Chapter 9

Hydrofluoric Acid Production

For purposes of this report, the hydrofluoric acid production industry consists of three facilities that, as of September 1989, were active[1] and reported generating two special mineral processing wastes: fluorogypsum and process wastewater from hydrofluoric acid production.[2] The data included in this chapter are discussed in additional detail in a technical background document in the supporting public docket for this report.

9.1 Industry Overview

Hydrofluoric acid is used primarily for the production of fluorocarbon chemicals, including fluoropolymers and chlorofluorocarbons.[3] Hydrofluoric acid is also used in the aluminum processing industry for the manufacture of synthetic cryolite and aluminum fluoride for reduction cells. In addition, it is used in the manufacture of uranium tetrafluoride, an intermediate in the processing of nuclear fuel and explosives. Furthermore, hydrofluoric acid is used in petroleum alkylation, oil and gas well treatment, stainless steel pickling, and cleaning and etching in some specialty glass and electronics applications. It is also utilized in the manufacture of fluorine chemicals used in herbicides, fluoride salts, plastics, water fluoridation, rare metals processing, and other applications.

The three currently active facilities and their production capacities are shown in Exhibit 9-1. The Geismar facility initiated operations in 1967 and was modernized in 1983; the Calvert City facility (formerly owned by Pennwalt Corp.) began operations in 1949 and was modernized in 1959.[4] A full SWMPF Survey response was not submitted by the LaPorte facility; therefore, no dates of initial operation or modernization are available for that facility. The aggregate 1988 production of hydrofluoric acid for the Geismar and Calvert City facilities was 116,795 metric tons; using the aggregate production capacity for the two facilities as reported in Exhibit 9-1, the average annual capacity utilization rate was 97.3 percent.

---

[1] A hydrofluoric acid facility was operated by Essex Chemical Corporation in Paulsboro, NJ until being "mothballed" in 1987. This facility, representing about five percent of the total 1987 aggregate production capacity (1989 Directory of Chemical Producers, SRI International, p. 691) is not addressed in this report.

[2] Several production facilities are operating which produce hydrofluoric acid as an intermediate product in the formulation of commercial chemicals or compounds. The 1989 Directory of Chemical Producers (SRI International, p. 691) reports, for example, that "Aluminum Company of America produces hydrofluoric acid as a nonisolatable product;" Bureau of Mines has confirmed that ALCOA produces hydrofluoric acid at Point Comfort, TX. These facilities did not nominate as special wastes any hydrofluoric acid production waste streams from their operations, are not considered to be part of the primary hydrofluoric acid industry, and therefore, are not addressed in this report.

[3] Bureau of Mines, 1987. Minerals Yearbook, 1987 Ed., p. 373.

[4] Allied Signal, Inc., 1989, and Pennwalt Corp., 1989. Company responses to the "National Survey of Solid Wastes from Mineral Processing Facilities," U.S. EPA, 1989.

Exhibit 9-1
Domestic Hydrofluoric Acid Producers

Owner	Location	Capacity (MT)[(a)]
Allied Signal	Geismar, LA	95,000
E.I. duPont	LaPorte, TX	68,000
Attochemical, N.A.	Calvert City, KY	25,000

(a) SRI International, 1987. Directory of Chemical Producers--United States, 1987 Ed., p. 964.

More than 70 percent of the reported fluorspar consumption in the U.S. in 1989 was for hydrofluoric acid production.[5] The reported consumption of acid-grade fluorspar has risen throughout the last half of the decade from 383,000 metric tons in 1985 to 449,000 metric tons estimated in 1989. This rise in acid-grade fluorspar consumption indicates that the demand for hydrofluoric acid has risen throughout the late 1980s.[6] The U.S. imported approximately 119,000 metric tons of hydrofluoric acid in 1988, nearly all of it (98 percent) from Canada and Mexico.[7]

Generally, U.S. producers of hydrofluoric acid are very competitive in the world market. U.S. firms are able to import low-cost Mexican acid-grade fluorspar for domestic hydrofluoric acid production. Since all of the acid-grade fluorspar used in the production of hydrofluoric acid is currently imported, the establishment of additional hydrofluoric acid production facilities is limited more by market access requirements than a lack of raw materials. The demand for hydrofluoric acid may increase in the future due to the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer. The U.S. and 22 other countries are party to the protocol, which calls for significant reductions in chlorofluorocarbon (CFC) consumption over the next decade. This could affect the demand for hydrofluoric acid because its primary use is in the production of fluorocarbon chemicals, including CFCs, and substitutes for CFCs are likely to require increased amounts of flourine. Alternatively, CFC substitutes could themselves require use of hydrofluoric acid, so that a CFC phase-out could actually increase demand for hydrofluoric acid.

Hydrofluoric acid is produced from acid-grade fluorspar (CaF_2) which is reacted with sulfuric acid in a heated retort kiln to produce hydrogen fluoride gas, as shown in Exhibit 9-2.[8] The residue remaining after retorting is calcium sulfate anhydrite, commonly known as fluorogypsum, which is a special waste. This solid is slurried in process water as it exits the kiln and is transported either to the waste management units[9] or, at the duPont plant, to a production operation for further processing for sale as a byproduct.[10] The crude product gas is purified by scrubbing; process wastewater reportedly is generated by this process as well.[11] The process wastewater, the second special waste generated by this sector, is stored/treated in on-site surface impoundments and then reused in the process operations

---

[5] David E. Morse, U.S. Bureau of Mines, "Fluorspar," Minerals Yearbook, 1988 Ed., p. 3.

[6] M. Michael Miller, U.S. Bureau of Mines, "Fluorspar," Mineral Commodity Summaries, 1990 Ed., p. 60.

[7] Morse, op. cit., p. 7.

[8] Bureau of Mines, 1985. Mineral Facts and Problems, 1985 Ed., p. 283.

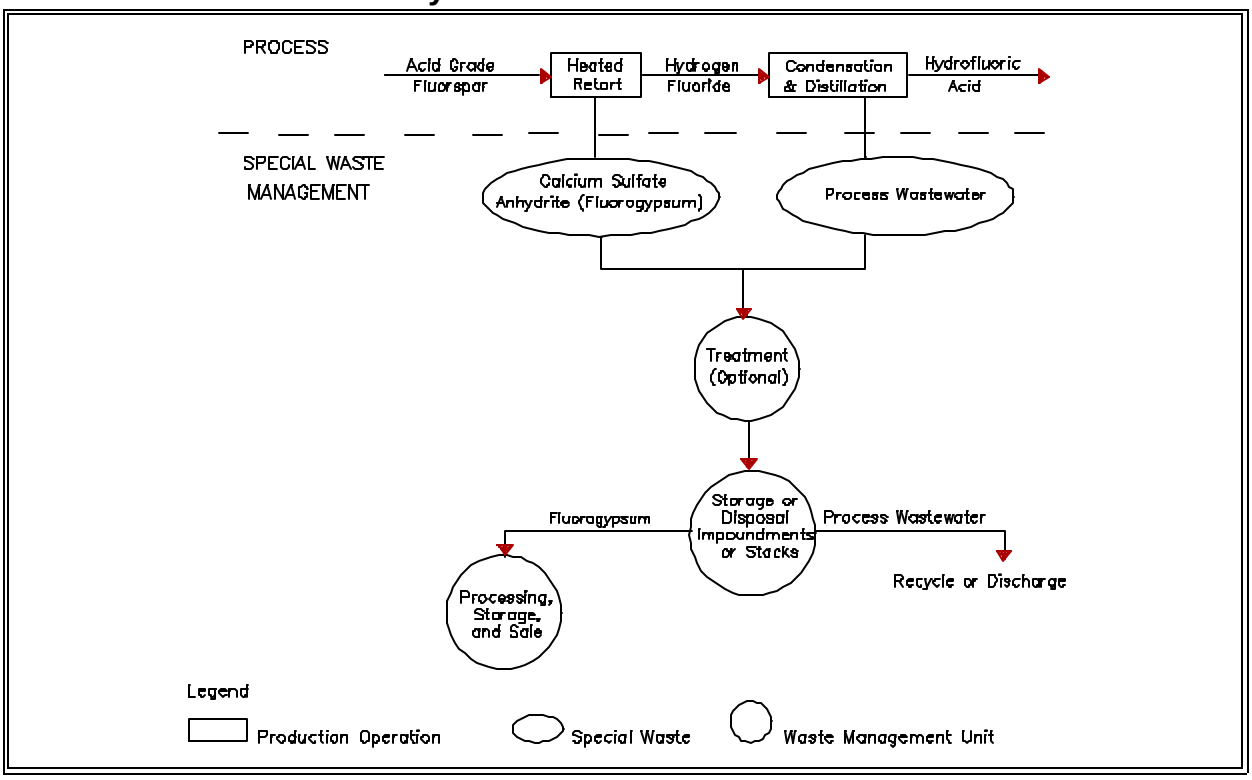
[9] Allied Signal, Inc., 1989. Public comments from Allied Signal, Inc. addressing the 1989 Proposed Reinterpretation of the Mining Waste Exclusion (Docket No. MW2P00020); November 8, 1989, p. 1.

[10] At the duPont facility, lime is added when the fluorogypsum is quenched in order to enhance the chemical characteristics of the material for construction applications.

[11] Pennwalt, 1989. Public comments from Pennwalt Corporation addressing the 1989 Proposed Reinterpretation of the Mining Waste Exclusion (Docket No. MW2P00013); November 8, 1989, p. 1.

or discharged. The hydrogen fluoride gas is condensed and distilled to form anhydrous hydrogen fluoride, a colorless fuming liquid. This liquid may be sold as is or absorbed in water to form hydrofluoric acid.

Exhibit 9-2
Hydrofluoric Acid Production



9.2 Waste Characteristics, Generation, and Current Management Practices[12]

The three hydrofluoric acid facilities generate both solid and aqueous special mineral processing wastes, which are fluorogypsum and process wastewater, respectively.

Fluorogypsum

Fluorogypsum is a solid material consisting primarily of fine particles of calcium sulfate, usually less than 0.02 mm in diameter, that is slurried for transport from the kilns to waste management units.

Using available data on the composition of fluorogypsum, EPA evaluated whether the waste exhibits any of the four characteristics of hazardous waste: corrosivity, reactivity, ignitability, and extraction procedure (EP) toxicity. Based on analyses of 4 samples from 2 facilities (Geismar and Calvert City) and professional judgment, the Agency does not believe the fluorogypsum exhibits any of these characteristics. All eight of the inorganic constituents with EP toxicity regulatory levels were measured in concentrations (using the EP leach test) that were at least two orders of magnitude below the regulatory levels.

[12] All responses, unless otherwise noted, are from the response of Allied Signal, Inc. and Pennwalt Corp. to EPA's "National Survey of Solid Wastes from Mineral Processing Facilities," conducted in 1989.

EPA estimates that the total quantity of fluorogypsum generated in 1988 at the three active facilities was 894,000 metric tons, ranging from 241,000 to 329,000 metric tons. The average annual generation was 297,000 metric tons with an average waste to product ratio of 4.83.

Because the two materials are largely co-managed at all three facilities, the management of fluorogypsum is discussed in the next section, along with process wastewater.

Process Wastewater

Process wastewater is an aqueous liquid, the chemical constituents of which include fluoride, calcium, and sulfate, with smaller amounts of iron and silicon, as well as many trace metals.

Using available data on the composition of hydrofluoric acid process wastewater, EPA evaluated whether the wastewater exhibits any of the four characteristics of hazardous waste: corrosivity, reactivity, ignitability, and extraction procedure (EP) toxicity. Based on available information and professional judgment, the Agency does not believe that the wastewater is reactive, ignitable, or EP toxic. All eight of the inorganic constituents with EP toxicity regulatory levels were measured in concentrations (using the EP leach test) that were no more than 0.6 times the regulatory levels. Some wastewater samples, however, exhibit the characteristic of corrosivity. Analyses of the pH of hydrofluoric acid process wastewater at the Geismar and Calvert City facilities indicated that the wastewater was corrosive in all of the nine samples analyzed, sometimes with pH values as extreme as 1.00 (for comparison, pH levels below 2.0 are operationally defined as corrosive wastes).

EPA estimates a total of 13.6 million metric tons of process water are generated annually, ranging from 2.9 to 5.7 million metric tons. The average generation per facility is 4.5 million metric tons and the average ratio of process wastewater to hydrofluoric acid product is 73.63.

Each of the three facilities manages the two special wastes somewhat differently. At the Calvert City facility, the fluorogypsum is slurried in process wastewater and routed with other process wastewaters to a treatment facility where the pH of the combined streams is adjusted with lime. The entire treated slurry is then routed to an on-site surface impoundment, which received over 3.8 million cubic meters (one billion gallons) of water in 1988. The fluorogypsum settles to the bottom and accumulates there until the pond is filled to capacity. After the solids settle, the liquids are routed to a 16 hectare (40 acre) clarifying pond, the pH is adjusted again, and the water is either recycled or discharged to a nearby river. Once filled, the settling ponds are closed with the fluorogypsum in place and a new pond is opened. There are three settling ponds at this facility, two of which are closed. Each of the closed ponds is between 20 and 30 hectares in area, ranges from 4.5 to 9 meters deep, and holds an estimated 3,200,000 metric tons of dried, solid fluorogypsum. The active pond covers approximately 16 hectares, is 9 meters deep, and held (as of mid-1989) approximately 1.3 million metric tons of fluorogypsum submerged beneath liquid.

At the Geismar facility, fluorogypsum is slurried with recycled process water and pumped to fluorogypsum stacks; the facility's stacks are devoted entirely to storage and disposal of fluorogypsum in a manner "facilitating reclamation" (through aging of fluorogypsum in the stacks). The fluorogypsum solids settle to the bottom of holding ponds on top of the stack, and are dredged and dumped immediately adjacent to the ponds to initially form and subsequently build up berms or dikes. The fluorogypsum is dredged and dumped in this fashion on a continuous basis as the holding ponds are filled, slowly increasing the height of the surrounding berms.

Given this management practice, the fluorogypsum exists in three different physical forms at the Geismar facility: (1) as sediment submerged beneath liquid in a holding pond; (2) as wet sediment/sludge freshly dredged and placed on the berms; and (3) as dried solids on the berms. When wet, fluorogypsum has a texture similar to wet cement (a very moist, pasty mixture of solid particles ranging from sand size to cobbles) and, when dry, the fluorogypsum is a very hard, solid mass, not unlike dried cement, rock, or wallboard.

The combined area of the fluorogypsum stack covers almost 17 hectares (43 acres), and the berms range from 11 meters to 20 meters high. As of late 1988, the total quantity of fluorogypsum accumulated in the stack was roughly 2.7 million metric tons. Transport water and precipitation run-off that drains from the stacks are held in an impoundment

for reuse in the operation; additional process wastewater may be routed directly to this impoundment, may be used in on-site operations, or may be directly recycled to the hydrofluoric acid operation.

As solids settle out in these ponds, overflow effluent is gravity fed from one pond to the next until the clarified process wastewater eventually reaches a final surface impoundment termed a "clearwell pond." This impoundment covers almost 4.1 hectares (10 acres), is roughly 2.5 meters deep, and holds roughly 5.7 million cubic meters (1.5 billion gallons) of wastewater and 45,400 metric tons of sludge. From the clearwell pond, the process wastewater is recycled on-site for a variety of uses.

Fluorogypsum at the LaPorte facility is lime-neutralized at the point of generation and is transported in slurry form (in process wastewater) to a gypsum stack, after which it undergoes further processing and subsequent sale for a number of construction-related uses.

9.3 Potential and Documented Danger to Human Health and the Environment

In this section, EPA discusses two of the study factors required by Section 8002(p) of RCRA for the special wastes generated in the hydrofluoric acid sector: (1) potential risk to human health and the environment associated with the management of fluorogypsum and hydrofluoric acid process wastewater; and (2) documented cases in which danger to human health and/or the environment has been proven. Overall conclusions about the hazards associated with each of these two wastes are based on the Agency's evaluation of these two factors.

9.3.1 Risks Associated With Fluorogypsum and Hydrofluoric Acid Process Wastewater

Any potential danger to human health and the environment posed by fluorogypsum and hydrofluoric acid process wastewater depends on the presence of hazardous constituents in the wastes and the potential for exposure to these constituents.

Fluorogypsum Constituents of Potential Concern

EPA identified chemical constituents in fluorogypsum that may present a hazard by collecting data on the composition of this waste and evaluating the intrinsic hazard of the chemical constituents.

Data on Fluorogypsum

EPA's characterization of fluorogypsum and its leachate is based on data from two sources: (1) a 1989 sampling and analysis effort by EPA's Office of Solid Waste (OSW); and (2) industry responses to a RCRA §3007 request in 1989. These data provide information on the concentrations of 20 metals, 4 ions (nitrate, fluoride, chloride, and sulfate), 1 radionuclide (radium-226), and 2 organic compounds (benzene and methyl ethyl ketone) in fluorogypsum solids and leachate. The leachate data were generated using EP, SPLP, and TCLP leach tests. Two of the three facilities that generate fluorogypsum are represented by these data: Allied-Signal in Geismar, LA, and Attochem in Calvert City, KY.

There are no particularly noteworthy trends in the data. With a very few exceptions, the concentrations of individual constituents in fluorogypsum solids are consistent (within an order of magnitude) across the two data sources and two facilities; the EP, SPLP, and TCLP leach test results are also usually within an order of magnitude of each other across the two facilities. However, several constituents were detected in higher concentrations in SPLP leach tests than EP leach tests. Neither facility is reported to have consistently higher (or lower) contaminant concentrations than the other.

Process for Identifying Constituents of Concern

As discussed in Section 2.2.2, the Agency evaluated the waste composition data summarized above to determine if fluorogypsum contains any chemical constituents that could pose an intrinsic hazard. The Agency

performed this evaluation by first comparing the concentration of chemical constituents to screening criteria and then by evaluating the environmental persistence and mobility of constituents that are present at levels above the criteria. These screening criteria were developed using assumed scenarios that are likely to overestimate the extent to which constituents in fluorogypsum are released to the environment and migrate to possible exposure points. As a result, this process eliminates from further consideration those constituents that clearly do not pose a risk.

The Agency used three categories of screening criteria that reflect the potential for hazards to human health, aquatic organisms, and water resources (see Exhibit 2-3). Given the conservative (i.e., protective) nature of these screening criteria, contaminant concentrations in excess of the criteria should not, in isolation, be interpreted as proof of hazard. Instead, exceedances of the criteria indicate the need to evaluate the potential hazards of the waste in greater detail.

Identified Constituents of Potential Concern

Based on a comparison of the concentrations of 24 constituents to the screening criteria summarized above, there do not appear to be any constituents in fluorogypsum solids in concentrations that exceed the screening criteria. That is, even under a very conservative set of release and exposure conditions, the chemical concentrations in fluorogypsum solids are not expected to pose a significant risk.

Exhibit 9-3
Potential Constituents of Concern in Fluorogypsum Leachate[a]

Potential Constituents of Concern	No. of Times Constituent Detected/No. of Analyses for Constituent	Screening Criteria[b]	No. of Analyses Exceeding Criteria/ No. of Analyses for Constituent	No. of Facilities Exceeding Criteria/ No. of Facilities Analyzed for Constituent
Arsenic[c]	7 / 7	Human Health* Resource Damage	7 / 7 2 / 7	2 / 2 1 / 2
Sulfate[c]	5 / 5	Resource Damage	5 / 5	1 / 1
Lead[c]	3 / 7	Human Health Resource Damage Aquatic Ecological	2 / 7 3 / 7 2 / 7	1 / 2 1 / 2 1 / 2
Chromium[c]	6 / 7	Human Health Resource Damage Aquatic Ecological	2 / 7 2 / 7 2 / 7	1 / 2 1 / 2 1 / 2
Mercury[c]	1 / 7	Aquatic Ecological	1 / 7	1 / 2
Iron	2 / 2	Resource Damage	1 / 2	1 / 2
Manganese	2 / 2	Resource Damage	1 / 2	1 / 2
Aluminum[c]	2 / 2	Aquatic Ecological	1 / 2	1 / 2

(a) Constituents listed in this table are present in at least one sample from at least one facility at a concentration that exceeds a relevant screening criterion. The conservative screening criteria used in this analysis are listed in Exhibit 2-3. Constituents that were not detected in a given sample were assumed not to be present in the sample. Unless otherwise noted, the constituent concentrations used for this analysis are based on EP leach test results.

(b) Human health screening criteria are based on cancer risk or noncancer health effects. "Human health" screening criteria noted with an "*" are based on a $1x10^{-5}$ lifetime cancer risk; others are based on noncancer health effects.

(c) Data for this constituent are from SPLP leach test results.

Of the 25 constituents analyzed in fluorogypsum leachate, eight are present in concentrations that exceed the screening criteria: arsenic, sulfate, lead, chromium, mercury, iron, manganese, and aluminum (see Exhibit 9-3). All of these constituents are metals or other inorganics that do not degrade in the environment. Arsenic and sulfate exceeded the screening criteria most frequently (in 100 percent of the samples); however, only lead exceeded the screening criteria by more than a factor of six. Despite these exceedances of the screening criteria, none of the samples contained any constituents in excess of the EP toxicity regulatory levels.

These exceedances of the screening criteria indicate the potential for the following types of impacts under the following conditions:

- Arsenic, lead, and chromium concentrations in the fluorogypsum leachate may pose a health risk if the leachate is released to ground water, diluted by a factor of 10 or less during migration to a downgradient drinking water well, and ingested without prior treatment over a long period of time. The diluted concentration of arsenic could result in a cancer risk exceeding 1×10^{-5}.

- If the fluorogypsum leachate is released to ground water and diluted by less than ten-fold, the resulting concentrations of arsenic, sulfate, lead, chromium, iron, and manganese could exceed the drinking water maximum contaminant level (MCL) for these constituents.
- Concentrations of lead, chromium, mercury, and aluminum in the fluorogypsum leachate may present a threat to aquatic organisms if the leachate migrates (with less than 100-fold dilution) to surface waters.

Although the two sources of data used to characterize the composition of fluorogypsum do not provide data on the radionuclide content of fluorogypsum leachate, such data are available from field monitoring results at the Allied-Signal site and at a site in Louisiana where fluorogypsum was used to construct a test highway embankment (see the damage case descriptions for more detail). Seven samples of run-off/seepage/leachate from this site contained elevated gross alpha radiation levels, ranging from 79 pCi/l to 226 pCi/l. Two additional samples of "ambient" surface water collected adjacent to the test embankment also contained elevated gross alpha concentrations of 24 to 103 pCi/l. The levels in all eight samples exceed the primary drinking water MCL of 15 pCi/l (by factors that range from 2 to 15). Similarly, two run-off samples contained radium-226 concentrations of 8 and 22 pCi/l, both of which exceed the MCL of 5 pCi/l.[13]

These exceedances of the screening criteria, by themselves, do not demonstrate that fluorogypsum poses a significant risk, but rather indicate that the waste may present a hazard under a set of very conservative hypothetical release, transport, and exposure conditions. To determine the potential for fluorogypsum to cause significant impacts, EPA analyzed the actual conditions that exist at the facilities that generate and manage the waste (see the following section on release, transport, and exposure potential).

Process Wastewater Constituents of Potential Concern

Using the same process outlined above for fluorogypsum, EPA identified chemical constituents in hydrofluoric acid process wastewater that conceivably may present a hazard.

Data on Process Wastewater

Two data sources were used to characterize the composition of hydrofluoric acid process wastewater: data gathered by OSW in a 1989 field sampling effort, and data submitted by industry in response to a §3007 request in 1989. These sources provide data on the concentrations of 20 metals, sulfate, and pH in process wastewater and wastewater leachate from the Geismar and Calvert City facilities.

Based on a comparison of the sample concentrations, the data from the two facilities are generally consistent, though the concentrations of barium, chromium, and lead in the wastewater from the Allied-Signal plant are one order of magnitude higher than corresponding concentrations at the Calvert City facility.

Identified Constituents of Potential Concern

Of the 22 constituents analyzed in hydrofluoric acid process wastewater, 14 are present in concentrations that exceed the screening criteria. These 14 constituents, the type of screening criteria they exceed, and the frequency with which they exceed the criteria are summarized in Exhibit 9-4. All of these constituents are inorganics that do not degrade in the environment.

Of the 14 constituents that exceed the screening criteria, only six were present in concentrations that exceed the criteria by more than a factor of 10: antimony, copper, iron, lead, manganese, and thallium. Measured concentrations of iron in the wastewater exceed the screening criteria by the widest margin (by as much as a factor of 160). None of these constituents were ever detected at levels that exceed the EP toxicity regulatory levels, however, and based on professional judgment, EPA does not believe that the wastewater exhibits the hazardous waste characteristics of

[13] EPA has only one sample result for the radionuclide concentration in fluorogypsum solids. In one fluorogypsum sample from the Allied-Signal facility, radium-226 was measured in a concentration of 2.5 pCi/g, which is below the screening criterion of 5 pCi/g.

ignitability and reactivity. However, some wastewater samples exhibit the characteristic of corrosivity. The pH values of the wastewater may be either very low (e.g., 1.0 to 1.9 at the Geismar and Calvert City plants prior to treatment) or very high (e.g., 12 to 14 at the LaPorte plant after treatment).

These exceedances of the risk screening criteria indicate the potential for the following types of impacts:

- If hydrofluoric acid process wastewater is released to ground water and diluted by a factor of 10 or less during migration to a downgradient drinking water well, concentrations of lead, chromium, antimony, and thallium could pose a health risk if the water is ingested without treatment on a long-term basis.
- Concentrations of iron, copper, aluminum, nickel, zinc, lead, and chromium in the process wastewater could present a threat to aquatic organisms if the wastewater migrates (with 100-fold dilution or less) to surface waters.
- If the process wastewater is released to ground water and diluted by a factor of 10 or less, the resulting concentrations of several constituents could render the water unsuitable for certain uses (i.e., cause water resource damages). Specifically, the resulting concentrations of iron, manganese, sulfate, lead, and chromium could exceed the drinking water maximum contaminant levels for these constituents. The concentrations of molybdenum, aluminum, nickel, and vanadium could also exceed irrigation guidelines, rendering the water less desirable for agricultural purposes.

If the process wastewater is released to ground or surface water at the Geismar or Calvert City facilities, the resulting pH levels may be less than the lower pH limit established for use as drinking water (6.5). Conversely, if the process wastewater is released at the LaPorte facility, the pH in receiving waters may be higher than the pH limit for drinking water use (8.5). Both low and high pH may cause increased corrosivity and an unpleasant taste.

Exhibit 9-4
Potential Constituents of Concern in Hydrofluoric Acid Process Wastewater (Total)[a]

Potential Constituents of Concern	No. of Times Constituent Detected/No. of Analyses for Constituent	Screening Criteria	No. of Analyses Exceeding Criteria/ No. of Analyses for Constituent	No. of Facilities Exceeding Criteria/ No. of Facilities Analyzed for Constituent
Iron	1 / 1	Resource Damage Aquatic Ecological	1 / 1 1 / 1	1 / 1 1 / 1
Manganese	1 / 1	Resource Damage	1 / 1	1 / 1
Thallium	1 / 1	Human Health	1 / 1	1 / 1
Copper	1 / 1	Aquatic Ecological	1 / 1	1 / 1
Antimony	1 / 1	Human Health	1 / 1	1 / 1
Molybdenum	1 / 1	Resource Damage	1 / 1	1 / 1
Aluminum	1 / 1	Resource Damage Aquatic Ecological	1 / 1 1 / 1	1 / 1 1 / 1
Nickel	1 / 1	Resource Damage Aquatic Ecological	1 / 1 1 / 1	1 / 1 1 / 1
Zinc	1 / 1	Aquatic Ecological	1 / 1	1 / 1
Sulfate	1 / 1	Resource Damage	1 / 1	1 / 1
Vanadium	1 / 1	Resource Damage	1 / 1	1 / 1
Lead	1 / 2	Human Health Resource Damage Aquatic Ecological	1 / 2 1 / 2 1 / 2	1 / 2 1 / 2 1 / 2
Chromium	1 / 2	Human Health Resource Damage Aquatic Ecological	1 / 2 1 / 2 1 / 2	1 / 2 1 / 2 1 / 2
pH	9 / 9	Resource Damage	9 / 9	2 / 2

(a) Constituents listed in this table are present in at least one sample from at least one facility at a concentration that exceeds a relevant screening criterion. The conservative screening criteria used in this analysis are listed in Exhibit 2-3. Constituents that were not detected in a given sample were assumed not to be present in the sample.

As discussed above, these exceedances of the screening criteria, by themselves, do not demonstrate that the process wastewater poses a significant risk, but rather indicate that the wastewater may present a hazard under a very conservative hypothetical set of release, transport, and exposure conditions. To determine the potential for the wastewater to cause significant impacts, EPA proceeded to the next step of the risk assessment to analyze the actual conditions that exist at the facilities that generate and manage the waste.

Release, Transport, and Exposure Potential

This analysis evaluates the baseline hazards of fluorogypsum and hydrofluoric acid process wastewater as they were generated and managed at the three hydrofluoric acid production plants in 1988. It does not assess the hazards of off-site use or disposal of the wastes. Neither of the wastes are disposed of off-site, but fluorogypsum may be used off-site as a lightweight aggregate, as discussed in Section 9.5. The hazards associated with the off-site use of fluorogypsum are discussed in the context of a damage case in Section 9.3.2. The following analysis also does not consider the risks associated with variations in waste management practices or potentially exposed populations in the future because of a lack of sufficient data to predict future conditions.

Ground-Water Release, Transport, and Exposure Potential

As discussed in the preceding section, EPA and industry test data show that several constituents in fluorogypsum leachate and hydrofluoric acid process wastewater are present in concentrations above the screening criteria. Considering the pH of the leachate and wastewater, several of the constituents are expected to be mobile in ground water if they migrate from the waste management units, including arsenic, lead, chromium, manganese, iron, thallium, copper, antimony, nickel, zinc, and sulfate.

The potential for these constituents to be released to ground water and cause subsequent impacts varies according to site-specific conditions, as summarized below:

- The fluorogypsum stack and clearwell pond at the Geismar, LA facility are underlain by in-situ clay and recompacted local clay. Both the stack and the pond are surrounded by an unlined "interceptor ditch" that is designed to capture run-off and leachate; fluids collected in this ditch are pumped back to the clearwell pond. Although the water table is as shallow as 3 meters beneath the site, the uppermost useable aquifer is considerably deeper, roughly 55 meters below the land surface.[14] This deeper aquifer is used primarily for livestock watering. The nearest downgradient well appears to be located 2.4 km (1.5 miles) away. The facility reports that it does not routinely monitor ground-water quality at the site.
- The settling ponds at the facility in Calvert City, KY are underlain by in-situ clay. The ponds are surrounded by slurry walls and ground-water monitoring wells to help control leachate migration. An aquifer that is used as a rural domestic drinking water supply is located roughly 5 meters below the land surface. Because the ponds at this site are roughly 9 meters deep, it is likely that the base of the ponds extends beneath the water table. The nearest downgradient drinking water well appears to be located 3.6 km (2.3 miles) from the facility.
- The fluorogypsum stack and process wastewater impoundments at the facility in LaPorte, TX are surrounded by an unlined drainage ditch to help capture seepage and run-off. Although ground water is relatively shallow (6 meters deep) and therefore potentially susceptible to contamination, the site is located in an extremely industrialized area near the Houston shipping channel and the suitability of the surficial ground water for domestic use appears limited. The closest potential users of the ground water are located more than 200 meters downgradient. The extent to which the shallow ground water has been contaminated (if at all) is not known because no monitoring has been conducted in recent years.

Although the fluorogypsum and process wastewater management units at each site are equipped with some type of leachate control system, these controls do not appear to be completely sufficient to prevent contamination of the shallow ground water at each site. This is substantiated by ground-water monitoring around the ponds at the Calvert City facility, which has indicated levels of cadmium, fluoride, iron, manganese, pH, and total dissolved solids that exceed the drinking water standards. Fluorogypsum and process wastewater are possible contributors to this contamination. As discussed in the preceding sections, EPA sample analyses found iron and manganese to be readily leachable from fluorogypsum, and found high concentrations of iron and manganese and low pH levels in process wastewater. Contamination seeps around the clearwell pond at the Geismar facility (see the damage cases) provide further indication of the potential for existing on-site management practices to cause ground-water contamination.

Given its extremely high or low pH, migration of the process wastewater into ground water may significantly damage the value of the ground water as a potential resource. A low pH may cause the need for heavier chlorination, whereas a high pH may cause increased halogen reactions. Both excessively high and low pH values will cause

[14] Company responses to the "National Survey of Solid Wastes from Mineral Processing Facilities" (EPA 1989) from the Arcadian phosphoric acid plant, which is adjacent to the Allied Signal plant, indicate that useable ground water occurs at a depth of 24 meters at this location.

increased corrosivity. Although high and low pH values may cause an unpleasant taste, a wide range of pH values for drinking water can be tolerated from a human health standpoint.[15]

The toxic constituents present in any ground-water contamination are not expected to cause significant human health impacts at present because:

- The shallow ground water beneath the Geismar facility is not useable, the useable aquifer is considerably deeper and more protected, the deeper aquifer does not appear to be used for human consumption, there are no downgradient wells that are close, and the concentrations of most constituents of concern in the waste exceed conservative screening criteria by less than a factor of 10 (and thus are likely to be well below levels of concern at distant exposure points);
- Existing slurry walls should help contain any contamination at the Calvert City plant and, even if contamination did escape, the closest well is far away and not likely to be significantly affected by the generally low concentrations of toxic constituents; and
- The shallow ground water at the LaPorte facility is not likely to be used for drinking within close distances.

EPA acknowledges, however, that human health risks could occur in the future if ground water near the waste management units is ever used for drinking, or if the wastewater is managed in a more sensitive environmental setting in the future.

Surface Water Release, Transport, and Exposure Potential

The fluorogypsum stack and clearwell pond area at the plant in Geismar, LA is located roughly 600 meters from the Mississippi River and 1,200 meters from the Bayou Breaux (a relatively small stream). Significant migration of contaminants into the Mississippi River appears unlikely because a levee on the bank of the river should prevent overland erosion and because ground water in this area appears to migrate from the river toward the facility. Even if contaminants did migrate into the Mississippi, the river's very large flow provides a significant enough assimilative capacity to disperse the contaminants. However, as discussed in the damage case section, the smaller Bayou Breaux could be contaminated in the event of a pipeline spill or a large failure of the fluorogypsum stack berms. Routine releases to the bayou are expected to be largely precluded by the interceptor ditch that surrounds the waste management units at this facility. The level of fluids collected in this ditch is controlled by an automatic pump that turns on when the fluid level reaches a certain height and pumps the liquid back to the clearwell pond.

The nearest surface water body at the plant in Calvert City, KY is the Tennessee River, located roughly 1,040 meters away. It appears unlikely that any contamination originating from the ponds could migrate to this river, either via ground-water seepage or direct overland run-off, because the ponds are equipped with slurry walls and run-on/run-off controls. The plant discharges treated process wastewater to the river in accordance with a NPDES permit and monitors the concentration of contaminants in the effluent on a weekly basis. The plant also monitors the ambient water quality, and reports that it has not observed an exceedance of drinking water or ecological protection criteria in the river. In the vicinity of the plant, the Tennessee River is very large, with an annual average flow of 16 million cubic meters (4,211 million gallons) per day. This river is used as a source of industrial process water at a point 520 meters downstream and as a source of drinking water at a point 25 km (16 miles) downstream. Considering all of these factors, it is unlikely that the routine management of fluorogypsum and process wastewater at this plant could cause significant surface water impacts.

The LaPorte facility is located roughly 50 meters from the San Jacinta Bay. Releases to this water body are possible, either through ground-water seepage or by direct overland runoff. Although the fluorogypsum and process wastewater impoundment at the site are surrounded by a drainage ditch that is designed to control overland run-off, plant personnel have indicated that the ditch has overflowed several times because of severe storms. Because the San Jacinta Bay is saline, it is not used for drinking water. Therefore, any contamination originating from the LaPorte facility is not likely to pose a direct drinking water threat, but could conceivably cause an aquatic ecological threat.

---

[15] EPA, 1984. National Secondary Drinking Water Regulations, EPA 570/9-76-000, June 1984, p. 30.

Air Release, Transport, and Exposure Potential

Because the primary constituents of fluorogypsum and process wastewater from hydrofluoric acid production are nonvolatile inorganics, contaminants can only be released to air in the form of dust particles. The release of dust, however, is precluded by the form of the wastes; fluorogypsum is either a hard solid mass or is submerged beneath liquid, while the process wastewater is a liquid. The most likely airborne release mechanism appears to be the potential for dust suspension caused by vehicular traffic on top of the fluorogypsum stacks in Louisiana and Texas. Any such airborne releases should have a minimal impact because, based on sampling data from EPA and industry, the fluorogypsum solids do not contain any constituents in concentrations that may pose a risk through the inhalation pathway.

Proximity to Sensitive Environments

All three hydrofluoric acid plants are located in or near environments that are either vulnerable to releases of contaminants or have high resource value that may warrant special consideration. In particular:

- The Calvert City plant is located in an endangered species habitat, according to the operator's response to the SWMPF Survey.
- The Geismar and Calvert City plants are both located in 100-year floodplains; large floods could create the potential for large, episodic releases.
- All three of the facilities are located within one mile upgradient of a wetland (defined here to include swamps, marshes, bogs, and other similar areas). Wetlands are commonly entitled to special protection because they provide habitats for many forms of wildlife, purify natural water, provide flood and storm damage protection, and afford a number of other benefits.
- The Calvert City plant is located in a fault zone. This creates the potential for earthquake damages to the slurry walls that help to contain ground-water contamination from the ponds at this site.

Risk Modeling

Based upon the evaluation of available data, the intrinsic hazard of the wastes and factors that influence risk presented above, a review of the risk modeling results for other mineral processing wastes, and a review and evaluation of information on documented damage cases (presented in the next section), EPA concluded that process wastewater and fluorogypsum were not high priorities for quantitative risk modeling. Accordingly, no risk modeling was performed.

9.3.2 Damage Cases

State and EPA regional files were reviewed in an effort to document the performance of process wastewater and fluorogypsum waste management practices at the three active hydrofluoric acid facilities: Attochem (Pennwalt) in Calvert City, Kentucky; duPont in LaPorte, Texas; and Allied Signal in Geismar, Louisiana. The file reviews were combined with interviews with State and EPA regional regulatory staff. Through these case studies, EPA found documented environmental damages associated with the co-management of process wastewater and fluorogypsum at one facility, Allied-Signal in Geismar, and with the off-site utilization of fluorogypsum from the Geismar facility.

Allied-Signal, Geismar, Louisiana

This facility is located south of Baton Rouge in an industrial/agricultural area; the nearest residence is about 1.6 km (one mile) away. Its receiving waters are the Bayou Breaux and the Mississippi River. Ground water in this area is used for livestock watering.

Releases from the Gypsum Stack/Clearwell

Fluorogypsum generated from the production of hydrofluoric acid is slurried with process water as it is removed from the furnace; the resulting slurry is transferred through a conduit system to an impoundment on the top of a fluorogypsum stack. Seepage and run-off from the fluorogypsum stack is collected in clay-lined ditches and flows into an impoundment referred to as the clearwell. Some water from the clearwell is recycled into various plant operations, while excess water is discharged as needed into the Mississippi River via a NPDES permitted outfall after passing through a wastewater treatment plant.[16,17]

To avoid excessive levels of water in the clearwell during periods of high rainfall, which could lead to catastrophic failure of the containing levee, Allied has on occasion bypassed the treatment facility and discharged the clearwell water directly into the Mississippi River. This situation is allowed by EPA and Louisiana Department of Environmental Quality (LADEQ) under proper emergency circumstances (i.e., prior notice, reasonable cause). Emergency discharges occurred in January 1983;[18] and from August 1983 through October 1983.[19] In April 1984, Allied notified EPA of its intention to again bypass the treatment facility when discharging its clearwell water if its level rose another 30 cm, to a depth of 9 meters (30 feet).[20]

Allied has discharged or spilled untreated wastewater during other situations as well. In April 1978, Allied noted a seepage area northwest of the clearwell; subsequent sampling revealed a low pH and the presence of phosphate in the seepage.[21] In July 1978, a gypsum line break reduced pH levels in a drainage ditch feeding into Bayou Breaux.[22] Allied discovered another leak in October 1980 in the northeast corner of the clearwell. Consultants to Allied noted that contaminated water penetrating the clay surfacing was "resulting in vegetation kills which cannot be tolerated."[23] In August 1981, a gypsum slurry transport line ruptured and a portion of the Bayou Breaux dropped in pH from around 7 to as low as 2.6.[24]

One of the primary difficulties in managing the gypsum stack and clearwell areas is preventing their physical failure. Stack failures have occurred in the past. In May 1979, Allied's east gypsum stack failed, resulting in the overflow

---

[16] Allied-Signal, Inc., 1989. Company response to the "National Survey on Solid Wastes from Mineral Processing Facilities," U.S. EPA, 1989.

[17] LA Stream Control Commission, 1977. Permit Application to Discharge Wastewater Revision form by William Chamberlain, General Manager of Allied. July 1, 1977.

[18] EPA Region VI, 1983. Letter from Myron O. Knudson, Director Water Management Division, to Herman J. Baker, Allied Chemical plant manager, Re: Administrative Order Docket No. VI-83-057, NPDES Permit No. LA0006181. January 1, 1983.

[19] Louis J. Capozzoli and Associates, Inc. Consulting Engineers, 1983. Letter from Louis J. Capozzoli and Associates, Inc. to Allied Chemical, Re: Modification of Operations Gypsum Stack and Clearwell. August 8, 1983.

[20] Swidler, Berlin and Strelow, 1984. Letter from L. Miller to Jack Ferguson, EPA Region VI, Re: NPDES Permit No. LA0006181. April 24, 1984.

[21] Allied Chemical, 1980. Letter to Kenneth Cooper, EPA Region VI, Re: (additional information on area northwest of Allied's phosphate clearwell). February 2, 1980.

[22] Allied Chemical, 1978. Letter from W.P. Chamberlain, General Manager to R.A. Lafleur, Executive Secretary, LA Stream Control Commission, Re: (gypsum line break). July 31, 1978.

[23] Allied Chemical, 1980. Letter from W.J. Dessert, Manager Environmental to Dale Givens, LA Water Pollution Control Division, Re: (Letter and supplemental information for October 24, 1980 meeting between Allied Chemical and EPA Region VI). November 11, 1980.

[24] Allied Chemical, 1981. Letter from W.P. Chamberlain, General Manager to Jack Ferguson, Chief Industrial Compliance Section (6E-WC), EPA Region VI, Re: NPDES Permit No. La 0006181. October 20, 1981.

of low pH gypsum slurry water into a roadside ditch along Highway 30.[25,26] An estimated 95 percent of the spilled water was recovered. In October 1980, consultants to Allied Chemical identified four interrelated clearwell and gypsum stack problems: (1) levee overtopping; (2) levee stability (high risk of stack failure); (3) levee crest subsidence; and (4) levee toe leak.[27] In August 1983, another slide (failure) occurred on Allied's gypsum stack.

Releases Associated with the Use of Gypsum as Road Construction Material

Within the time period from 1986 to 1987, in an effort to find a profitable use for the large quantities of gypsum waste accumulating at Allied Signal's facility, Louisiana Synthetic Aggregates, Inc. (LASYNAG) began marketing the gypsum as a road base material.[28] According to consulting engineers contracted by LASYNAG, the gypsum was processed by milling (excavating and screening) the material from the fluorogypsum stockpile located at the Allied-Signal hydrofluoric acid plant in Geismar, Louisiana. Once milled, the fluorogypsum was marketed and shipped as "Florolite."[29]

In 1987, LASYNAG had the milled fluorogypsum analyzed by several laboratories for different parameters. One laboratory reported that with a resistivity of 500 ohms-cm and a pH of 5.2, the material is considered very corrosive for most iron and steel products. The laboratory also stated that the high sulfate content and the low pH would likely make the material corrosive to concrete as well.[30]

During 1987, after several rounds of requests and data submittals, Louisiana's Department of Transportation and LADEQ's Office of Solid and Hazardous Waste authorized the use of Florolite on various road shoulders, embankments, and base courses.[31,32] At least some of these approved projects were completed, including road work at a mobile home park.[33]

In July 1988, the City of New Orleans Department of Streets concluded that the material would be acidic and corrosive for iron, steel, and concrete products, and deemed the use of Florolite as a road base material in the City inadvisable.[34]

On June 7, 1989, LASYNAG began construction of a test embankment for the "U.S. Highway 90 relocation construction project" through a stretch of wetlands in southern Louisiana near Amelia. After three weeks, LADEQ

---

[25] Allied Chemical, 1979. Letter from W.P. Chamberlain to R.A. Lafleur, with attachments, Re: None. (failure of east gypsum stack). June 25, 1979.

[26] EPA Region VI, 1983. Letter from Myron O. Knudson, Director Water Management Division, to Herman J. Baker, Allied Chemical plant manager, Re: Administrative Order Docket No. VI-83-057, NPDES Permit No. LA0006181. January 21, 1983.

[27] Allied Chemical, 1980. Letter from W.J. Dessert, Manager Environmental to Dale Givens, LA Water Pollution Control Division, Re: (Letter and supplemental information for October 24, 1980 meeting between Allied Chemical and EPA Region VI). November 11, 1980.

[28] LASYNAG, located in Gretna, Louisiana, is owned by Coastal Contractors, Inc., of Baton Rouge.

[29] G&E Engineering, Inc., 1989. Analyses of Florolite Aggregate Runoff and Surface Waters - U.S. Highway 90 Reallocation Construction Site--Obtained in Response to LADEQ Compliance Order. September, 1989.

[30] Analysis Laboratories, Inc., 1987. Letter to C. Lundstrom, Eustis Engineering Co., Re: Examination of Florolite Sample. March 27, 1987.

[31] Louisiana Department of Transportation. Projects Containing Florolite. Date unknown.

[32] LADEQ, 1987. Letter from J. Koury, OSHW, to D.G. Azar, LASYNAG, Re: Use of Allied Chemical Company Gypsum. June 8, 1987.

[33] LADEQ, 1987. Complaint form received by Jesse Chang from anonymous resident in Twin Lakes Mobile Home Park, Re: None. (use of Allied Chemical's gypsum for road paving and fill). January 15, 1987.

[34] City of New Orleans Department of Streets, 1988. Letter from R.J. Kaufmann to J. Poolych, LASYNAG, Re: None (Use of Florolite as road base material). July 15, 1988.

responded to complaints of dying biota and found "extremely acidic pH and high conductivity in water adjacent to the roadbed." Construction was ceased immediately.[35]

Exhibit 9-5 summarizes the analytical results for run-off/seepage/leachate samples collected near a Florolite stockpile at the Amelia test site. These results show pH values ranging from 1.6 to 2.9, while sulfate concentrations ranged from 6,030 to 11,500 mg/L, up to 46 times the National Secondary Drinking Water MCL of 250 mg/L. Arsenic, cadmium, chromium, lead, and mercury levels also exceeded Primary MCLs in run-off/seepage/leachate samples. In addition, gross alpha and radium levels were detected at levels above MCLs in several samples.[36]

As shown in Exhibit 9-6, ambient surface water samples collected adjacent to the embankment exhibited elevated levels of pH, sulfates, salinity, and specific conductivity, as well as arsenic, cadmium, chromium, and lead. The elevated concentrations in comparison to the more remote ambient surface water sampling locations were attributed by LASYNAG to leaching and/or run-off from the "Florolite" embankment.[37]

In addition to sampling the Florolite stockpile at the Amelia site, Allied also sampled "fluorogypsum run-off/leachate water" from the Allied-Signal fluorogypsum stockpile. From analysis of one sample, elevated levels of arsenic, cadmium, chromium, lead, mercury, gross alpha radiation, and radium, were detected (Exhibit 9-7).[38]

LASYNAG is now undertaking remedial measures to remove the environmental hazard posed by Florolite at the Amelia test site.[39]

9.3.3 Findings Concerning the Hazards of Fluorogypsum and Process Wastewater

Although both fluorogypsum and hydrofluoric acid process wastewater contain several constituents in concentrations that could pose significant risk under worst-case exposure conditions, the process wastewater is intrinsically much more hazardous. Based on an analysis of nine samples, the wastewater consistently exhibits the hazardous waste characteristic of corrosivity (the pH may be as low as 1.0 at the Geismar and Calvert City facilities, and as high as 14 at the LaPorte facility). The wastewater also contains six constituents in concentrations that exceed the screening criteria by a factor of 10 or more, though none of the constituents were detected in excess of the EP toxicity regulatory levels. In contrast, no constituents were detected in the fluorogypsum solids in concentrations that could pose a risk, and only one contaminant in the fluorogypsum leachate (lead) exceeded the screening criteria by more than a factor of 10. Run-off/leachate samples collected at the Allied-Signal stack as well as the test embankment site near Amelia, LA indicate that fluorogypsum leachate may contain elevated levels of gross alpha radioactivity and radium-226, but the gross alpha and radium concentrations that were measured rarely exceeded the MCL by more than a factor of 10. Furthermore, based on available data and professional judgment, EPA does not believe that fluorogypsum exhibits any of the characteristics of a hazardous waste.

Based on an analysis of existing exposure and environmental conditions at the three active hydrofluoric acid production plants, there is a relatively high potential for shallow ground-water contamination caused by the seepage of process wastewater and the migration of fluorogypsum leachate. This is substantiated by documented ground-water contamination near the impoundment at the Calvert City facility and observed

---

[35] G&E Engineering, Inc., 1989. Analyses of Florolite Aggregate Runoff and Surface Waters - U.S. Highway 90 Reallocation Construction Site - Obtained in Response to LADEQ Compliance Order. September, 1989.

[36] Ibid.

[37] Ibid.

[38] Ibid.

[39] Ibid.

Exhibit 9-5
Run-off/Seepage/Leachate from Florolite at Test Site Near Amelia, LA

Parameter	MCL (mg/L)[b]	No. Samples Exceeding MCL[a]	Range of Exceedance (mg/L)[b]
As	0.05	4	0.2 -- 1.1
Cd	0.01	7	0.07 -- 0.56
Cr	0.05	7	0.67 -- 9.5
Pb	0.05	7	0.3 -- 1.6
Hg	0.002	2	0.0043 -- 0.0050
Gross Alpha	15 pCi/L	6	79 -- 226 pCi/L
Total Radium	5 pCi/L	2	8 -- 22 pCi/L
pH	6.5 -- 8.5 S.U.	7	1.4 -- 2.9 S.U.

(a) Out of 7 samples collected.
(b) Except as noted.

Exhibit 9-6
"Ambient" Surface Water (Area Affected by Florolite) at Test Site Near Amelia, LA

Parameter	MCL (mg/L)[b]	No. Samples Exceeding MCL[a]	Range of Exceedance (mg/L)[b]
As	0.05	1	0.15
Cd	0.01	2	0.03 -- 0.07
Cr	0.05	2	0.39 -- 1.3
Pb	0.05	2	0.2 -- 0.2
Gross Alpha	15 pCi/L	2	24 -- 103 pCi/L
pH	6.5 -- 8.5 S.U.	10	2.1 -- 6.4

(a) Out of 10 samples collected.
(b) Except as noted.

Exhibit 9-7
Fluorogypsum Run-off/Leachate Water From The Allied-Signal Fluorogypsum Stockpile

Parameter	MCL (mg/L)	Sample Concentration (mg/L)[a]
As	0.05	0.06
Cd	0.01	0.18
Cr	0.05	3.6
Pb	0.05	0.5
Hg	0.002	0.0062
Gross Alpha	15 pCi/L	140 pCi/L
pH	6.5 - 8.5 S.U.	1.7 S.U.

(a) One sample collected (07/11/89).

contamination seeps around the process wastewater "clearwell" pond at the Geismar facility. This contamination is not expected to cause significant health risks at present, either because the shallow ground water is not likely to be used at close downgradient distances (as is the case at Geismar and LaPorte) or because the waste management units are equipped with slurry walls and a monitoring well network to help contain any contamination (as is the case at Calvert City). However, the very low or high pH of the process wastewater could cause considerable ground-water resource damage (e.g., affected ground water may be corrosive, have an objectionable taste, and require additional treatment prior to use).

The potential for significant releases to surface water during routine operations is limited at each site by some type of management control, including perimeter ditches, retention ponds, and/or slurry walls. Even if contaminants did migrate to nearby surface waters at the Calvert City and La Porte facilities, both of the sites borders major water bodies (the Tennessee River and San Jacinta Bay) that should be able to readily assimilate the low pollutant loadings that would be expected. The smaller Bayou Breaux near the Geismar facility may receive contaminants in the event of spills and gypsum stack failures, but routine releases to the bayou are expected to be minimal given the site's perimeter ditch system and the large distance (1,200 meters) separating the bayou from the waste management units. Occasional overflows and emergency discharges to surface waters have occurred during major storms, but these are generally isolated events that are controlled under the NPDES program.

Considering the form of the wastes (nonvolatile liquids and moist/wet solids) and the absence of any contaminants that could pose an inhalation threat, the potential for significant releases and exposures via the air pathway appears very low.

Documented cases of damage identified by EPA provide two important findings. First, the damage case at the Geismar facility demonstrates difficulties in preventing the physical failure of gypsum stacks. There have been at least six separate incidents since 1979 in which the stack at this facility failed (i.e., slumped, collapsed, and/or overflowed). Although relatively rare, these failures allow sporadic large releases of the highly acidic process wastewater. Second, the documented case of environmental contamination caused by the off-site use of fluorogypsum demonstrates that the distribution and use of this material warrants close control. Specifically, when used off-site for applications that result in contact with the land (e.g., road construction), pH adjustment is required to prevent adverse environmental impacts, and run-off controls are needed to prevent the spread of potentially harmful concentrations of contaminants.

9.4 Existing Federal and State Waste Management Controls

9.4.1 Federal Regulation

Under the Clean Water Act, EPA has the responsibility for setting "effluent limitations," based on the performance capability of treatment technologies. These "technology based limitations," which provide the basis for the minimum requirements of NPDES permits, must be established for various classes of industrial discharges, including a number of ore processing categories.

Permits for mineral processing facilities may require compliance with effluent guidelines based on best practicable control technology currently available (BPT) or best available technology economically achievable (BAT). BPT effluent limitations for existing sources applicable to discharges resulting from the production of hydrofluoric acid include (40 CFR 415.82):

Pollutant	Daily Maximum	Monthly Average
Total Suspended Solids	11 Kg/kkg	5.3 Kg/kkg
Total Fluorine	6.1 Kg/kkg	2.9 Kg/kkg
Total Nickel	0.036 Kg/kkg	0.011 Kg/kkg
Total Zinc	0.12 Kg/kkg	0.036 Kg/kkg
pH	6-9	6-9

BAT effluent limitations for existing sources for discharges resulting from the production of hydrofluoric acid include (40 CFR 415.83):

Pollutant	Daily Maximum	Monthly Average
Total Fluorine	3.4 Kg/kkg	1.6 Kg/kkg
Total Nickel	0.020 Kg/kkg	0.0060 Kg/kkg
Total Zinc	0.072 Kg/kkg	0.022 Kg/kkg

Effluent limitations for new sources of these discharges include (40 CFR 415.85):

Pollutant	Daily Maximum	Monthly Average
Total Suspended Solids	6.0 Kg/kkg	3.0 Kg/kkg
Total Fluorine	3.4 Kg/kkg	1.6 Kg/kkg
Total Nickel	0.020 Kg/kkg	0.0060 Kg/kkg
Total Zinc	0.072 Kg/kkg	0.022 Kg/kkg
pH	6-9	6-9

In Texas and Louisiana, states which do not have EPA-approved NPDES programs, EPA Regional personnel have stated that they would apply the above guidelines. The State, however, may also adopt state water quality standards for control of discharges from hydrofluoric acid manufacturing facilities.

9.4.2 State Regulation

The three hydrofluoric acid production facilities addressed by this report, all of which generate and co-manage fluorogypsum and process wastewater, are located in Kentucky, Louisiana, and Texas. All three of these states were selected for regulatory review (see Chapter 2 for a discussion of the methodology used to select study states for detailed regulatory review).

All three states with hydrofluoric acid production facilities exclude mineral processing wastes from hazardous waste regulation. Of the three states, Louisiana appears to be the most comprehensive in its coverage of both fluorogypsum and process wastewater, which the state classifies as industrial solid wastes. Although no requirements have been drafted specifically for fluorogypsum waste piles, facility owner/operators must comply with general waste pile provisions for soils (e.g., stability, permeability), hydrologic characteristics, precipitation run-on and run-off, location standards, security, safety, and waste characterization. Similarly, process wastewater management must meet general industrial waste surface impoundment requirements such as run-on controls, liner requirements, design standards (e.g., to prevent overtopping and minimize erosion), waste characterization, and ground-water monitoring requirements. Surface impoundments must be dewatered and clean-closed (i.e., all residuals removed) or closed according to solid waste landfill closure provisions. Louisiana also requires that owners/operators of all industrial solid waste piles and surface impoundments maintain financial responsibility for the closure and post-closure care of those waste units. Although Louisiana does not have an approved NPDES program, the state does require state permits for the discharge of leachate or run-off to surface waters. Finally, Louisiana air regulations require that its one hydrofluoric acid processing facility manage its wastes in a manner necessary to minimize fugitive dust emissions.

As does Louisiana, Texas classifies mineral processing wastes, including wastes from the production of hydrofluoric acid, as industrial solid wastes. Because the hydrofluoric acid facility in Texas disposes of its wastes on property that is both within 50 miles of the facility and controlled by the facility owner/operator, the state has not required the facility to obtain a solid waste disposal permit. The facility has notified the state of its waste disposal activities, as required, and has obtained federal NPDES and Texas wastewater discharge permits. Finally, Texas air regulations include provisions that could apply to the disposal of hydrofluoric acid processing wastes, though it does not appear that these provisions have been applied to the facility.

Kentucky also classifies the hydrofluoric acid processing wastes generated at its one facility as solid waste and requires the facility to maintain a solid waste permit that includes provisions for ground-water monitoring and waste characterization. The facility's surface impoundment is not designed to discharge to either ground or surface water. Kentucky's facility also maintains a NPDES permit, though state officials believe that all of the process wastewater is recycled at the facility, and must meet stormwater run-off standards for both its operating and closed fluorogypsum ponds. The state recently proposed a new residuals regulation that may apply to hydrofluoric acid processing wastes. If these wastes are subject to the new rule, the facility owner/operator could be required to upgrade existing ground-water monitoring efforts, continue waste characterization, undertake the formal closure of waste management units, and demonstrate financial responsibility. Finally, although general fugitive dust emission control requirements apply, the nature of fluorogypsum as it is currently managed at the facility effectively precludes fugitive dust problems and state officials were unaware of any such problems.

In summary, all three states with hydrofluoric acid processing facilities exclude the fluorogypsum and process wastewaters generated at those facilities from hazardous waste regulation. Moreover, all three states address these wastes under their solid waste regulations to varying degrees. Of the three states, Louisiana currently appears to be the most comprehensive in its regulation under solid waste provisions. Kentucky applies some regulatory controls to its facility and appears to be preparing to strengthen those requirements under a recently promulgated residuals regulation. Texas classifies hydrofluoric acid processing wastes as solid wastes, but exempts its facility from the requirement to obtain a solid waste disposal permit because the wastes are disposed of on-site. All three facilities maintain federal

and/or state NPDES permits. Finally, although all three states have general fugitive dust emission control provisions, none of the states appear to have applied those requirements to hydrofluoric acid processing wastes because of the nature of fluorogypsum and process wastewater.

9.5 Waste Management Alternatives and Potential Utilization

This section provides a brief summary of current management practices and potential areas of utilization for both fluorogypsum and process wastewater, because they are generally co-managed.

Fluorogypsum

In 1988, the three U.S. facilities generated an estimated 890,000 metric tons of fluorogypsum.[40] The primary alternative to disposal of fluorogypsum in stacks is utilization in construction materials as a lightweight aggregate. Two of the three facilities sell fluorogypsum from their stacks to on-site contractors who subsequently sell it to construction firms and highway departments. The third facility disposes of all of its fluorogypsum. This facility (Attochem's facility in Calvert City, Kentucky) currently disposes of all its fluorogypsum in a surface impoundment, though the firm is currently investigating the possibility of utilizing the fluorogypsum to produce a road base aggregate.[41]

Allied Signal's Geismar, Louisiana plant sent over 323,000 metric tons of fluorogypsum to its disposal stack in 1988 and removed and sold 140,000 metric tons.[42] Louisiana Synthetic Aggregate, an on-site contractor, retrieves the fluorogypsum from the stack, screens and sizes it, adds a quantity of reagent to the product for neutralization, and sells the fluorogypsum to construction companies and local highway departments for use as a lightweight aggregate in road beds.[43] There has been one reported damage case associated with use of fluorogypsum without neutralization from Allied's facility as an embankment material (see Section 9.3.2 for details). Louisiana Synthetic Aggregate is investigating the use of fluorogypsum in building materials (i.e., plaster of Paris, self-leveling sub-floor base) as a substitute for natural gypsum.[44]

Of the three U.S. facilities generating fluorogypsum, the duPont plant in LaPorte, Texas has had the greatest success in selling its fluorogypsum for utilization in construction. duPont sells its fluorogypsum to an on-site contractor, Gulf States Materials, which markets the product in the Houston area. The sales to production ratio for duPont's fluorogypsum in 1988 and 1989 were 153 percent and 161 percent, respectively. Approximately 60 percent of the material sold is used as a limestone replacement for road base aggregate and 40 percent is used as a fill material. Except for screening and sizing, the fluorogypsum sent to the stack at the LaPorte facility does not require any processing before being utilized. If the material is used as road base, cement or fly ash may be added to give it pozzollanic characteristics. DuPont expects that the market for fluorogypsum as a construction material will continue to grow as it has in the 11 years since the material was first sold.[45]

Hydrofluoric Acid Process Wastewater

At present, the only waste management practices being applied by the three hydrofluoric acid producers to the process wastewater are returning it to the production process and/or adjusting the pH prior to recycling or discharge. None of the three facilities report that they completely neutralize their process wastewater, and in some cases the

---

[40] Company responses to the "National Survey of Solid Wastes from Mineral Processing Facilities," U.S. EPA, 1989.

[41] Pennwalt Corporation, company response to the "National Survey of Solid Wastes form Mineral Processing Facilities," U.S. EPA, 1989.

[42] Allied-Signal, Inc., company response to the "National Survey of Solid Wastes form Mineral Processing Facilities," U.S. EPA, 1989.

[43] Personal communication, Dennis Cheuvront, Environmental Supervisor, Allied-Signal Inc., Geismar, Louisiana, May 11, 1990.

[44] Ibid.

[45] Personal communication, Larry Schwarz, Staff Engineer-HF Operation, E.I. DuPont, LaPorte, Texas, May 10, 1990.

recycled wastewater is used because of its acidity.[46] Therefore, the only potential waste management alternative is complete neutralization, though this might reduce the quantity of wastewater that can be recycled.

9.6 Costs and Economic Impacts

Section 8002(p) of RCRA directs EPA to examine the costs of alternative practices for the management of the special wastes considered in this report. EPA has responded to this requirement by evaluating the operational changes that would be implied by compliance with three different regulatory scenarios, as described in Chapter 2. In reviewing and evaluating the Agency's estimates of the cost and economic impacts associated with these changes, it is important to remember what the regulatory scenarios imply, and what assumptions have been made in conducting the analysis.

The focus of the Subtitle C compliance scenario is on the costs of constructing and operating hazardous waste management units. Other important aspects of the Subtitle C system (e.g., corrective action, prospective land disposal restrictions) have not been explicitly factored into the cost analysis. Therefore, differences between the costs estimated for Subtitle C compliance and those under other scenarios (particularly Subtitle C-Minus) are less than they might be under an alternative set of conditions (e.g., if most affected facilities were not already subject to Subtitle C, if land disposal restrictions had been promulgated for "newly identified" hazardous wastes). The Subtitle C-Minus scenario represents, as discussed above in Chapter 2, the minimum requirements that would apply to any of the special wastes that are ultimately regulated as hazardous wastes; this scenario does not reflect any actual determinations or preliminary judgments concerning the specific requirements that would apply to any such wastes. Further, the Subtitle D-Plus scenario represents one of many possible approaches to a Subtitle D program for special mineral processing wastes, and has been included in this report only for illustrative purposes. The cost estimates provided below for the three scenarios considered in this report must be interpreted accordingly.

In accordance with the spirit of RCRA §8002(p), EPA has focused its analysis on impacts on the firms and facilities generating the special wastes, rather than on net impacts to society in the aggregate. Therefore, the cost analysis has been conducted on an after-tax basis, using a discount rate based on a previously developed estimate of the weighted average cost of capital to U.S. industrial firms (9.49 percent), as discussed in Chapter 2. Waste generation rate estimates (which are directly proportional to costs) for the period of analysis (the present through 1995) have been developed in consultation with the U.S Bureau of Mines.

In this section, EPA first outlines the way in which it has identified and evaluated the waste management practices that would be employed under different regulatory scenarios by facilities producing hydrofluoric acid. Next, the section discusses the cost implications of requiring these changes to the existing waste management practices. The last part of the section discusses and predicts the ultimate impacts of the increased waste management costs faced by this industry.

9.6.1 Regulatory Scenarios and Required Management Practices

Based upon the information presented above, EPA believes that process wastewater from hydrofluoric acid production may pose a relatively high risk potential and generally exhibits that hazardous waste characteristic of corrosivity. Accordingly, the Agency has estimated the costs associated with RCRA Subtitle C regulation, as well as with two somewhat less stringent regulatory scenarios, referred to here as "Subtitle C-Minus" and "Subtitle D-Plus" (a more detailed description of the cost impact analysis and the development of these regulatory scenarios is presented in Chapter 2, above). In the following paragraphs, EPA discusses the assumed management practices that would occur under each regulatory alternative.

The Agency's sampling efforts indicated that the process wastewater at Allied-Signal's Geismar facility exhibits the hazardous characteristic of corrosivity. While the conservative approach would be to assume that the remaining two facilities also generate corrosive process wastewaters, EPA believes that present practices are such that no compliance costs would be imposed on those facilities. The Calvert City facility currently treats its slurried fluorogypsum and

[46] Company responses to the "National Survey of Solid Wastes from Mineral Processing Facilities," U.S. EPA, 1989.

process wastewater such that the wastewater leaving the treatment unit is neutral (i.e., with pH of 8, as reported in the SWMPF Survey). The duPont facility reportedly treats its slurried waste stream with lime to bring it to a very high pH, possibly even greater than 12.5, such that the process water may be considered corrosive at the alkaline extreme. The purpose of this treatment is to prepare the gypsum for sale as a byproduct. The Agency assumes that the facility would decrease the extent of its lime treatment to the point at which the process wastewater would not exhibit the corrosivity characteristic (pH < 12.5), and that this treatment process modification would not impose any compliance costs per se.

Because the available data indicate that fluorogypsum does not exhibit any of the characteristics of hazardous waste and has been found to pose only low potential risk, the issues of how waste management costs might change because of new regulatory requirements and what impacts such costs might impose upon affected facilities are moot. Consequently, EPA has not estimated regulatory compliance costs for this waste.

A decision by EPA that Subtitle C regulation is appropriate for process wastewater would result in incremental waste management costs at one facility. The Agency has estimated the incidence, magnitude, and impacts of the costs for that facility; this analysis is presented in the following paragraphs.

Subtitle C

Under Subtitle C standards, hazardous waste that is managed on-site must meet the rigorous standards codified at 40 CFR Part 264 for hazardous waste treatment, storage, and disposal facilities. Because hydrofluoric acid production process wastewater is a dilute, aqueous liquid, that is corrosive but non-EP toxic, the management practice of choice under Subtitle C is treatment (neutralization) in a tank. EPA has determined that within the relevant size range, tank treatment is the least-cost management method, and has conducted its analysis accordingly. The scenario examined here involves construction of a Subtitle C surge pond (double-lined surface impoundment), and a tank treatment system. Following neutralization, the treated process wastewater may be reused by the facility (e.g., to slurry fluorogypsum to the gypsum stack or impoundment), just as it is under current practice. The treatment sludge, which is assumed to not be hazardous, is disposed in an unlined disposal impoundment/landfill.

Subtitle C-Minus

Assumed practices under Subtitle C-Minus are identical to those described above for the full Subtitle C scenario, with the exception that some of the strict requirements for construction and operation of the hazardous waste surge pond have been relaxed, most notably the liner design requirements. Because other Subtitle C provisions apply in full, there are no significant operational differences between the two scenarios.

Subtitle D-Plus

Assumed practices under Subtitle D-Plus are identical to those described above for the full Subtitle C scenario, with the exception that, as under Subtitle C-Minus, some of the strict requirements for construction and operation of the hazardous waste surge pond have been relaxed, most notably the liner design requirements. Because other Subtitle C provisions apply in full, there are no significant operational differences between this and the other two scenarios.

9.6.2 Cost Impact Assessment Results

Results of the cost impact analysis for the hydrofluoric acid sector are presented by regulatory scenario in Exhibit 9-8

. Under the Subtitle C scenario, annualized incremental regulatory compliance costs for Allied-Signal's facility are estimated to be $1.8 million greater than baseline (over 8 times the baseline costs). Annualized incremental capital compliance expenditures are estimated at $512,000, approximately 29 percent of total incremental compliance costs.

Under the somewhat less rigorous requirements of the Subtitle C-Minus scenario, costs of regulatory compliance are lower, due to decreased capital construction outlays. Allied-Signal's annualized compliance costs under this scenario are estimated to be $1.7 million greater than baseline (about 8 times baseline costs). The total compliance cost is only about four percent less than that under the full Subtitle C scenario. The primary reason for the difference in waste management costs is the configuration of the surge pond liner system; under the Subtitle C-Minus scenario, disposal units are equipped with a single synthetic/clay liner and leachate collection system, rather than the dual system required under full Subtitle C regulation.

Costs under the Subtitle D-Plus regulatory scenario are virtually identical to those under Subtitle C-minus scenario. The configuration of the surge pond, the only varying factor, is the same for D-Plus as under C-Minus (installation of a composite liner and clean closure). Variations in permitting costs between C-Minus and D-Plus account for the difference in the annual compliance cost.

9.6.3 Financial and Economic Impact Assessment

In order to evaluate the ability of the affected facility to bear these regulatory compliance costs, EPA conducted an impact assessment consisting of three steps. First, the Agency compared the estimated costs to several measures of the financial strength of the facility and thereby generated financial impact ratios in order to assess the magnitude of the financial burden that would be imposed in the absence of changes in supply, demand, or price. Next, in order to determine whether compliance costs could be distributed to (shared among) other production input and product markets, EPA conducted a qualitative evaluation of the salient market factors that affect the competitive position of domestic primary hydrofluoric acid producers. Finally, the Agency combined the results of the first two steps to arrive at predicted ultimate compliance-related economic impacts on the hydrofluoric acid industry. The methods and assumptions used to conduct this analysis are described in Chapter 2.

Financial Ratio Analysis

EPA believes that regulation under any of the three scenarios would not significantly affect the financial viability of the one affected facility, Allied-Signal's facility in Geismar, Louisiana. As shown in Exhibit 9-9, the annualized incremental costs associated with waste management under Subtitle C, C-Minus, or D-Plus should only marginally affect the facility in terms of both value added and value of shipments, as indicated by ratio values of less than 1.5 percent in all cases. The only potentially significant impact is indicated by the annualized compliance capital as a percentage of the total annual sustaining capital investment; additional capital approaching ten percent of current levels of sustaining capital would be required to cover increased waste management costs.

Evaluation of Cost/Economic Impacts

EPA believes that stringent regulation of hydrofluoric acid process wastewater as a hazardous waste would not impose highly significant economic or financial impacts on Allied-Signal's facility in Geismar, Louisiana, though a large capital investment relative to current sustaining capital would be required. Furthermore, EPA's analysis suggests that the operator could pass through a portion of any regulatory compliance costs to product consumers, because demand for and prices of hydrofluoric acid have been strong in recent years, and are expected to remain so for the foreseeable future. As a final note, the Agency expects

Exhibit 9-9
Significance of Regulatory Compliance Costs for Management of Hydrofluoric Acid[(a)]

Facility	CC/VOS	CC/VA	IR/K
Subtitle C			
Allied-Signal - Geismar, LA	1.2%	1.5%	9.7%
Subtitle C-Minus			
Allied-Signal - Geismar, LA	1.1%	1.5%	8.7%
Subtitle D-Plus			
Allied-Signal - Geismar, LA	1.1%	1.4%	8.7%

CC/VOS = Compliance Costs as Percent of Sales
CC/VA = Compliance Costs as Percent of Value Added
IR/K = Annualized Capital Investment Requirements as Percent of Current Capital Outlays
(a) Values reported in this table are based upon EPA's compliance cost estimates. The Agency believes that these values are precise to two significant digits.
Costs and impacts have been estimated for only the facility for which sampling data indicate that the waste fails a RCRA hazardous waste characteristic.

there to be no significant difference in the cost impacts of the Subtitle C, C-Minus, and D-Plus regulatory scenarios, suggesting that adequately protective management standards will eventually be required, irrespective of whether process wastewater from hydrofluoric acid is retained within the Mining Waste Exclusion.

9.7 Summary

As discussed in Chapter 2, EPA developed a step-wise process for considering the information collected in response to the RCRA §8002(p) study factors. This process has enabled the Agency to condense the information presented in the previous six sections of this chapter into three basic categories. For each special waste, these categories address the following three major topics: (1) potential for and documented danger to human health and the environment; (2) the need for and desirability of additional regulation; and (3) the costs and impacts of potential Subtitle C regulation.

Fluorogypsum

Potential and Documented Danger to Human Health and the Environment

The intrinsic hazard of fluorogypsum is relatively low compared to the other mineral processing wastes studied in this report. Fluorogypsum does not exhibit any of the four characteristics of hazardous waste. No constituents in the fluorogypsum solids were detected at levels above the risk screening criteria used in this analysis, and only two constituents -- gross alpha radiation and lead -- were detected in the waste leachate in a concentration that exceeds the screening criteria by as much as a factor of 10. Gross alpha levels as high as 226 pCi/l (15 times the MCL) and radium-226 levels as high as 22 pCi/l (4 times the MCL) were measured in leachate/run-off collected at field locations where fluorogypsum had been disposed. Information collected through EPA's damage case research also indicates that fluorogypsum may be mildly corrosive to iron, steel, and concrete, although not so corrosive as to qualify as a hazardous waste. This residual corrosivity is likely the result of the fluorogypsum being co-managed with the highly acidic process wastewater, rather than an intrinsic property of the fluorogypsum itself.

Based on an analysis of existing release and environmental conditions at the three active hydrofluoric acid plants, there is a relatively high potential for fluorogypsum leachate to migrate into shallow ground water. This is substantiated by documented leachate migration near the impoundment at the Calvert City facility. Such migration, however, is not expected to cause significant impacts, either because the shallow ground water is not likely to be used at close downgradient distances and contaminant concentrations at potential exposure points should be below levels of concern (as is the case at Geismar and LaPorte), or because the waste management units are equipped with slurry walls and a monitoring well network to detect and help contain any ground-water contamination (as is the case at Calvert City). The potential for significant releases to surface water during routine operations is limited at each site by some type of management control, including perimeter ditches, automatic pumps, retention ponds, and/or slurry walls. Even if contaminants did migrate to nearby surface waters, each of the existing sites borders major water bodies (the Mississippi River, the Tennessee River, and San Jacinta Bay) that should be able to assimilate the low pollutant loadings that would be expected during routine operating conditions. Contaminants from the Geismar facility may migrate into a smaller water body, the Bayou Breaux, in the event of a large spill or gypsum stack failure, but routine releases to this bayou are not expected. Occasional overflows and emergency discharges to surface water have occurred during major storms, but these are generally releases of process wastewater rather than fluorogypsum. Such emergency discharges also are isolated events that are controlled under the NPDES program. Finally, considering the form of fluorogypsum (moist/wet solids that dry to form a surface crust) and the fact that no contaminants were detected in the waste at levels that could pose an inhalation threat, the potential for significant releases and exposures via the air pathway also appears low.

Through its damage case research, EPA identified two cases of documented environmental contamination that are associated with the management of fluorogypsum. In one case, fluorogypsum was used to construct a test highway embankment in a wetland near Amelia, LA, resulting in high contaminant concentrations in run-off and ambient surface water at the site. This damage case demonstrates that the distribution and use of this material warrants close control. The other damage case involves at least six separate incidents since 1979 in which the fluorogypsum stack at the Geismar facility has physically failed (i.e., slumped, collapsed, and/or overflowed). In each incident, localized environmental contamination has occurred, but this contamination appears to be more attributable to the process wastewater that was spilled along with the stack failure than to the fluorogypsum.

Likelihood That Existing Risks/Impacts Will Continue in the Absence of Subtitle C Regulation

As discussed above, the current fluorogypsum management practices and environmental conditions at the three active hydrofluoric acid production facilities may allow leachate from this waste to migrate into shallow ground water, both now and in the future. This potential for migration exists partly because the existing fluorogypsum management units are not lined and are underlain by shallow ground water, and partly because fluorogypsum is co-managed with highly acidic (or basic) process wastewater that can mobilize metals in the gypsum and provide a hydraulic head to drive contaminants into the subsurface. After closure, and if the process wastewater is removed, the potential for leachate migration from this waste will be reduced considerably. This migration is not expected to pose a significant human health and environmental threat at present for the reasons outlined above, and considering the measured contaminant concentrations in fluorogypsum leachate, would pose a hazard in the future only if shallow ground water very near the waste management units is allowed to be used for drinking or agricultural purposes.

There is a relatively high potential for fluorogypsum to be generated and managed at alternate sites in the future. Acid-grade fluorospar that is used as a feedstock is largely imported, such that additional plants could be located nearly anywhere that provides adequate access to water transportation. Although the addition of new plants is uncertain, it is a distinct possibility given that many potential chlorofluorocarbon (CFC) substitutes are likely to require more fluorine than do CFCs.[47] In addition, two of the three active facilities currently sell fluorogypsum to construction firms and highway departments for use at off-site locations. As demonstrated by the damage case in Amelia, LA, such off-site uses can lead to damages if not properly controlled. However, given the low intrinsic hazard of fluorogypsum,

[47] Production of CFCs is being phased out due to their adverse effects on stratospheric ozone. Substitute compounds that are less persistent in the atmosphere are expected to have more fluorine atoms per molecule, thus increasing demand for a source of fluorine in the production of these compounds.

damages from off-site uses are likely only in extreme mismanagement scenarios, such as disposal of the material in a wetland (as was the case at Amelia) or disposal in a manner that would allow people to drink largely undiluted leachate.

At present, of the three states with hydrofluoric acid processing facilities, Louisiana appears to be the most comprehensive in its regulation of fluorogypsum under its solid waste provisions. Fluorogypsum is classified as an industrial solid waste in Louisiana, and although the gypsum is not subject to specific requirements, stacks must meet the State's general requirements for solid waste landfills. Owners/operators in Louisiana also must maintain Federal NPDES permits and State air emission permits, the latter of which include provisions for fugitive dust control. The other states where active facilities are located -- Kentucky and Texas -- impose less stringent solid waste and air regulatory requirements on hydrofluoric acid production facilities within their jurisdictions, though Kentucky recently proposed new solid waste regulations that may address the waste more stringently.

Costs and Impacts of Subtitle C Regulation

Because of the low risk potential of fluorogypsum, the general absence of documented damages associated with the appropriate use of this material, and the fact that this waste does not exhibit any characteristics of hazardous waste, EPA has not estimated the costs and associated impacts of regulating fluorogypsum from hydrofluoric acid production under RCRA Subtitle C.

Hydrofluoric Acid Process Wastewater

Potential and Documented Danger to Human Health and the Environment

In contrast to fluorogypsum, the intrinsic hazard of hydrofluoric acid process wastewater is relatively high compared to the other mineral processing wastes studied in this report. All nine samples of process wastewater that were analyzed (from two of the three active facilities) exhibited the hazardous waste characteristic of corrosivity -- the pH may be as low as 1 at the Geismar and Calvert City facilities, and as high as 14 at the LaPorte facility. In addition, the wastewater contains six constituents in concentrations that exceed the risk screening criteria used in this analysis by a factor of 10, though none of the constituents were detected in excess of the EP toxicity regulatory levels.

Because the process wastewater is co-managed with fluorogypsum, the potential for wastewater to migrate into the environment at the active facilities is similar to that described above for fluorogypsum. However, the extreme pH and higher concentrations of toxic constituents in process wastewater make it a greater potential threat than fluorogypsum. There is a relatively high potential for process wastewater to migrate into shallow ground water at the three facilities, as demonstrated by the contaminant migration observed near the impoundment at the Calvert City facility and the contamination seeps observed around the process wastewater clearwell pond at the Geismar facility. This migration is not expected to pose significant current health risks, either because the shallow ground water is not likely to be used at close downgradient distances (as is the case at Geismar and LaPorte), or because the waste management units are equipped with slurry walls and a monitoring well network to detect and help contain ground-water contamination (as is the case at Calvert City). However, the very low or high pH of the process wastewater could cause considerable ground-water resource damage (e.g., affected ground water may be corrosive, have an objectionable taste, and require additional treatment prior to use). Routine operations are not expected to cause significant surface water impacts, considering the management controls, distances to surface water, and assimilative capacity of nearby waters. Nevertheless, as demonstrated by the damage case at the Geismar facility, there may be occasional spills and emergency discharges of process wastewater that may kill vegetation on affected land and cause short-term pH excursions in surface waters (such emergency discharges are controlled under the NPDES program). Airborne releases and risks associated with the management of process wastewater are not expected to occur, given the physical state of this waste stream.

Likelihood That Existing Risks/Impacts Will Continue in the Absence of Subtitle C Regulation

Current process wastewater management practices may allow seepage into ground water, both now and in the future, because the existing waste management units are not lined and are underlain by shallow ground water. The co-management of process wastewater with fluorogypsum enhances the potential for contaminant migration because the highly acidic process wastewater percolating through the fluorogypsum may mobilize metals in the gypsum and provide a force to carry contaminants into the subsurface. In addition, there are difficulties in preventing the physical failure of gypsum stacks. Although rare, these stack failures allow large spills of the process wastewater and intense localized impacts. These releases are expected to continue in the absence of more stringent regulation, and although EPA does not believe that they have caused significant long-term risks at the active facilities, significant exposures could occur if the wastewater is managed in a more sensitive environmental setting in the future. In addition, the corrosive nature of the wastewater would likely render affected ground water near the waste management units unfit for future uses without prior treatment.

While process wastewater is not likely to be used off-site, there is a potential for new hydrofluoric acid production plants to start up at alternate sites in the future. As discussed above for fluorogypsum, more plants may be needed to produce the more fluorine-rich substitutes for CFCs. If constructed, these new plants may be located in environmental settings where the corrosive wastewater may pose substantial risks if not properly controlled.

Finally, of the three States where the active facilities are located, Louisiana appears to be most comprehensive in its regulation of hydrofluoric acid process wastewater. The process wastewater is classified as an industrial solid waste in Louisiana, and although the wastewater is not subject to specific requirements, the wastewater impoundments must meet general requirements for all surface water impoundments. Owners/operators in Louisiana also must maintain Federal NPDES permits for the discharge of process wastewater. In contrast, Kentucky and Texas (the other States where active facilities are located) impose less stringent requirements on hydrofluoric acid production facilities, though Kentucky recently proposed new solid waste regulations that may address process wastewater more directly.

Costs and Impacts of Subtitle C Regulation

Because of the relatively high risk potential of this waste and the fact that EPA waste sampling data indicate that process wastewater from hydrofluoric acid production exhibits the hazardous waste characteristic of corrosivity, the Agency has evaluated the costs and associated impacts of regulating this waste as a hazardous waste under RCRA Subtitle C. However, information collected by EPA indicates that at two of the three active facilities (LaPorte and Calvert City), neutralization of the process wastewater (i.e., removal of the characteristic of hazardous waste) is part of the current management practice. Consequently, EPA believes that removal of process wastewater from the Mining Waste Exclusion would not impose significant operational or cost impacts on these two facilities. Therefore, EPA's analysis of costs and impacts is limited in scope to the Geismar facility.

Total costs of regulatory compliance at the Geismar hydrofluoric acid plant exceed $1.5 million annually under each of the three regulatory scenarios. Costs under the full Subtitle C, Subtitle C-Minus, and Subtitle D-Plus scenarios are similar (within nine percent of one another), because adequately protective waste management unit design and operating standards are essentially the same under all three scenarios, given the nature of the waste and the environmental setting in which it is currently managed. These compliance costs represent from one to one and one half percent of the value of shipments of and value added by the Geismar facility, though the annualized capital requirements of compliance are on the order of nine to ten percent of the sustaining capital required for the hydrofluoric acid operation. EPA's economic impact analysis suggests that the operator of the potentially affected facility could pass through a portion of any regulatory compliance costs that they might incur to product consumers, because demand for and prices of hydrofluoric acid have been strong in recent years, and are expected to remain so for the foreseeable future. Because the costs of Subtitle C regulatory compliance would not impose significant immediate impacts on the affected facility (less than one and a half percent of value added), because the facility may have some ability to pass any such costs through to product consumers through higher prices, and perhaps most importantly, because two of the three active facilities in the sector <u>currently</u> treat their process wastewater in the manner contemplated here, EPA does not believe

that a decision to regulate process wastewater from hydrofluoric acid production under Subtitle C would threaten the long-term profitability or viability of the Geismar facility, or any other future hydrofluoric acid plant.

Finally, EPA is not aware of any significant recycling or utilization initiatives that would be hampered by a change in the regulatory status of this waste. At the one potentially affected facility, the process water is likely to be managed in much the same way as it is currently, with the exception that it would be treated prior to discharge. EPA does not believe that the additional waste management requirements would materially affect the production processes employed at or general operation of the affected facility.

Exhibit 9-8
Compliance Cost Analysis Results for Management of Hydrofluoric Acid Process Wastewater[a]

Facility	Baseline Waste Management Cost	Incremental Costs of Regulatory Compliance								
		Subtitle C			Subtitle C-Minus			Subtitle D-Plus		
	Annual Total ($ 000)	Annual Total ($ 000)	Total Capital ($ 000)	Annual Capital ($ 000)	Annual Total ($ 000)	Total Capital ($ 000)	Annual Capital ($ 000)	Annual Total ($ 000)	Total Capital ($ 000)	Annual Capital ($ 000)
Allied-Signal - Geismar, LA	236	1,758	3,429	512	1,686	3,046	454	1,583	3,046	454
Total:	236	1,758	3,429	512	1,686	3,046	454	1,583	3,046	454

(a) Values reported in this table are those computed by EPA's cost estimating model and are included for illustrative purposes. The data, assumptions, and computational methods underlying these values are such that EPA believes that the compliance cost estimates reported here are precise to two significant figures.

Costs have been estimated only for facilities for which sampling data indicate that the waste would fail a RCRA hazardous waste characteristic.