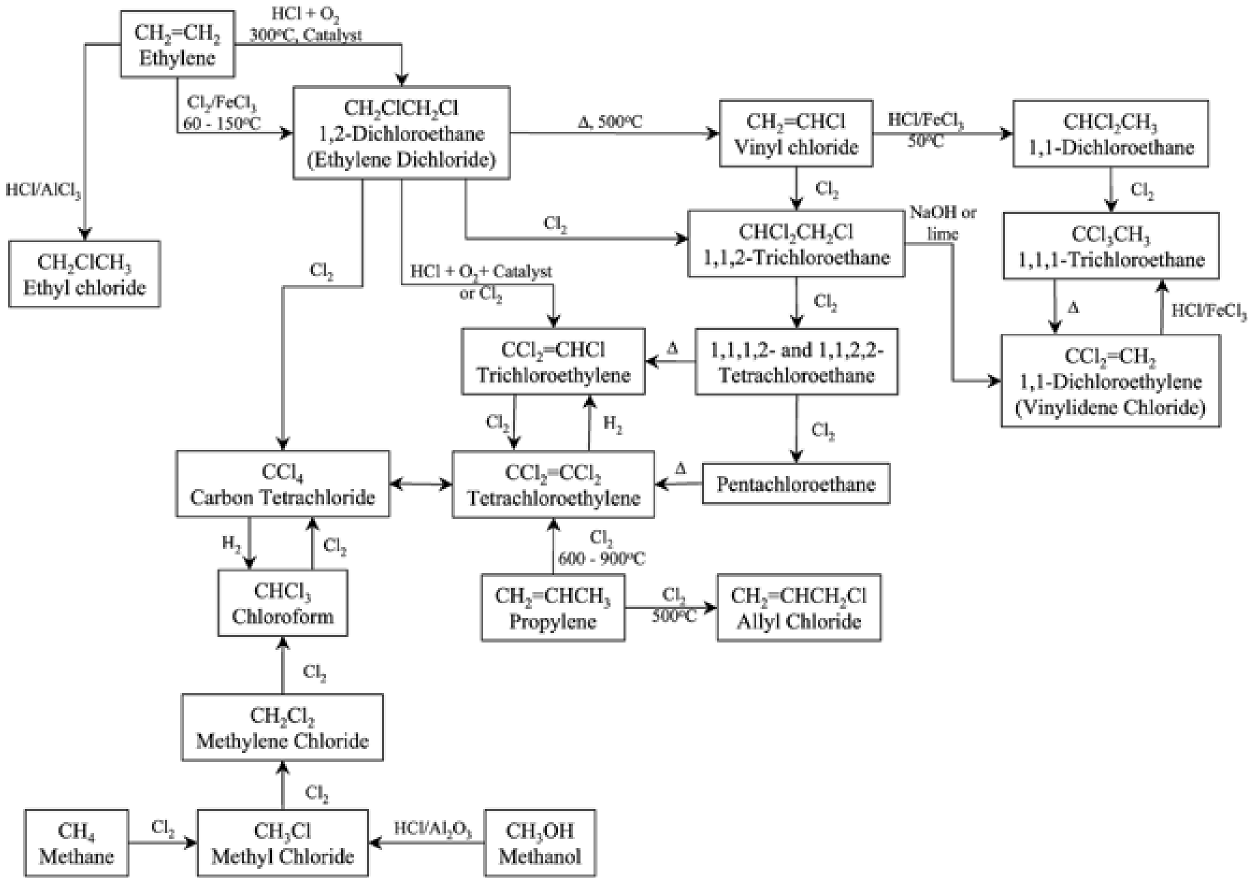

Figure 1. Example of Representative Integrated Manufacturing Process for Production of Chlorocarbons and Chlorohydrocarbons [7]

ERG identified seventeen chlorinated hydrocarbon products and the following types of manufacturing processes in Figure 1:

- **Direct Chlorination -** Introduction of chlorine into a chemical compound by one of the following mechanisms:

  — Free radical substitution: Chlorine radicals may be generated by thermal (>250^{o}C), photochemical (UV light), or chemical (initiators) means [7],

  — Addition chlorination: Ionic addition method typically uses a Lewis acid, such as ferric chloride, aluminum chloride, antimony pentachloride, or cupric chloride. A radical chain mechanism can also be applied [7], or

  — Electrophilic aromatic substitution [8];

- **Oxychlorination:** Reaction of chlorine or hydrogen chloride with oxygen and a hydrocarbon or chlorinated hydrocarbon in the presence of a chloride catalyst (typically copper chloride) to form a chlorinated hydrocarbon [7];

- **Hydrochlorination -** Introduction of chlorine into a chemical compound by one of the following mechanisms:

  — Electrophilic addition of HCl to alkenes [7], or

  — Chloro Dehydroxylation: Substitution of a hydroxyl group with HCl to form an alkyl chloride and water. (e.g., Hydrochlorination of methanol to produce methyl chloride) [7]; and

- **Dehydrochlorination -** Elimination of HCl from a chlorinated hydrocarbon to produce an unsaturated product. Can be accomplished by reaction with bases (caustic dehydrochlorination), catalytic reactions, or by thermal noncatalytic chemistry (thermal cracking). [7]

Additional Data Sources

The following is a description of the additional data sources ERG used to develop the list of chlorinated hydrocarbons. All chlorinated hydrocarbons identified in these sources are included in Table 3 at the end of this section.

1. **OCPSF Technical Development Document [9].** ERG created a list, using Table V-36 of the OCPSF TDD to identify chlorinated hydrocarbons that are manufactured using the four manufacturing processes from Figure 1. In addition to identifying 26 chlorinated hydrocarbon compounds, the TDD identified eight chlorinated organic compounds that do not meet the definition of chlorinated hydrocarbon proposed in this memorandum. Process descriptions for the chlorinated organic compounds are provided at the end of this memorandum in Attachment A.

2. **TRI Contacts.** ERG contacted OCPSF facilities that reported dioxin releases to water in 2002 to identify other potential sources of dioxins. Attachment B presents the findings from the telephone calls. One facility, Velsicol, in Memphis, TN, manufactures hexachlorocyclopentadiene and is included in the CCH manufacturing segment based on information obtained from the site (see Attachment B).

3. **Office of Solid Waste (OSW) Chlorinated Aliphatics Listing Determination [3].** OSW promulgated a hazardous waste rule under the Resource Conservation and Recovery Act (RCRA) on Chlorinated Aliphatics Production Wastes on November 8, 2000. OSW defined chlorinated aliphatics as any organic compound characterized by straight-chain, branched-chain, or cyclic hydrocarbons containing one to five carbons, with varying amounts and degrees of chlorine substitution. Hydrocarbons are organic compounds composed solely of the atoms hydrogen and carbon. Aliphatics occur where the chemical bonds between carbon atoms are single, double, or triple covalent bonds (not aromatic bonds). Cyclic aliphatic hydrocarbons included consist of alkanes, alkenes or alkadienes, and alkynes. The definition of chlorinated aliphatics came from definitions used previously by OSW in the F024 listing. Although OSW had previously limited its definition to wastes generated from the production of chlorinated aliphatics by free

radical catalyzed processes for the F024 listing, OSW did not limit this rulemaking by type of process.

Chlorinated aliphatic products and intermediates reported (as of 1996) from facilities studied as part of the OSW listing investigation included:

- Allyl chloride (107-05-1);
- Chloromethane (74-87-3);
- Dichloromethane (75-09-2);
- Chloroform (67-66-3);
- Carbon tetrachloride (56-23-5);
- Chloroprene (126-99-8);
- Ethylene dichloride (EDC) (107-06-2);
- trans-1,2-Dichloroethylene (156-60-5);
- 1,3-Dichloropropene (542-75-6);
- Vinyl chloride monomer (VCM) (75-01-4);
- Hexachlorocyclopentadiene (77-47-4);
- 1,1,2-Trichloroethane (79-00-5);
- 1,1,1-Trichloroethane (71-55-6);
- Methallyl chloride (513-37-1);
- Perchloroethylene (127-18-4);
- Trichloroethylene (79-01-6);
- Chloroethane (75-00-3);
- Vinylidene chloride (75-35-4);
- 3,4-Dichloro-1-butene (760-23-6); and
- 1,4-Dichloro-2-butene (764-41-0).

The OSW chemical list included an additional three chemicals whose names were redacted for CBI purposes. (Chlorinated Aliphatics Listing Determination Background Document, Final Rule, Final 2 June 30, 2000). EDC and VCM were the most common processes in the chlorinated aliphatics industry in 1996 accounting for more than 85 percent of the total production. Methyl chloride was the second most common process. ERG reviewed the OSW document to identify additional chlorinated hydrocarbons, manufacturing processes, and manufacturers.

4. **OCPSF Guidance Document [10].** ERG searched Appendix A of the OCPSF Guidance Document, which lists organic chemical products regulated under 40 CFR Part 414. ERG added any chlorinated hydrocarbons found in Appendix A that were not originally identified in the OCSPF TDD. The guidance document does not provide information on the type of chemical process that is used to manufacture the chemical.

Table 3 is a complete list of the chemicals from the OCSPF TDD, TRI calls, OSW report, and OCSPF Guidance Document. ERG further refined the list of chlorinated hydrocarbons using the following resources. Updates are noted in Table 3. The final recommended list of chlorinated hydrocarbons in the CCH manufacturing segment is presented in Table 4.

- **2002 Toxic Substances Control Act (TSCA) Inventory Update Rule (IUR) [11].** In 1986, EPA promulgated the Inventory Update Rule (IUR) for the partial updating of the Toxic Substances Control Act (TSCA) Chemical Inventory Database. The rule requires manufacturers and importers of certain chemical substances included on the TSCA Chemical Substances Inventory to report current data on the production volume, plant site, and site-limited status of these substances. ERG checked each chlorinated hydrocarbon for company listings in the IUR database. If no records exist in the IUR database for a chemical, the chemical may not be manufactured in the United States.

- **Montreal Protocol [12].** This international treaty was signed in 1987 and amended in 1990 and 1992. The Montreal Protocol stipulates that the production and consumption of compounds that deplete ozone in the stratosphere, such as chlorofluorocarbons (CFCs), halons, carbon tetrachloride, and methyl chloroform, are to be phased out by 2000 (2005 for methyl chloroform). ERG reviewed the compounds included in the Montreal Protocol and eliminated two chlorinated hydrocarbons, carbon tetrachloride and 1,1,1-trichloroethane, from the list.

- **Pesticides Chemicals List [13].** Table 1 of 40 CFR Part 455 lists the organic pesticide active ingredients that are regulated under the Pesticide Chemicals point source category. ERG identified chlorinated hydrocarbons that are listed in Part 455 as pesticide active ingredients and removed them from the CCH chemical list.

Table 3. List of Identified Chlorinated Hydrocarbons

IUPAC	Common Name	CAS	Source(s)	OCPSF Subpart	Manufacturing Process(es)	Included in the scope of CCH Manufacturing Segment?
Chlorinated Methanes						
Chloromethane	Methyl Chloride	74-87-3	Kirk OCPSF OSW Guide	G	(1) Chlorination of methane. (2) Hydrochlorination of methanol.	Yes
Dichloromethane	Methylene Chloride	75-09-2	Kirk OCPSF OSW Guide	G	(1) Chlorination of methyl chloride.	Yes
Trichloromethane	Chloroform	67-66-3	Kirk OCPSF OSW Guide	G	(1) Chlorination of methyl chloride. (2) Chlorination of methane.	Yes
Tetrachloromethane	Carbon Tetrachloride	56-23-5	Kirk OCPSF OSW	G	(1) Chlorination of methyl chloride. (2) Chlorination of low MW hydrocarbons.	No (Montreal Protocol)
Chlorinated Ethanes						
Chloroethane	Ethyl Chloride	75-00-3	Kirk OCPSF OSW Guide	G	(1) Hydrochlorination of ethylene (byproduct of EDC manufacturing). (2) Hydrochlorination of ethyl alcohol. (3) Chlorination of ethane.	Yes
1,1-Dichloroethane	Ethylidene Chloride	75-34-3	Kirk OCPSF Guide	G	(1) Chlorination of VCM with HCl. (2) Chlorination of ethane.	Yes
1,2-Dichloroethane	Ethylene Dichloride	107-06-2	304m Kirk OCSPF OSW Guide	F	(1) Direct Chlorination of Ethylene (2) Oxychlorination of Ethylene	Yes

Table 3 (Continued)

IUPAC	Common Name	CAS	Source(s)	OCPSF Subpart	Manufacturing Process(es)	Included in the scope of CCH Manufacturing Segment?
1,1,1-Trichloroethane	Methyl Chloroform	71-55-6	Kirk OCPSF OSW Guide	G	(1) Chlorination of VCM with HCl. (2) Direct chlorination of Ethane. (3) Catalyzed addition of HCl to vinylidene chloride.	No (Montreal Protocol)
1,1,2-Trichloroethane	Vinyl Trichloride	79-00-5	Kirk OSW Guide	H	(1) Chlorination of EDC. (2) Oxychlorination of ethylene.	Yes
1,1,1,2-Tetrachloroethane	Chloromethyltrichloro-methane	630-20-6	Kirk Guide	H	Direct chlorination.	Yes
1,1,2,2-Tetrachloroethane	Acetylene Tetrachloride	79-34-5	Kirk OCPSF Guide	H	(1) Catalytic addition of Cl to Acetylene. (2) Oxychlorination of ethylene. (3) Direct chlorination of ethylene.	Yes
Pentachloroethane	Ethane pentachloride	76-01-7	Kirk	H**	Direct chlorination.	Yes
1,1,1,2,2,2-hexachloroethane	Hexachloroethane	67-72-1	OCPSF Guide	H	(1) Chlorination of PCE (2) Chlorination of ethylene (3) Pyrolysis of carbon tetrachloride (co-product)	Yes
Chlorinated Ethenes						
Monochloroethylene	Vinyl Chloride	75-01-4	304m Kirk OCPSF OSW Guide	F	(1) Dehydrochlorination of EDC	Yes
1,2-Dichloroethene	Acetylene dichloride	156-60-5 (trans)	OSW Guide	H	(1) Direct chlorination of Acetylene (2) Dehydrochlorination of 1,1,2 – TCA.	Yes
1,1,-Dichloroethene	Vinylidene Chloride	75-35-4	Kirk OCPSF OSW Guide	H	(1) Dehydrochlorination of 1,1,2-trichloroethane with lime or caustic excess (commercial) (2) Catalytic cracking of trichloroethane, HCl byproduct (low yield)	Yes

Table 3 (Continued)

IUPAC	Common Name	CAS	Source(s)	OCPSF Subpart	Manufacturing Process(es)	Included in the scope of CCH Manufacturing Segment?
1,1-dichloro-2-chloroethylene	Trichloroethylene	79-01-6	Kirk OCPSF OSW Guide	G	(1) Oxychlorination of EDC (PPG). (2) Direct chlorination of EDC (DOW).	Yes
1,1,2,2-Tetrachloroethylene	Perchloroethylene	127-18-4	Kirk OCPSF OSW Guide	G	(1) Direct chlorination of hydrocarbons. (2) Oxychlorination of ethylene.	Yes
Chlorinated Propanes						
1-Chloropropane	n-Propyl chloride	540-54-5	Guide	H	No information	Yes*
1,1-Dichloropropane	Propylidene chloride	78-99-9	OCPSF	G	Direct chlorination.	Yes*
1,2-Dichloropropane	Propylene dichloride	78-87-5	OCPSF Guide	H	(1) By-product of the chlorohydrin process to make propylene oxide. (2) Direct chlorination of propylene.	Yes
1,3-Dichloropropane	Trimethylene Dichloride	142-28-9	OCPSF	G	Direct chlorination.	Yes*
2,2-Dichloropropane	Dimethyl-dichloromethane	594-20-7	OCPSF	G	Direct chlorination.	Yes*
1,2,3-Trichloropropane	Allyl trichloride	96-18-4	Guide	H	(1) Chlorination of propylene.	Yes
Chlorinated Propenes						
3-Chloro-1-propene	Allyl Chloride	107-05-1	Kirk OCPSF OSW	G	Direct chlorination.	Yes
1,2-Dichloropropene	1,2-Dichloropropylene	563-54-2	OCPSF	H**	Direct chlorination. Dehydrochlorination.	Yes*

Table 3 (Continued)

IUPAC	Common Name	CAS	Source(s)	OCPSF Subpart	Manufacturing Process(es)	Included in the scope of CCH Manufacturing Segment?
1,3-Dichloropropene	cis-Propylene dichloride	10061-01-5 (cis), 10061-02-6 (trans)	OSW	H	(1) Chlorination of propylene. (2) Dehydration of 1,3-dichloro-2-propanol.	No (Pesticide)
1,2,3-Trichloropropene	Trichloropropene	96-19-5	OCPSF	H	Direct chlorination.	Yes*
Chlorinated Butanes						
1-Chlorobutane	Butyl Chloride	109-69-3	Guide	H	No information.	Yes
trans-1,4-Dichloro-2-butene	trans-2-Butylene dichloride	110-57-6	Guide	H	No information.	Yes*
1-Chloro-2-methylpropene	Methyl Allyl Chloride	513-37-1	OSW	H	CBI redacted	Yes*
3,4-dichloro-1-butene		760-23-6	OSW	H**	Chlorination of butadiene	Yes
1,4-dichloro-2-butene		764-41-0	OSW	H	Chlorination of butadiene	Yes
2-Chlorobutadiene	Chloroprene	126-99-8	OSW Guide	G	Chlorination of butadiene followed by isomerization and dehydrochlorination.	Yes
Hexachlorobutadiene	Perchlorobutadiene	87-68-3	Guide	H	No information.	Yes*
Chlorinated Cyclopentadiene						
Hexachlorocyclopentadiene	Perchlorocyclopentadiene	77-47-4	OSW TRI	H	(1) Chlorination of cyclopentadiene. (2)Dechlorination of octachlorocyclopentadiene.	Yes
Chlorinated Hexanes						
1-Chlorohexane	Hexyl chloride	544-10-5	Guide	H	No information.	Yes
1,2,3,4,5,6-hexachlorocyclohexane	Hexachloride (Benzene Hexachloride)	608-73-1		NA	(1) Photochlorination of benzene.	No (Pesticide)

Table 3 (Continued)

IUPAC	Common Name	CAS	Source(s)	OCPSF Subpart	Manufacturing Process(es)	Included in the scope of CCH Manufacturing Segment?
Chlorinated Aromatics						
Chlorobenzene	Monochlorobenzene	108-90-7	OCPSF Guide	G	Direct chlorination.	Yes
1,2-Dichlorobenzene	o-Dichlorobenzene	95-50-1	OCPSF Guide	H	Direct chlorination.	Yes
1,4-Dichlorobenzene	p-Dichlorobenzene	106-46-7	OCPSF Guide	H	Direct chlorination.	No (Pesticide)
1,3-Dichlorobenzene	m-Dichlorobenzene	541-73-1	Guide	H	Direct chlorination	Yes*
Trichlorobenzene	Trichlorobenzene	12002-48-1	OCPSF Guide	H	Direct chlorination.	Yes*
1,2,3,4-tetrachlorobenzene	Tetrachlorobenzene	12408-10-5	OCPSF Guide	H	Direct chlorination.	Yes*
1,2,3,4,5-Pentachlorobenzene	Pentachlorobenzene	608-93-5	OCPSF Guide	H	Direct chlorination.	Yes*
Hexachlorobenzene (HCB)	Amatin	118-74-1	OCPSF	H	Direct chlorination.	Yes*
Chloromethyl Benzene	Benzyl Chloride	100-44-7	OCPSF	G	Direct chlorination.	Yes
Chlorotoluene	o,m,p-Chlorotoluene	25168-05-2	Guide	H	Direct chlorination	Yes
Chlorinated Paraffins		63449-39-8	Guide	G	Direct chlorination	Yes
Polyvinyl Chloride		9002-86-2	304m	D	Polymerization of VCM	Yes

*ERG did not identify manufacturers of this compound in the IUR database. Chemical may not be manufactured in the U.S.

**Chemical assumed to be included in Subpart H though it was not specifically listed in the OCPSF TDD or Guidance Document. However, Subpart H does not provide an all-inclusive list of specialty chemicals for regulation.

Table 4. List of Chemicals Included in CCH Manufacturing Segment

	IUPAC	Common Name	CAS
1	Chlorine		7782-50-5
2	Chloromethane	Methyl Chloride	74-87-3
3	Dichloromethane	Methylene Chloride	75-09-2
4	Trichloromethane	Chloroform	67-66-3
5	Chloroethane[1]	Ethyl Chloride[1]	75-00-3
6	1,1-Dichloroethane[1]	Ethylidene Chloride[1]	75-34-3
7	1,2-Dichloroethane	Ethylene Dichloride	107-06-2
8	1,1,2-Trichloroethane[1]	Vinyl Trichloride[1]	79-00-5
9	1,1,1,2-Tetrachloroethane	Chloromethyltrichloromethane	630-20-6
10	1,1,2,2-Tetrachloroethane[1]	Acetylene Tetrachloride[1]	79-34-5
11	Pentachloroethane[1]	Ethane pentachloride[1]	76-01-7
12	1,1,1,2,2,2-hexachloroethane	Hexachloroethane	67-72-1
13	Monochloroethylene	Vinyl Chloride	75-01-4
14	1,2-Dichloroethene[1]	Acetylene dichloride[1]	156-60-5 (trans)
15	1,1,-Dichloroethene	Vinylidene Chloride	75-35-4
16	1,1-dichloro-2-chloroethylene	Trichloroethylene	79-01-6
17	1,1,2,2-Tetrachloroethylene	Perchloroethylene	127-18-4
18	1-Chloropropane[2]	n-Propyl chloride[2]	540-54-5
19	1,1-Dichloropropane[2]	Propylidene chloride[2]	78-99-9
20	1,2-Dichloropropane	Propylene dichloride	78-87-5
21	1,3-Dichloropropane[2]	Trimethylene Dichloride[2]	142-28-9
22	2,2-Dichloropropane[2]	Dimethyl-dichloromethane[2]	594-20-7
23	1,2,3-Trichloropropane	Allyl trichloride	96-18-4
24	3-Chloro-1-propene	Allyl Chloride	107-05-1
25	1,2-Dichloropropene[2]	1,2-Dichloropropylene[2]	563-54-2
26	1,2,3-Trichloropropene [2]	Trichloropropene[2]	96-19-5
27	1-Chlorobutane	Butyl Chloride	109-69-3
28	trans-1,4-Dichloro-2-butene[2]	trans-2-Butylene dichloride[2]	110-57-6
29	1-Chloro-2-methylpropene[2]	Methyl Allyl Chloride[2]	513-37-1
30	3,4-dichloro-1-butene		760-23-6
31	1,4-dichloro-2-butene		764-41-0
32	2-Chlorobutadiene	Chloroprene	126-99-8
33	Hexachlorobutadiene[2]	Perchlorobutadiene[2]	87-68-3
34	Hexachlorocyclopentadiene	Perchlorocyclopentadiene	77-47-4
35	1-Chlorohexane	Hexyl chloride	544-10-5
36	Chlorobenzene	Monochlorobenzene	108-90-7
37	1,2-Dichlorobenzene	o-Dichlorobenzene	95-50-1
38	1,3-Dichlorobenzene[2]	m-Dichlorobenzene[2]	541-73-1
39	Trichlorobenzene[2]	Trichlorobenzene[2]	12002-48-1
40	1,2,3,4-tetrachlorobenzene[2]	Tetrachlorobenzene[2]	12408-10-5
41	1,2,3,4,5-Pentachlorobenzene[2]	Pentachlorobenzene[2]	608-93-5

Table 4 (Continued)

	IUPAC	Common Name	CAS
42	Hexachlorobenzene (HCB) [2]	Amatin[2]	118-74-1
43	Chloromethyl Benzene	Benzyl Chloride	100-44-7
44	Chlorotoluene	o,m,p-Chlorotoluene	25168-05-2
45	Chlorinated Paraffins		63449-39-8
46	Polyvinyl Chloride		9002-86-2

[1]OSW industry study determined these processes do not generate wastewater.
[2]ERG did not identify manufacturers of this compound in the IUR database. Chemical may not be manufactured in the U.S.
[3]Chemical assumed to be included in Subpart H though it was not specifically listed in OCPSF TDD or Guidance Document. However, Subpart H does not provide an all-inclusive list of specialty chemicals for regulation.

Facility List

ERG used the publicly available sources listed below to determine the manufacturers of the chlorinated hydrocarbons listed in Table 4:

- Kirk-Othmer [7];
- PCS;
- TRI;
- Chemical Market Reporter [16];
- Chlorine Institute [17]; and
- Company web sites.

The industry trade groups provided comments on EPA's initial facility list on September 9, 2005. Table 5 shows the list of facilities currently in the CCH project manufacturing segment. EPA plans to send all listed facilities an industry questionnaire to obtain more detailed information about manufacturing processes and wastewater treatment.

Table 5. List of Facilities Included in CCH Manufacturing Segment

Company	Location	Chlorine	Chlorinated Hydrocarbons	PVC
Allvac-OreMet (formerly Oregon Metallurgical)	Albany, OR	X		
ASHTA Chemicals, Inc	Ashtabula, OH	X		
Bayer Corporation	Baytown, TX	X		
Certainteed Corp.	Westlake, LA			X
Colorite Specialty Resins	Burlington, NJ			X
Dover Chemical	Hammond, IN		X	
Dover Chemical	Dover, OH		X	
Dow	Freeport, TX	X	X	
Dow	Plaquemine, LA	X	X	
Dow	Texas City, TX		X	X
Dow Corning	Carrollton, KY		X	
DuPont	Niagara Falls, NY	X		
DuPont Performance Elastomers	LaPlace, LA		X	
DuPont Performance Elastomers	Louisville, KY		X	
ERCO Worldwide (formerly Vulcan)	Port Edwards, WI	X		
Ferro Corporation	Bridgeport, NJ		X	
Formosa Plastics	Baton Rouge, LA	X	X	X
Formosa Plastics	Delaware City, DE			X
Formosa Plastics	Point Comfort, TX	X	X	X
General Electric Co.	Burkeville, AL	X		
General Electric Co.	Mt. Vernon, IN	X		
Georgia Gulf	Aberdeen, MS			X
Georgia Gulf Chemicals & Vinyls L.L.C.	Oklahoma City, OK			X
Georgia Gulf Corporation	Plaquemine, LA	X	X	X
Georgia Gulf Lake Charles LLC	Westlake, LA		X	
Georgia Pacific Corporation	Green Bay, WI	X		
Georgia Pacific Corporation	Muskogee, OK	X		
Georgia Pacific Corporation	Rincon, GA	X		
Hexion[1]	Columbus, OH		X	
Kuehne Chemical Company	Delaware City, DE	X		
Kuehne Chemical Company	Kearny, NJ	X		
Occidental Chemical Corp and Oxymar	Ingleside, TX	X	X	
Occidental Chemical Corporation	Convent, LA	X		
Occidental Chemical Corporation	Delaware City, DE	X		
Occidental Chemical Corporation	Mobile, AL	X		

Table 5 (Continued)

Company	Location	Chlorine	Chlorinated Hydrocarbons	PVC
Occidental Chemical Corporation	Niagara Falls, NY	X		
Occidental Chemical Corporation	Taft, LA (Hahnville)	X		
Olin Corporation	Augusta, GA	X		
Olin Corporation	Charleston, TN	X		
Olin Corporation	McIntosh, AL	X		
Olin Corporation	Niagara Falls, NY	X		
OxyChem	Muscle Shoals, AL	X		
OxyChem (Vulcan, Basic Chemicals, LLC)	Geismar, LA	X	X	
OxyChem (Vulcan, Basic Chemicals, LLC)	Wichita, KS	X	X	
OxyVinyls	Louisville, KY			X
OxyVinyls	Pedricktown, NJ			X
OxyVinyls Battleground Chlor-Alkali Plant	La Porte, TX	X		
OxyVinyls Deer Park PVC Plant	Deer Park, TX			X
OxyVinyls Deer Park VCM Plant	Deer Park, TX		X	
OxyVinyls La Porte VCM Plant	La Porte, TX		X	
OxyVinyls Pasadena PVC Plant	Pasadena, TX			X
Pioneer	Henderson, NV	X		
Pioneer	St. Gabriel, LA	X		
Polyone Corp.	Henry, IL			X
Polyone Corp.	Louisville, KY			X
Polyone Corp.	Pedricktown, NJ			X
PPG Industries, Inc.	Lake Charles, LA	X	X	
PPG Industries, Inc.	Natrium, WV (New Martinsville)	X	X	
Shell Oil Company[1]	Deer Park, TX		X	
Shell Oil Company[1]	Norco, LA		X	
Shintech Inc.	Addis, LA			X
Shintech Inc.	Freeport, TX			X
Solutia	Sauget, IL		X	
Titanium Metals Corporation of America (TIMET)	Henderson, NV	X		
US Magnesium LLC (MagCorp)	Rowley, Utah	X		
Velsicol	Memphis, TN		X	
Westlake Monomers	Calvert City, KY	X	X	
Westlake Monomers (Geismar Vinyls)	Geismar, LA		X	
Westlake PVC Corp.	Calvert City, KY			X

[1]Shell's company Web site does not list chlorinated hydrocarbons in their chemicals list. These production lines may now be owned by Hexion.

References

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13. Pesticide Chemicals Point Source Category 40 CFR Part 455. <Accessed at: http://www.epa.gov/epahome/cfr40.htm on February 9, 2006>

14. U.S. EPA. 1994. *Locating and Estimating Air Emissions from Sources of Chlorobenzenes.* EPA-454/R-93-044. <Accessed at: http://www.epa.gov/ttn/chief/le/chlorbnz.pdf on February 9, 2006>

15. United Nations Environment Programme (UNEP). 2003. *BAT and BEP for Chemical Processes Involving Chlorine.* UNEP/POPS/EGB.2/INF/11.

16. Chemical Market Reporter, The Innovation Group http://www.the-innovation-group.com/welcome.htm

17. Chlorine Institute. *North American Chlor-Alkali Industry Plants and Production Data Report – 2004*. 2005.

Attachment A:
Process Descriptions for Other Chlorinated Organic Compounds

ERG identified eight chlorinated organic compounds in the OCPSF TDD that do not meet the definition of chlorinated hydrocarbons. These 8 compounds fall into the following 4 chemical groups.

Chlorohydrins are excluded from the definition of chlorinated hydrocarbons because they contain a hydroxyl group, and therefore are not composed solely of chlorine, hydrogen, and carbon. Chlorohydrins are best described as aliphatic compounds having chloro and hydroxyl substituents on adjacent carbon atoms. These compounds are most commonly manufactured by the reaction of an alkene with chlorine and water though many other methods of preparation are known. The most useful reaction of chlorohydrins is dehydrochlorination to form oxirane compounds. Propylene oxide and epichlorohydrin are produced on an industrial scale via chlorohydrin intermediates. [7]

Phosgene is excluded from the definition of chlorinated hydrocarbons because the phosgene molecule contains an oxygen atom, and therefore is not solely composed of chlorine, hydrogen, and carbon. Phosgene is manufactured by reaction of carbon monoxide with chlorine over activated carbon. Reactors are relatively simple, tubular heat exchangers that are filled with granulated activated carbon. Because the reaction is rapid and exothermic, efficient heat removal is important. Decomposition of phosgene into its starting materials begins to take place at 200°C. The temperature of the carbon bed in the initial reaction zone of the tubes can reach 400°C, but it rapidly falls to product temperatures of 40–150°C. [7]

Chlorofluorocarbons (CFCs) are excluded from the definition of chlorinated hydrocarbons because they contain fluorine, and therefore are not composed solely of chlorine, hydrogen, and carbon. The most important commercial method for manufacturing CFCs and HCFCs is the successive replacement of chlorine by fluorine using hydrogen fluoride. The traditional, liquid-phase process uses antimony pentafluoride or a mixture of antimony trifluoride and chlorine as catalysts. Continuous vapor-phase processes that employ gaseous hydrogen fluoride in the presence of heterogenous chromium, iron, or fluorinated alumina catalysts also are widely used. Carbon tetrachloride, chloroform, and hexachloroethane (or tetrachloroethylene plus chlorine) are commonly used starting materials for one- and two-carbon chlorofluorocarbons. The extent of chlorine exchange can be controlled by varying the hydrogen fluoride concentration, the contact time, or the reaction temperature. [7]

Nitrochlorobenzenes are excluded from the definition of chlorinated hydrocarbons because they contain nitrogen, and therefore are not composed solely of chlorine, hydrogen, and carbon. Nitrochlorobenzenes are manufactured by the nitration of monochlorobenzene (MCB) using a mixed acid solution of nitric acid and sulfuric acid at 40°C to 70°C (104°F to 158°F) for 12 hours. Input materials to produce 1 metric ton of combined nitrochlorobenzenes include 4536 kilograms (10,000 pounds) of MCB and 9570 kilograms (21,098 pounds) of combined 30 to 35 percent nitric acid and 52 to 55 percent sulfuric acid. The product mixture at the end of 12 hours is comprised of (34 percent) ortho- and (65 percent) para-nitrochlorobenzenes. [14]

Attachment B
Table B-1. Summary of TRI Phone Calls

Facility Name	Facility Contact	Total Annual Pounds of Dioxins Released (TM17)	Dioxin TWPE (lb-eq/yr)[1]	Basis of TRI Estimate	Was Dioxin Detected in Waste-water Samples?	Is a Manufacturing Process Suspected as a Dioxin Source?	Summary of Telecon
ATOFINA (TOTAL) PETROCHEMICALS INC. LAPORTE, TX	Ray Bednar 281-476-3760	0.0031	57,489	TCEQ Sampling Episode	Not sure since state collected the data.	No process source suspected. The Total site manufactures polypropylene plastic, which is not expected to form dioxins. The site does not use chlorine in any of its manufacturing processes. Chlorine is only used as bleach for cooling towers.	Dioxin water release is based on results of sampling done by TCEQ in 1999. The sampling was conducted at the final outfall for the facility's NPDES permit. The TCEQ provided one concentration that represented a mixture of dioxin congeners (site does not know how non-detects were handled). The facility multiplies this concentration by the total wastewater flow for the outfall. An increase in dioxin mass in their TRI report, therefore, is reflective of an increase in the wastewater flow rate. The facility continues to use the TCEQ dioxin number for their TRI reports in future years.
VELSICOL CHEMICAL CORP.* MEMPHIS, TN	Pat Kitchens 901-320-0293	0.0039	37,068	Routine monitoring conducted by facility	Yes	Chlorination process to manufacture ring chlorinated compounds, such as hexachlorocyclobutadiene. Incinerator scrubber wastewater.	The dioxin water release was based on wastewater sampling data where dioxin was measured at concentrations above its detection limit. Dioxin could be the result of past and current manufacturing activities at the site. The site manufactures ring chlorinated compounds that are processed at temperatures that could form dioxin. In addition the site burns chlorinated compounds in an incinerator. Wastewater from the incinerator scrubber may also contain dioxin. Wastewater monitoring is on-going and TRI release is updated every year.
DOW CHEMICAL CO. MIDLAND OPS. MIDLAND, MI	Paul Dean 989-636-2646	0.0095	25,502	Routine monitoring conducted by facility	Yes	Historical process and waste management units no longer in operation. Very small amount may come from an onsite incinerator.	TRI dioxin water release is a TM 17 value that sums the average congener concentrations from samples collected throughout the year. Dow uses EPA Method 1613b to analyze for dioxin and set non detects to zero. Chlorine is used onsite for manufacture of agricultural products.
SASOL N.A. INC. LAKE CHARLES CHEMICAL COMPLEX WESTLAKE, LA	Scott Shaw 337-494-5058	0.00088	17,183	Non-routine monitoring for studies conducted over the years.	Yes	Plant receives wastewater from the Georgia Gulf Lake Charles VCM plant.	The Sasol Lake Charles plant does not use chlorine for any of their manufacturing processes. Chlorine is used for cooling tower treatment. Products manufactured onsite include ethylene, alcohols, linear alkyl benzene, and aluminum.
CYTEC INDS. INC. WALLINGFORD, CT	Charlie Cappannari 203-284-4210	0.00020	13,460	Engineering estimate	Not Monitored	Wet air pollution control on incinerator.	Dioxin water release was based on an engineering estimate for the operation of an incinerator that was used to dry out biosolids. This incinerator is no longer in operation and site does not report dioxin to TRI for 2005. No chlorine chemistry conducted on site. Manufacturing is halogen-free.

Table B-1 (Continued)

Facility Name	Facility Contact	Total Annual Pounds of Dioxins Released (TM17)	Dioxin TWPE (lb-eq/yr)[1]	Basis of TRI Estimate	Was Dioxin Detected in Waste-water Samples?	Is a Manufacturing Process Suspected as a Dioxin Source?	Summary of Telecon
CELANESE ACETATE CELCO PLANT NARROWS, VA	Jay Johns 540-921-6405	0.000030	941	Engineering estimate	Not Monitored	Dioxin content of wood pulp used onsite. Facility contact thinks it is highly unlikely that dioxin present in the wood pulp would end up in stormwater.	Dioxin water release was based on a worst-case scenario estimate. The Celanese facility uses wood pulp as a raw material. Celanese had reviewed a study that looked at the dioxin content of wood pulp and its potential to end up in stormwater. Wastewater monitoring data for Celanese's Form 2C application shows all non-detects for dioxin. Celanese stopped reporting water releases of dioxin to TRI in 2004.
DU PONT CHAMBERS WORKS DEEPWATER, NJ	Maria Angelo 856-540-2012	0.0023	334	Engineering estimate	Not Monitored	Contaminated ferric chloride additive used for solids settling in the wastewater treatment plant.	DuPont used information from the vendor on the dioxin composition of the contaminated ferric chloride to estimate their TRI releases. The site has since stopped using ferric chloride for settling. The dioxin release for TRI 2004 will be zero.
LYONDELL CHEMICAL CO. WESTLAKE, LA	Don Starkovich 337-491-3273	0.0025	219	Combination of routine monitoring and engineering estimate	Yes	Minor amount is produced by hazardous waste incinerator scrubber. Bulk of dioxin enters the plant with the source water from the Sabine River.	The site monitors the intake and final effluent for dioxin, then calculates a balance to report what is discharged. The balance is reported to TRI. The site uses chlorine to manufacture phosgene. No water is generated or discharged from this process. The process is kept water-free because phosgene reacts very quickly with water to form HCl and CO2.
SASOL N.A. INC. BALTIMORE, MD	Davud Mahler 410-355-6200	0.000037	3	Routine monitoring conducted by facility	Yes	Chlorination process known to cause dioxin was shut down in 2003.	Sasol used to operate a chlorination process that generated dioxin. They began sampling process wastewater and final effluent in 2001 and detected trace amounts of OCDD. The dioxin release reported to TRI was based on this single detected congener (concentration was just above the detection limit). The site stopped monitoring for dioxin in 2003 when the chlorination process was shut down. They no longer report dioxin water releases to TRI.

TM17 = Total mass of 17 dioxin congeners.
TWPE = Toxic Weighted Pound Equivalents.
[1]To calculate TWPE, ERG multiplies TM17 by the TRI-reported dioxin congener distributions and the congener-specific toxic weighting factors (TWFs).