CHAPTER SEVEN

EXISTING REGULATORY CONTROLS ON CKD MANAGEMENT

7.0 INTRODUCTION AND METHODS

7.0.1 Objectives

EPA's objective in this analysis was to identify and evaluate the existing regulatory controls that pertain to management of CKD. The Agency carried out this analysis in accordance with the spirit of RCRA Section 8002(o), which suggests that EPA "review studies and other actions of other Federal and State agencies . . . with a view toward avoiding duplication of effort." The regulatory analysis also served more generally to help characterize current waste management practices. This knowledge will guide the development of the Agency's position on any additional CKD management regulations that EPA may deem appropriate.

7.0.2 Methodology

EPA has addressed federal, state, and local regulations, based on the environmental media that they were established to protect. Therefore, the Agency examined those regulations that protect air quality and surface and ground water. In examining existing management controls on CKD, the Agency evaluated both the strengths and areas needing improvement for the present regulatory framework. EPA also evaluated cross media impacts created by regulation; one example of such an impact is the effect that air pollution control devices, installed to remove dust from cement plant exhaust gases, had on the prevalence of collecting, landfilling, and storing CKD.

In the initial phase of the analysis, EPA examined the relevant statutes and regulations pertaining to air quality, water quality, and solid waste as they might apply to the management of CKD. To develop a baseline of information about current federal and state regulations, EPA conducted an on-line search of the Computer-Aided Environmental Legislative Data System (CELDS), a data base containing abstracts of federal and state environmental regulations. By querying CELDS with various combinations of key words, such as "cement plants," "dust," and "fugitive emissions," the Agency obtained abstracts of federal and state environmental regulations that might affect on-the-ground management of CKD.

EPA identified and evaluated the existing federal regulatory controls on CKD, focusing on programs and requirements established by EPA. This characterization is necessary for two reasons. First, some states do not have EPA-approved programs for regulating air pollution emissions to the atmosphere or discharging contaminants to surface waters. In those states, federal EPA regulations take precedence. Second, the federal government has not delegated authority to the states for implementing some environmental protection statutes and regulations and is thus responsible for their implementation. EPA contacted EPA Regional staff in those states that do not have federally approved programs for implementing the major environmental statutes (e.g., RCRA, The Clean Water Act [CWA]), and performed a detailed regulatory analysis of the implementation of existing federal statutes and regulations that pertain to the management of CKD.

The next step of EPA's analysis was to perform a more detailed review of statutes and regulations in four selected states. Based on time and resources, EPA limited this review to four of the states with the largest clinker production and finished grinding capacities. Together, California, Michigan, Pennsylvania, and Texas represent over 35 percent of 1990 clinker production capacity. EPA assumed that these states would have the most extensive experience in controlling the management of CKD and would have the greatest interest in regulating CKD.

Based on the state statutory and regulatory language, EPA discovered that the scope of state programs in these four states was not always clear. Therefore, EPA contacted state and

local officials involved with implementing CKD management requirements to learn how those statutes and regulations are interpreted in practice, and to obtain facility-specific implementation information. The information compiled from these contacts was combined with the existing information on statutory and regulatory requirements to produce the final implementation analysis.

7.0.3 Summary of Findings

The control of stack emissions at cement plants during the last 30 years may have prompted an increase in landfilling and stockpiling of CKD as air pollution control devices removed non-useable dust from kiln exhaust gases.[1] Prior to regulation of air pollutant emissions, CKD was released into the atmosphere from stack and fugitive emissions with little or no control. More recently, air pollution control has been expanded to regulate fugitive dust emissions from non-stack sources (e.g., storage piles and transportation equipment).

As cement plant stack and fugitive emissions have been increasingly regulated, the generation and long-term management and disposal of CKD have become solid waste management issues. States have become concerned about contamination of surface and ground water from improper management of solid wastes. This growing concern has manifested itself in closer solid waste regulatory control of CKD at the state level. More stringent solid waste requirements for landfilling and stockpiling may in turn be a factor in the rise of CKD recycling and beneficial use.

On the federal level, air quality has been improved through implementation of controls on releases of CKD through kiln stacks and via fugitive dust emissions. Under the New Source Performance Standards (NSPS) for cement plants, a facility must comply with specific emission limitations for particulate matter. Prevention of Significant Deterioration (PSD) review also is required for a cement plant located in a geographic area that is classified as an attainment area. In addition, cement plants are subject to Nonattainment Review if they are located in an air quality control area that is not in compliance with the National Ambient Air Quality Standards (NAAQS) for a given pollutant (e.g., particulate matter or sulfur dioxide). Cement kilns that burn hazardous waste fuels also are being controlled under new regulations for the Burning of Hazardous Waste in Boilers and Industrial Furnaces (BIF), which imposed new controls on those facilities.

At the state level, air quality requirements for CKD management incorporate the federal standards as a baseline but many states have established additional, more stringent requirements. Individual states subject cement plants to visible emission or opacity limitations that are more stringent than the federal standards; for example, Pennsylvania requires opacity to be measured over a three-minute period rather than the six-minute period in the federal standard. Texas also requires notification of "excessive emissions" and establishes particulate matter ground level concentration limits. Michigan and Pennsylvania have established fugitive dust control programs; Pennsylvania has actually required two cement plants to store CKD and clinker in a warehouse or silo to control fugitive emissions. California, Michigan, Pennsylvania, and Texas all require permits to construct and operate cement plants. In all states, the permit review process is designed to ensure that emissions from such sources will not interfere with the attainment and maintenance of ambient air quality standards.

Similarly, treatment of wastewater and stormwater run-off from cement plants has been beneficial in maintaining and improving water quality. National Pollutant Discharge Elimination System (NPDES) permits establish effluent limits on suspended solids, pH, toxic pollutants such as heavy metals, and material run-off from CKD storage piles. Monitoring and reporting requirements assure compliance with the applicable effluent limitations, water quality standards, and pretreatment standards. In addition to controls on process wastewater from cement plants, stormwater run-off is also regulated. Under new federal stormwater regulations, pollution

[1] Personal communication with Gary Linns, Pennsylvania Department of Environmental Resources, Bureau of Air Quality, October 9, 1992.

prevention plans and Best Management Practices (BMPs) should continue to reduce the amount of uncontrolled CKD contained in stormwater discharges.

In states where responsibility for implementation of the NPDES program to regulate discharges to surface water has been delegated, such as California, Michigan, and Pennsylvania, only one state water permit regulating the discharge of pollutants is required. In Texas, where delegation of authority has not occurred, both federal and state permits must be obtained. Cement plants in any of the states generally are subject to State Pollutant Discharge Elimination System and pretreatment regulations that are either identical or similar to the federal requirements. Each of the four states has adopted both descriptive (e.g., all waters should support agricultural use) and numeric surface water quality standards.

In addition, state regulation of discharges has been expanded beyond the scope of the NPDES to include discharges to ground water. Ground-water protection requirements include facility siting restrictions, design standards, ground-water monitoring, and the designation of wellhead protection areas. Michigan has established ground-water quality regulations. Similarly, Pennsylvania's Pollutant Discharge Elimination System program applies both to streams and ground water. California's ground-water protection policy includes closely regulating a number of potential sources of ground-water degradation, such as waste management facilities.

In implementing the federal stormwater requirements, each state has established different permit issuance policies. California has decided not to issue permits specific to industrial categories, but has established a general permit that applies to all stormwater dischargers. Cement plants in Pennsylvania and Texas, where delegation has not occurred, will be subject to a general permit program that is industry-specific. In Michigan, on the other hand, individual cement plants or groups of plants must apply for stormwater permits.

While CKD is temporarily excluded from regulation under Subtitle C of RCRA, CKD is still subject to regulation as a non-hazardous solid waste under RCRA Subtitle D. In the area of solid waste management, CKD is landfilled or stored in piles on site at many cement plants. Under Subtitle D, flexibility exists for states to implement requirements for industrial non-hazardous waste and this flexibility results in a diverse collection of state Subtitle D programs. Enforcement of Subtitle D is primarily a state's responsibility. The federal government, however, has the authority and resources under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, or Superfund) to respond to situations in which CKD is or may be released into the environment such that it poses an imminent and substantial danger to human health and the environment. Two cement kiln facilities are currently on the National Priorities List (NPL) in response to CKD-related environmental damage.

Because the Bevill Amendment does not preclude more stringent (e.g., hazardous waste) requirements for CKD at the state level, states (such as California) are free to characterize CKD as a hazardous waste; indeed, several differences in CKD management requirements exist between the states. However, California does not enforce the management of CKD as a hazardous waste because of recent legislation imposing a one year moratorium on enforcement of these requirements pending a study of CKD (See Section 7.3, subsection 7.3.2 for further discussion). Pennsylvania, on the other hand, classifies CKD as a residual waste, regulating CKD less stringently than if it was considered a hazardous waste, but still requiring comprehensive waste management practices. Michigan and Texas characterize CKD as an industrial, non-hazardous solid waste and, therefore, subject CKD to fewer management requirements than either California or Pennsylvania. Pennsylvania and Michigan also require beneficial use approvals for CKD. This approval is required if a cement facility plans to reuse CKD for a particular beneficial purpose, such as to make fertilizer or to use CKD as a soil stabilizer.

State solid waste management requirements for CKD control appear to be in transition because of a trend toward creation of new state industrial solid waste programs and expansion of existing programs. Concerns about ground-water protection and the desire to examine the effects of burning hazardous waste as a fuel supplement also support this trend. Pennsylvania is an example of a state in which new regulations on residual waste management apply more

stringent requirements to all industrial solid waste, including CKD. Texas has new waste classification requirements and will be proposing new boiler and industrial furnace regulations in the near future. California has imposed a moratorium on enforcement of regulations that affect CKD pending further evaluation. In contrast, Michigan appears to be reviewing CKD management practices as well as examining with interest other states' programs for examples of effective innovations.

7.0.4 Limitations of the Analysis

This regulatory analysis must be interpreted with care, as the scope of the state regulatory review was limited. Time and resource constraints precluded a detailed analysis of all of the states that contain cement plants. In addition, EPA found that the scope of state programs was not always clear from the state statutory and regulatory language reviewed. As a result, EPA contacted state and local officials to interpret legal requirements. State and local regulatory officials, while helpful, sometimes had differing interpretations of requirements.

The ability to draw conclusions concerning the relative performance of waste management controls among states is limited by variations in requirements and recordkeeping among the states. Recordkeeping varies significantly among states; where states have pertinent records, information on implementation may be readily available. Also, as this study was limited to four states, the analysis may not be completely representative of CKD management controls throughout the country.

Most often, because CKD waste is not regulated under Subtitle C of RCRA, states do not specifically regulate the management of this waste at cement manufacturing facilities. Similarly, enforcement and monitoring records are incomplete and/or distributed throughout regional offices within a state, making the effectiveness of existing CKD management controls more difficult to evaluate.

7.1 AIR

7.1.1 Federal Controls

Clean Air Act

The federal Clean Air Act requires EPA to establish the maximum ground level concentrations of pollutants in the ambient air that protect public health and the environment.[2] Currently, national ambient air quality standards (NAAQS) exist for sulfur dioxide (SO_2), particulate matter smaller than 10 microns in size (PM_{10}), carbon monoxide (CO), ozone (O_3), nitrogen oxides (NO_x), and lead (Pb).[3] The NAAQS for particulate matter is the standard having the most effect in controlling the release of CKD to the atmosphere through kiln stack or fugitive dust emissions. The standard for particulate matter was changed in 1987 from one measuring total suspended particulate (TSP) to one measuring particulate matter ten microns in diameter or smaller (PM_{10}).[4] PM_{10} emission limitations apply not only to kiln dust, but also to particulates from grinding and milling processes, coal dust, and quarry dust.

The NAAQS establish ceilings for individual pollutant concentrations and require the development and implementation of emission limitations pursuant to other sections of the Clean Air Act. Therefore, NAAQS determine the degree of control that will be imposed on existing sources and the restrictions on location of new sources, depending on whether air quality is better or worse than the NAAQS in the particular area where a source is or will be located.

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[2] 42 U.S.C. §§ 7401-7671q.

[3] 40 CFR Part 50.

[4] Fine particles pose a greater hazard to human health as they can pass through the body's natural defenses and penetrate deep into the lungs.

Regulatory agencies enforce the emission limitations to comply with the NAAQS. Various implementing regulations and air pollution control programs are described below.

Implementing Regulations

State Implementation Plans

The state implementation plan (SIP) under Section 110 of the Clean Air Act[5] is the primary regulatory mechanism by which emission controls are imposed by the states on stationary sources in order to meet NAAQS. EPA's approval of a state plan makes its provisions enforceable by the federal government, the state, and by citizen suit. All the states have SIPs, but the 1990 Amendments to the Clean Air Act require many changes in current SIPs, as delineated below.

In particular, Section 110(a)(2) of the Clean Air Act has been amended to require that an acceptable SIP contain detailed provisions addressing the following topics:

- Emission limitations and control measures;
- Monitoring requirements;
- Review of new and modified sources for compliance with new source performance standards (NSPS), prevention of significant deterioration (PSD), and nonattainment;
- A demonstration of adequate legal authority to operate and enforce the program;
- Emergency authority similar to that granted EPA under Section 303 of the Clean Air Act; and
- A permit program.

New Source Performance Standards

EPA established NSPS for portland cement plants in 40 CFR 60 Subpart F. These performance standards apply to plants that were constructed or modified after August 17, 1971.[6] Components of cement plants (referred to as "facilities") specifically affected are kilns, clinker coolers, raw mill systems, finish mill systems, raw mill dryers, raw material storage facilities, clinker storage facilities, finished product storage facilities, conveyor transfer points, and bagging and bulk-loading and unloading systems. For these plants, EPA establishes performance standards that reflect the emission limitations achievable through application of the best available pollution control technology. The performance standards consider other environmental (e.g., increased water pollution in exchange for reduced air pollution) and energy impacts.[7]

In accordance with the NSPS, no portland cement plant owner or operator may exceed the particulate matter emission limits. Owners or operators must monitor each stack using a continuous opacity monitoring system or a certified visible emissions observer. In all cases, each owner or operator must submit semi-annual reports of excess emissions (defined as all 6-minute periods during which the average opacity exceeds the standard) and of equipment malfunctions. The emission standards for these facilities are shown in Exhibit 7-1. In addition,

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[5] 42 U.S.C. § 7410.

[6] A "modification" is any physical or operational change of an existing facility that increases the emission of any air pollutant.

[7] 42 U.S.C. § 7411.

owners or operators must record daily production rates and kiln feed rates and conduct monitoring activities.

Prevention of Significant Deterioration

The goal of the PSD program is to avoid deterioration of air quality in attainment ("clean air") areas by maintaining pollutant emissions levels such that ambient air quality remains below the NAAQS. For example, Oakland County, Michigan, is an attainment area for particulate matter, SO_2, NO_x, and lead; thus, the PSD program seeks to limit emission levels of these pollutants so that ambient concentrations remain within their respective NAAQS.

Exhibit 7-1

New Source Performance Standards for Portland Cement Plants

Affected Facility	New Source Performance Standards	
	Particulate Matter (kg/mt)[a]	Opacity (percent)
Kiln	0.15	20
Clinker Cooler	0.05	10
All Other Affected Facilities	--	10

[a] Particulate matter is measured in terms of kilograms of particulate matter per metric ton of feed (dry basis) to the kiln.

Section 165 of the Clean Air Act requires a PSD permit prior to construction or modification of a source in an attainment area. To obtain a PSD permit, a source must demonstrate that it will use Best Available Control Technology (BACT), to reduce emissions for each pollutant subject to regulation under the Clean Air Act. Section 169(3) defines BACT as air pollution controls that achieve the

> maximum degree of [emission] reduction . . . which the permitting authority, on a case-by-case basis, taking into account energy, environmental, and economic impacts and other costs, determines is achievable for such facility . . . .

BACT limitations must be at least as stringent as those limitations required by applicable NSPS. The BACT provision gives EPA or the authorized state the ability to tighten emission control technology requirements by incorporating state-of-the-art control technology developments.

Nonattainment Review

Whereas PSD review applies where a new or modified emission source is to be located in an attainment area, Nonattainment Review applies where an air quality control area is in nonattainment of the NAAQS. State implementation plans must require that permits be obtained for the construction or modification of major stationary sources in a nonattainment area.

Nonattainment status typically means that more stringent emission limitations will be necessary for the source than if it were being built in an attainment area. In addition, the stationary source must obtain an emission offset, which is a reduction in emissions of the nonattainment pollutant by an existing source (or sources) in the same area. Regulations establish offsets on the basis of total emission discharges. The offsets must be somewhat greater than the potential emissions of the new or modified source to produce a net air quality benefit or "reasonable further progress" toward compliance with the NAAQS.

Hazardous Air Pollutants

The 1990 Clean Air Act Amendments completely revised Section 112 of the Clean Air Act that had provided for national emission standards for hazardous air pollutants (NESHAPs). The revised Section 112(b)(1) establishes a program to regulate emissions of 189 toxic air pollutants through technology-based standards.[8] EPA will not establish control requirements directly on a substance-by-substance basis. Instead, EPA identified categories of industrial facilities, including Portland Cement plants, that emit substantial quantities of each air toxic.[9]

[8] 42 U.S.C. § 7412(b)(1).

[9] 42 U.S.C. § 7412(d).

NESHAPs apply to facilities that emit or have the potential to emit 10 tons or more of any single hazardous air pollutant in a year. Alternatively, a facility that emits or has the potential to emit more than 25 tons per year of any combination of hazardous air pollutants would also be subject to NESHAPs. In setting standards, EPA is allowed to distinguish between new and existing facilities, and to set less stringent technology-based standards for existing facilities. The standards can compel a wide range of control measures, including not only the installation of control equipment but also process changes or the substitution of materials. Within eight years of establishing a NESHAPs for a source category, EPA must provide for a second phase of regulatory controls aimed at protecting public health with "an ample margin of safety."[10] If necessary, additional health-based standards will be required.

EPA is currently developing NESHAPs for Portland Cement plants that will address stack emissions and fugitive emissions. Hazardous air pollutant emissions from CKD storage piles will be considered for regulation. It is uncertain how, or if, CKD storage piles will be regulated. The NESHAPs for Portland Cement plants are scheduled to be promulgated no later than November 1997.

Boiler and Industrial Furnace Regulations

On February 21, 1991, EPA finalized regulations that expanded controls on the burning of hazardous waste in boilers and industrial furnaces.[11] The boiler and industrial furnace (BIF) regulations require owners and operators of boilers and industrial furnaces burning hazardous waste to limit the emissions of toxic metals, carbon monoxide, hydrogen chloride, chlorine gas, and particulate matter.[12] Cement kilns that burn hazardous waste are subject to the regulation because they are defined as industrial furnaces.[13] Prior to the BIF rule, cement kilns burning hazardous waste for energy recovery in urban areas could do so only if they complied with the emission standards applicable to hazardous waste incinerators.[14] These urban cement kilns, along with all other cement kilns that burn hazardous waste, are now subject only to the BIF rule requirements.

Burning hazardous waste that contains toxic organic compounds under poor combustion conditions can result in emissions of organic compounds. EPA regulates the emissions of organics as follows:

- A 99.99 percent destruction and removal efficiency (DRE) standard for organic hazardous constituents in waste feeds and a 99.9999 percent DRE for dioxin-listed hazardous waste;
- Limits on flue gas concentrations of carbon monoxide (CO) and hydrocarbons to control products of incomplete combustion; and
- Special controls for chlorinated dibenzodioxins and dibenzofurans (CDD/CDF) for BIFs burning hazardous wastes under specific circumstances.

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[10] 42 U.S.C. §7412(f)(2).

[11] 56 Fed. Reg. 7134.

[12] While the BIF rules are promulgated under the authority of the Resource Conservation and Recovery Act, 42 U.S.C. §§ 6901 to 6992K, for the purpose of this report, the discussion concerning the BIF rule emission limits is included under the section on air pollution controls. For further discussion of the impacts of the BIF rule on solid waste management, see Section 7.4.1.

[13] 40 CFR § 260.10.

[14] 42 U.S.C. § 6924(q)(2)(C). See also 40 CFR § 266.31(c).

The rules also establish emission limits for toxic metals based on site-specific testing and analyses (e.g., emissions testing, dispersion modeling).[15] Emissions of hydrogen chloride and free chlorine are regulated under the same general approach. EPA established a particulate matter emission limit to control emissions of toxic metals; metals and organic compounds may adsorb onto particulate matter in the flue gas. Under the terms of an October 22, 1993 settlement, EPA will initiate a new rulemaking on whether to revise provisions of existing BIF regulations that establish standards for cement kilns by September 20, 1995.[16]

In an effort to protect the public from health risks associated with burning hazardous wastes, EPA announced on September 28, 1993 enforcement actions against 11 cement kilns for violations of the BIF rules. These enforcement actions are seeking over $13 million in penalties from owners and operators for violations that range from failure to comply with emission standards and inadequate monitoring of hazardous waste fuel feeds to failure to maintain proper records.

The BIF rule directly affects the regulatory status of CKD generated by cement kilns burning hazardous waste as fuel. These effects are discussed in detail in the Solid Waste Management Federal Controls section (7.4.1).

7.1.2 State Controls

At the state level, California, Michigan, Pennsylvania, and Texas have established air quality requirements for CKD management that incorporate the federal standards and also subject cement plants to more stringent visible emission or opacity limitations. A summary of the four states' air pollution controls can be found in Exhibit 7-2 and a discussion of the individual state's air quality requirements follows.

[15] Owners and operators must analyze the hazardous waste to be burned and comply with the standards for each of the 10 metals (antimony, arsenic, barium, beryllium, cadmium, hexavalent chromium, lead, mercury, nickel, selenium, silver, and thallium) that could reasonably be expected to be in the waste.

[16] Horsehead Resource Development Co. Inc. v. EPA, No. 91-1221 (D.C. Cir. Oct. 22, 1993). EPA also agreed to describe the option of adopting technology-based emission standards for cement kilns. Final rulemaking would be required by December 15, 1996.

Exhibit 7-2

Summary of State Air Pollution Controls

States	California	Michigan	Pennsylvania	Texas
Permits	Permit to construct and to operate; some air pollution control districts require permitting of CKD storage facilities	Permit to construct and to operate	Permit to construct and to operate; permit for fugitive emissions	Permit to construct and to operate
General Requirements	Compliance with Federal NSPS, and PSD and Nonattainment Review	Compliance with Federal NSPS, and PSD and Nonattainment Review	Compliance with Federal NSPS, and PSD and Nonattainment Review	Compliance with Federal NSPS, and PSD and Nonattainment Review
Particulate Matter Emission Controls	Particulate matter emission limits; opacity limits	Particulate matter emission limits; opacity limits	Particulate matter emission limits; opacity limits	Particulate matter emission limits; opacity limits
Fugitive Dust Emission Controls	Air pollution control district may require fugitive dust control program	State may require fugitive dust control program	Fugitive emission controls as permit condition	Opacity limits

California

The California Air Resources Board (ARB), local or regional air pollution control districts, and air quality management districts ("air districts") are the state agencies primarily responsible for controlling air pollution.[17] The ARB has responsibility to set air standards, measure local compliance, assist air districts in the preparation of plans to attain the standards, and review those plans and their implementation.

Air districts have the primary responsibility for enforcement of state and air district regulations. Enforcement options available to the air districts include notices of violation, abatement orders, administrative penalties, civil and criminal penalties, and permit revocations.[18] The ARB reviews district enforcement practices and is authorized to exercise district enforcement authority if it finds that a district's actions are inadequate.[19]

The air districts closely monitor compliance with fugitive dust emission limits for cement plants. The North Central Coast Air Basin inspectors review cement plant operations and records monthly.[20] Other air districts usually inspect cement plants annually unless there has been a complaint or reason to believe a cement plant is in violation.[21] Inspectors review the measures that facilities use to control fugitive dust emissions from CKD such as storage tanks or storage buildings.

Ambient Air Quality Standards

[17] Cal. Health and Safety Code §§ 39000-44384.

[18] Cal. Health and Safety Code §§ 42400-42402.

[19] Cal. Health and Safety Code §§ 41502-41507.

[20] Personal communication with Greg Chee, Air Quality Engineer, North Central Coast Air Basin, March 3, 1993.

[21] Personal communication with Tom Krinke, Air Quality Specialist, Compliance Section, San Bernadino Air Quality Control District, July 28, 1992.

The state ambient air quality standards adopted by the ARB are in addition to the NAAQS adopted by EPA under the Clean Air Act. In adopting state ambient air quality standards, the ARB is required to consider "the public health, safety, and welfare, including, but not limited to health, illness, irritation to the senses, aesthetic value, interference with visibility and effects on the economy." According to a December 1988 ARB report, 23 of California's 41 air districts were in federally-designated nonattainment areas.[22] Therefore, most regulatory attention focuses on developing rules necessary to attain the federal standards.

Currently, California state ambient air quality standards exist for the following pollutants:

- ozone (O_3);
- carbon monoxide (CO);
- nitrogen dioxide (NO_2);
- sulfur dioxide (SO_2);
- particulate matter (PM_{10});
- sulfates (SO_4);
- particulate lead (Pb);
- hydrogen sulfide (H_2S); and
- visibility-reducing particles.[23]

Authority To Construct

An owner or operator of a cement plant proposing to construct or modify a stationary source in California that may emit pollutants into the atmosphere must first obtain an Authority to Construct from the county or regional air pollution control district or air quality management district where the source is or will be located. The air districts must ensure that emissions from such sources will not interfere with the attainment and maintenance of state ambient air quality standards.

Generally, an air district requests the following information before granting an Authority to Construct:

- Description of the business, including the materials used and the particle sizes of all bulk solids involved;
- Type of air pollution control equipment and its anticipated degree of efficiency;
- Types of fuel; and
- Operating schedule for emission sources.

Permit To Operate

Cement plants must also obtain a Permit to Operate from the air district for the area in which the facility is located. In general, the air district asks the applicant to verify that construction or modification of a facility was completed in accordance with the Authority to Construct and that the facility will meet the district's regulations.

Prevention of Significant Deterioration and New Source Review

Unless the local air district has been delegated the authority by EPA to issue these permits, a new or modified project may also require a PSD permit from EPA. A PSD permit is only required if the facility is located in an attainment area for a pollutant.

In nonattainment areas, air districts have adopted New Source Review Rules, which regulate all new or modified sources with emissions exceeding a specified limit for any pollutant for which a state or national ambient air quality standard exists. For example, standards exist for sulfur dioxide and particulate matter. The average "trigger" level is 250 pounds per day. If this level is exceeded by the projected operation of the new source or modification of an existing facility, New Source Review requirements become applicable.

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[22] Air Resources Board, Stationary Source Division, *Technical Review Group Emissions Credit Systems and New Source Review Programs: A Report to the Legislature* (Dec. 8, 1988).

[23] 17 CCR § 70200.

Approval for the new source or modification will be granted only if the owner or operator provides "offsets" for all net emission increases.[24] The owner or operator must reduce emissions within the source at a 1 to 1 ratio, or reduce other sources in the nonattainment area at a ratio of at least 1.2 to 1. For example, an applicant proposing a new or modified source producing 1,000 pounds of pollutants per day must eliminate a minimum of 1,000 pounds of pollutants per day from his/her existing source or 1,200 pounds of pollutants per day from other existing sources. Offsets must be located upwind in the same or adjoining counties, or within 15 miles downwind of the proposed new or modified source.

In addition to complying with applicable New Source Review and/or PSD requirements, owners and operators of cement plants must comply with the federal NSPS.

Cement plants are also subject to visible emission limitations in accordance with Section 41701 of the California Health and Safety Code. This provision prohibits any air contaminant discharge to the atmosphere that continues for an aggregate period of more than three minutes in any one hour in which such emission is either:

- As dark or darker than "No. 2 on the Ringelmann Chart";[25] or
- Of such opacity as to obscure an observer's view in the same degree as smoke equalling Ringelmann No. 2.[26]

Some Air Districts, such as the South Coast Air Quality Management District, set more stringent opacity limits (emissions no darker than No. 1 on Ringelmann Chart) and these have been applied to cement plants.[27]

These visible emission limitations also regulate fugitive dust emissions from CKD storage. In addition, some air pollution control districts require permitting of CKD storage facilities and fugitive dust control programs. For example, air pollution control districts have required cement plants to control fugitive emissions by managing CKD in storage tanks or in warehouses before the CKD is insufflated (recycled to the feed stream) or landfilled.

Michigan

Ambient Air Quality and Permits

The Air Pollution Control Commission within the Michigan Department of Natural Resources (DNR) establishes state ambient air quality standards and requires permits for construction and operation of a cement plant.[28] Permits, for the most part, are issued by the regional DNR offices.[29] Permit requirements subject cement plants to the same general

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[24] Emission Offset Interpretive Ruling, 40 CFR Part 51, Appendix S.

[25] A Ringelmann Chart grades the shade or opacity of visible air contaminant emissions. The chart is a color coded strip that an observer holds up and compares to the shade of color of the air emissions discharging from a smokestack. Darker colors and higher numbers correspond with greater emissions. Ringelmann's Scale for Grading the Density of Smoke as published in United States Bureau of Mines Information Circular 8333.

[26] Cal. Health and Safety Code §§ 41701, 41704.

[27] SCAQMD Rule 401.

[28] Mich. Comp. Laws § 336.13.

[29] The Air Pollution Control Commission issues a permit only when a facility's emissions significantly affect a PSD or nonattainment area.

requirements as in California (e.g., compliance with the U.S. EPA's New Source Performance Standards for cement plants, and PSD and Nonattainment Review).[30]

As in California, inspections and enforcement occur primarily at the district (Michigan DNR) level. The Michigan DNR Air Quality Division has approximately 35-40 inspectors, including district supervisors, to review all stationary sources of air pollution.[31] For cement plants, inspections are performed annually. The district offices may inspect more frequently in response to complaints or if a facility has a history of compliance problems. The Wayne County Health Department, Air Pollution Control Division, monitors the cement facility located in Wayne County.[32]

On the basis of submitted monitoring reports or plant inspections, the DNR district office will send a notice of violation for any noncompliance with federal or state requirements or permit conditions. This notice of violation requires initiation of corrective actions and may establish a deadline for compliance. If a voluntary agreement is not entered into with DNR, DNR may initiate further enforcement actions such as administrative orders, injunctions, and civil and criminal penalties.

Particulate Matter and Visible Emissions Limitations

Michigan has established particulate matter emission limits for cement manufacturers that are equivalent to the federal new source performance standards, but the state may impose more stringent emission limits. The Air Pollution Control Commission usually applies the opacity limit in the federal new source performance standards for cement plants (that range from 20 percent for kilns to 10 percent for clinker coolers). The state regulations require a cement plant not to exceed 27 percent opacity for more than one six-minute period per hour.[33] The Michigan Air Pollution Control Commission is also authorized to require a more stringent standard on a case-by-case basis.

In addition, the Air Pollution Control Commission may request that a cement plant's operator submit a fugitive dust control program.[34] This requirement applies to any facility that "processes" bulk materials, including raw materials for cement manufacture or clinker on its way to a grinding unit. These requirements are triggered only by a notification from the Commission. The Commission has required fugitive dust control programs that include the pneumatic conveyance of CKD, the use of particulate matter collection devices during transfer operations, the application of dust suppression liquids to haul roads (twice each month), and weekly sweeping of paved haul roads. In addition, at one cement facility, the Commission required that CKD be pneumatically pumped to the floor of a quarry rather than simply dumped from the top of the quarry. More recently, the Commission required a facility to mix its CKD with water to form pellets as a means of reducing fugitive emissions.

Pennsylvania

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[30] Mich. Admin. Code §§ 336.1203 and 336.1208.

[31] Personal communication with Barb Rosenbaum, Michigan Department of Natural Resources, Air Quality Division, September 10, 1993.

[32] Personal communication with Bob Zabick, Wayne County Health Department, Air Pollution Control Division, Enforcement, October 13, 1992. Currently, the cement plant located in Wayne County only grinds clinker delivered from Canadian cement plants. The kiln which was permitted to burn hazardous waste for fuel was shut down for economic reasons.

[33] Mich. Admin. Code § 336.1301 (1)(a).

[34] Mich. Admin. Code §§ 336.1371-72.

Under the Pennsylvania Clean Air Act, the Department of Environmental Resources (DER) establishes ambient air quality standards for the Commonwealth.[35]

In a manner similar to that used in California and Michigan, permitting and enforcement of air programs generally are handled by the six regional DER offices. However, Allegheny and Philadelphia Counties have autonomous air pollution control programs that have been approved by DER. As in the other states, permits to construct and operate are required.

DER conducts annual inspections of cement plants and reviews monitoring reports submitted by facilities. Generally, DER enforcement procedures parallel the enforcement procedures employed in California and Michigan. DER is concerned with fugitive dust emissions from CKD storage and other plant operations.[36] Inspectors are placing some emphasis on reviewing fugitive dust control programs and discouraging the use of open storage of CKD. Currently, all the operating cement plants recycle some of the CKD back into the kiln. DER is encouraging this trend to reuse CKD.

Nonattainment Review

In Pennsylvania, special permit requirements exist for a cement plant locating in or significantly affecting nonattainment areas.[37] Pennsylvania's nonattainment review is slightly different than the reviews required by California and Michigan. These special permit requirements only apply to cement plants constructed or modified after June 30, 1979. In addition, a cement plant must discharge greater than 50 tons per year of emissions, 1,000 pounds per day, or 100 pounds per hour, whichever is more restrictive. Finally, facilities must also be significantly affecting a nonattainment area. To be considered significantly affecting a nonattainment area, a facility's discharge must exceed established emission limits. For example, the significance levels for ambient total suspended particulate and sulfur dioxide are one microgram per cubic meter annually, or five micrograms per cubic meter in a 24-hour period. In determining whether a source exceeds the emission rates or significance levels, all emissions resulting from the operation must be considered, including flue (e.g., stack) and fugitive (e.g., material transfer, storage piles, and roads on the plant property) emissions. To be permitted, a facility that exceeds the significance levels must offset its emissions by reducing emissions from its own facility or another facility located in the nonattainment area or from a facility affecting the nonattainment area. To improve air quality in the nonattainment area, the ratio of particulate matter or sulfur dioxide emission reductions required for any new emissions must be equal to or greater than 1.3 to 1 for flue emissions and 5 to 1 for fugitive emissions.

Particulate Matter and Visible Emissions Limitations

Pennsylvania has additional criteria for particulate matter that apply independently of PSD and nonattainment review. No source may cause the emission of visible air contaminants that exceed either of two opacity limits:

- 20 percent for a three-minute period in any hour; or
- 60 percent at any time.[38]

Visible emissions may be measured by either (1) any device approved by DER to provide accurate opacity measurements or (2) by a trained observer.

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[35] 35 Pa. Stat. § 4004.

[36] Personal communication with Gary Linns, Pennsylvania Department of Environmental Resources, Air Quality Control Division, October 9, 1992.

[37] 25 Pa. Code §§ 127.61-127.73.

[38] 25 Pa. Code § 123.41.

The Pennsylvania Air Pollution Control regulations also establish particulate matter emission limits for cement plants.[39] Cement plants may not emit particulate matter, at any time, in excess of either a rate calculated by a formula (variables exist for clinker production and clinker cooling) or 0.02 grains per dry standard cubic foot in the effluent gas.

As in Michigan, the emission into the atmosphere of fugitive air contaminants from a source is prohibited unless permitted by the state.[40] DER may require an owner or operator of a source to provide a description of proposed control measures, characteristics of emissions, quantity of emissions, and ambient air quality analysis showing the impact of the source on ambient air quality. At least two cement plants in Pennsylvania have been required to store CKD in a warehouse or silo to control fugitive emissions.

> Permits may only be issued if the fugitive emissions, after being treated by an appropriate air pollution control, meet the following requirements:
>
> - Emissions are of minor significance with respect to causing air pollution; and
> - Emissions are not preventing or interfering with the attainment or maintenance of any ambient air quality standard.

Texas

The Texas Clean Air Act authorizes the Texas Air Control Board to set standards and emission limits for air pollution.[41] As in the other states, the 11 cement plants in Texas must have permits for construction and operation and must comply with applicable air quality standards.

On September 1, 1993, the Texas Air Control Board was abolished and all powers and duties were transferred to the Texas Water Commission. This transfer of authority completed the process of consolidating all environmental protection programs into one agency. At this time, the agency became the Texas Natural Resources Conservation Commission.

As in the other three states, primary responsibility for compliance monitoring occurs in the regional offices. Personnel from 12 regional offices conduct annual inspections of cement plants.[42] The regional offices also respond to citizen's complaints, review upset reports (i.e., if a facility violates its emission limitations, the facility must report this violation to the Commission), perform investigations, and if necessary, recommend enforcement actions. The primary enforcement mechanism is the notice of violation. The notice of violation provides a facility operator the opportunity to correct any problems within 30 days. Facilities usually come into compliance within this time period. The Commission will take no further action if the violation is not continuing or not a repeating problem. If a facility fails to conduct remedial activities, however, additional enforcement activities may be initiated.

Other Requirements Applicable to Cement Plants

Because the Air Quality Program of the Texas Natural Resources Conservation Commission requires the control of air pollution from visible emissions and particulate matter, cement plants are subject to visible emission requirements that vary depending upon age and exhaust gas flow rate.[43] Currently, the opacity limits for existing cement plants in Texas range

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[39] 25 Pa. Code § 123.13.

[40] 25 Pa. Code § 123.1.

[41] Tex. Health and Safety Code § 1.05.

[42] Personal communication with Richard Lee, Natural Resources Conservation Commission, Air Quality Program, Compliance Division, August 25, 1993.

[43] Tex. Admin. Code tit. 31, § 111.111.

from 10 percent (the facility was subject to more stringent PSD requirements) to 30 percent. Visible emissions must not exceed the following opacities:

(1) 30 percent average over a six-minute period for any source on which construction was begun on or before January 31, 1972;

(2) 20 percent average over a six-minute period for any source on which construction was begun after January 31, 1972; or

(3) 15 percent average over a six-minute period for any source having a flow rate greater than or equal to 100,000 cubic feet per minute unless a continuous opacity monitoring system is installed.

Categories (1) and (2) apply to facilities that utilize a continuous opacity monitoring system but otherwise would be subject to the third category. Fugitive dust emissions from CKD piles or roads on which CKD is transported must not exceed an opacity of 30 percent over a six-minute period.

Continuous opacity monitors and annual inspections assist in keeping a facility in compliance. Currently, all 11 portland cement manufacturing plants in Texas have continuous opacity monitors. Facilities submit quarterly monitoring reports and notify the Air Quality Program of any exceedance of the permit requirements. Monitoring and report records must be maintained on site for two years. Inspectors review these on-site records as part of the annual facility inspection.

In addition, ground level particulate matter concentration limits exist for all sources, including cement plants.[44] Emissions of particulate matter from a source may not exceed either of the following net ground level concentrations:

- 200 micrograms per cubic meter of air sampled, averaged over any three consecutive hours; or
- 400 micrograms per cubic meter of air sampled, averaged over any one hour period.

The owner or operator of a cement plant also must notify the Air Quality Program of any major upset condition that causes or may cause an excessive emission.[45] A "major upset" is defined as "[a]n unscheduled occurrence or excursion of a process or operation that results in an emission of air contaminants that contravenes the Texas Clean Air Act and is beyond immediate control . . ."[46] The notification must identify the cause and duration of the upset and the equipment involved. In addition, the compound-specific types and quantities of emissions released during the upset must be provided. Upon request of the Air Quality Program, the owner or operator may be required to prepare a technical evaluation of the upset. At a minimum, the evaluation must include an analysis of the probable causes of the upset and any necessary actions to prevent or minimize recurrence.

[44] Tex. Admin. Code tit. 31, § 111.155. Net ground level concentrations are obtained by subtracting the representative concentration of air contaminants flowing onto a property from the concentration of air contaminants generated by the source as measured at or beyond the property boundary. Id. at § 101.1.

[45] Tex. Admin. Code tit. 31, § 101.6.

[46] Tex. Admin. Code tit. 31, § 101.1.

Special Report on Texas Cement Plants' Excess Emissions

From November 1990 to May 1991, the Air Quality Program conducted a special study of all 11 portland cement manufacturing plants in Texas to gain a better understanding of emissions.[47] The study analyzed whether the kilns and clinker coolers were in continuous compliance with particulate matter and stack opacity limits, such as those found in the federal NSPS (40 CFR Part 60, Subpart F). The Program conducted the cement plant study to gain a better understanding of emissions, especially as more facilities are using hazardous waste as a fuel.

The Air Quality Program concluded that quantities and causes of excess emissions varied greatly between companies. The Program reviewed the causes of excess emissions, their levels and duration, and what actions were taken to prevent a recurrence in the future. In response to the study, the Air Quality Program developed guidance for companies to use in reporting excess emissions. The Air Quality Program also provided resources for the Compliance Division to hire an additional staff person with the responsibility to monitor maintenance and upsets at facilities.[48]

7.2 WATER

7.2.1 Federal Controls

The Clean Water Act

The basic framework for federal water pollution control is the Federal Water Pollution Control Act of 1972, also known as the Clean Water Act (CWA).[49] The CWA establishes national goals to eliminate the discharge of pollutants into navigable waters. The principle means to achieve these goals is to impose effluent limitations on, or otherwise to prevent, discharges of pollutants into any waters of the United States.

Under the Clean Water Act, the discharge of a pollutant from a point source into any waters of the United States, except as authorized by a permit, is illegal. Accordingly, any cement production facility seeking to discharge wastewater effluent and/or a point source discharge of stormwater to surface waters must apply for and obtain an NPDES permit. A cement facility has typically two types of discharges: process wastewater and stormwater run-off.

To impose limitations on pollutant discharges, the CWA established a nationwide NPDES permit program (see 40 CFR 122). An NPDES permit establishes specific "effluent limitations" and conditions regarding any discharges to surface waters. For the cement industry, these effluent limitations include requirements for total

For regulatory purposes, process wastewater has been divided into two categories. The first category of process wastewater includes the following discharges:

- water that comes into contact with kiln dust as an integral part of the manufacturing of cement; or
- water that is used in wet scrubbers to control kiln stack emissions.

The second category of process wastewater includes:

- water that does not come into contact with kiln dust as an integral part of the manufacturing process; and
- water that is not used in wet scrubbers to control kiln stack emissions.

The other discharge of concern is stormwater run-off from materials storage piles and exposed surfaces at a facility.

[47] Cement Plant Resources Group, draft *Final Report on Cement Plant Excess Emissions* (July 31, 1991).

[48] Personal communication with Richard Lee, Natural Resources Conservation Commission, Air Quality Program, Compliance Division, August 25, 1993. This person's responsibilities include not only monitoring maintenance and upsets at cement plants but also at facilities that emit vinyl chloride.

[49] 33 U.S.C. §§ 1251-1387.

suspended solids, temperature, and pH. A permit writer may impose additional limits on toxics if an adequate basis exists using a Best Professional Judgment (BPJ) determination. Monitoring and reporting requirements assure compliance with the applicable effluent guideline limitations (40 CFR 411), water quality standards, and pretreatment standards.

Under Section 402(b) of the CWA, responsibility for administration of the NPDES program can be approved for individual states. To obtain program approval, a state must have a statutory program for regulating discharges to surface waters. EPA has approved state programs for implementing the NPDES permit system for three of the states analyzed in this report: California, Michigan, and Pennsylvania. In these states, only one state water permit regulating the discharge of pollutants is required. In Texas, which has not received authority, both federal and state permits must be obtained.

For those cement facilities that discharge to publicly owned treatment works (POTWs) and not directly to surface waters, different but comparable treatment standards exist. These indirect discharges are regulated by pretreatment standards. Pretreatment standards protect the operation of POTWs (e.g., prohibit the introduction of pollutants that create fire or explosion hazards) and prevent the discharge of pollutants that might pass through POTWs without receiving adequate treatment. Cement facilities are subject to the general pretreatment standards in 40 CFR Part 403 as modified by or in addition to the effluent guideline limitations in 40 CFR Part 411 discussed above. Pretreatment requirements are directly enforceable by EPA and states with NPDES permitting authority.

The CWA also requires that states establish water quality standards for all surface waters. The standards are subject to EPA approval. States are allowed to set more stringent water quality standards than those derived by EPA in water quality criteria documents. In establishing NPDES permit requirements, the effluent limitations discussed above (that established a technology-based minimum treatment standard) may be superseded by more stringent effluent limitations necessary to maintain water quality in specific water bodies. Therefore, the stringency of particular water quality standards, established to protect designated uses for sections of a water body, can significantly affect the final effluent guideline limitations specified in a facility's NPDES permit.

In addition to controls on process wastewater from cement production facilities, stormwater run-off is also regulated. Generally, stormwater discharges from cement facilities contain CKD from materials storage piles and surficial areas at a facility. On November 16, 1990, EPA adopted a rule setting forth NPDES permit application requirements for stormwater discharges associated with industrial activity.[50] Stormwater run-off from cement facilities is considered a discharge associated with industrial activity.[51] Facilities located in Michigan may apply for coverage under a stormwater permit through an individual application. In addition to an individual application for a permit, facilities in Texas, California, and Pennsylvania may also obtain coverage under a general permit.[52]

Under the stormwater permit application regulations, pollution prevention plans and best management practices will be required to reduce pollutants in stormwater discharges. Prior to 1990, cement plants already had to meet the effluent limitations for run-off from materials storage piles. Numeric limitations existed for discharges of total suspended solids (TSS) and pH levels. Facilities meeting these limitations are deemed to be in compliance with the new

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[50] 40 CFR § 122.26.

[51] 40 CFR § 122.26(b)(14)(ii).

[52] EPA issued NPDES general permits for stormwater discharges associated with industrial activity on September 6, 1992. 57 Fed. Reg. 41236. Facilities in Texas are eligible for general permits because EPA maintains NPDES authority for Texas while California and Pennsylvania have been approved to issue general permits as part of their NPDES programs and have chosen to issue general permits. Michigan does not yet issue general permits.

stormwater requirements for the remainder of an existing NPDES permit.[53] If an existing permit, which covers discharges of stormwater, expires, the facility is required to obtain separate permits for both their stormwater discharge and any process wastewater discharge.

Safe Drinking Water Act

The Safe Drinking Water Act (SDWA) has several provisions that can be significant to the operation of cement plants, including requirements for setting drinking water regulations and maximum contaminant levels (MCLs) for toxic water contaminants, as well as wellhead protection area programs. MCLs are "the maximum permissible level of a contaminant in water which is delivered to any user of a public water system."[54] EPA is responsible for establishing MCLs for pollutants as part of the primary drinking water regulations.

The importance of MCLs can be found in determining the level of cleanup required at Superfund sites containing CKD (for further discussion of Superfund and CKD, see section 7.4.1). Two cement production facilities described in the Damage Case Study (see Chapter 6) are currently listed on the National Priorities List. These facilities are:

- Holnam Incorporated, Mason City, Iowa; and
- Portland Cement Company, Salt Lake City, Utah.

For these facilities, MCLs constitute one of the primary classes of applicable and relevant or appropriate requirements (ARARs) when any hazardous substance, pollutant, or contaminant will remain on a Superfund site. MCLs have been established for many of the compounds found in CKD, including arsenic (As), barium (Ba), cadmium (Cd), chromium (Cr), mercury (Hg), selenium (Se), and silver (Ag).

The SDWA also requires EPA to establish national secondary drinking water regulations, standards that reflect welfare concerns such as odor, taste, and color. While these less stringent standards protect public welfare other than human health, their violation can be used to justify the abandonment of a water source or treatment to remedy the problem. The national secondary drinking water standards most applicable to CKD are those for pH and total dissolved solids.

In addition, the wellhead protection area program encourages states to develop systematic and comprehensive programs within their jurisdictions to protect public water supply wells and wellfields. A wellhead protection area is defined as "the surface and subsurface area surrounding a water well or wellfield, supplying a public water system, through which contaminants are reasonably likely to move toward and reach such well or wellfield."[55] Based on the 1991 PCA Survey, 25 of 91 operating cement kiln facility respondents indicated that they are located within one mile of a public drinking water well.

7.2.2 State Controls

California, Michigan, and Pennsylvania have been delegated responsibility for implementation of the NPDES program to regulate discharges to surface water; in Texas, however, where delegation has not occurred, Texas has its own water program but EPA continues to manage the NPDES program. In California, Michigan, and Pennsylvania, only one state water permit regulating the discharge of pollutants is required. In Texas, where delegation has not occurred, both federal and state permits must be obtained. A summary of the four

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[53] 40 CFR § 122.26(e)(6).

[54] 42 U.S.C. §§ 300f-300j.

[55] 42 U.S.C. § 300h-7(e).

states' water pollution controls can be found in Exhibit 7-3, below, and a discussion of individual state's water quality requirements follows.

Exhibit 7-3

Summary of State Water Pollution Controls

States	California	Michigan	Pennsylvania	Texas
EPA-Approved Permit Program	Yes; adopted all federal NPDES requirements	Yes; adopted all federal NPDES requirements	Yes; adopted all federal NPDES requirements	No; separate State permit and a NPDES permit from EPA Region VI
Water Quality Standards	Existing and anticipated beneficial uses; regional water boards adopt numeric water quality standards for specific water body segments	All waters protected for agricultural use, public water supply, and recreation; numeric water quality standards for specific water body segments	Designated water uses; numeric water quality standards for specific water body segments	Three classifications: recreation, domestic water supply, and aquatic life; numeric water quality standards for specific water body segments
Stormwater Requirements	General stormwater permit applicable to all stormwater dischargers (not by industrial category)	Individual stormwater permits (no general permitting authority)	Individual permit for run-off from material storage piles; general permit for all other stormwater discharges	EPA administers the stormwater program but must incorporate state hazardous metal effluent limitations to comply with Texas water quality standards
Ground-Water Protection Policy	Non-degradation; classification system based on beneficial uses	Non-degradation; no degradation above local background levels in all current and potential drinking water sources	Non-degradation; use of best demonstrated control technology and best management practices to protect ground-water resources	Non-degradation; four classes of ground water; EPA-approved wellhead protection program

California

The California Porter-Cologne Water Quality Act establishes the Water Resources Control Board and nine regional water resources control boards within the California Environmental Protection Agency. The state board and the regional boards are authorized to perform the following activities:

- Adopt water quality plans;
- Regulate discharges to surface and ground water; and

- Require cleanup of discharges of hazardous materials and other pollutants.

Responsibility for water quality planning is shared by the state board and the nine regional boards.

Holders of state-issued NPDES permits must provide monthly discharge monitoring reports. The monitoring data are input into a computerized data base (EPA's Permit Compliance System (PCS)).[56] The monitoring data are compared to the effluent limitations included in the permit, and cement plants that exceed permit limits may be subject to possible enforcement action.

The state and regional boards may inspect a facility as necessary to ensure compliance with water quality requirements. The state board does not consider cement plants major dischargers (as compared to some POTWs that may discharge over a million gallons of water per day) and therefore, these facilities are subject to less frequent inspections. However, the state board must inspect each facility at least once per year. The regional boards will consider more frequent inspections if a cement plant has received a complaint, exceeded permit limits, or if the facility has a past record of permit violations.

The state water resources control board has broad enforcement authority. The state board may designate and authorize regional water quality control boards to exercise enforcement authority. The state board and designated regional boards have administrative and civil penalty authority.[57] A regional board can issue a cease and desist order to a discharger who is violating a discharge requirement or prohibition if a likelihood exists that the violation will continue in the future. The board may direct the discharger to comply immediately or in accordance with a time schedule set by the board to remedy or prevent future violations. A regional board may, through the Office of the Attorney General, seek a Superior Court injunction to prohibit an actual or threatened waste discharge if it constitutes an emergency. This applies if the discharge or threatened discharge causes or will cause a condition of pollution or nuisance constituting an emergency that requires immediate action to protect public health, safety, or welfare.[58]

The Porter-Cologne Act contains a number of civil and criminal penalty provisions.[59] Civil penalties may be imposed on owners or operators that negligently or intentionally violate a cease and desist order. Persons who, even unintentionally, cause or permit the discharge of a hazardous substance (under California law, CKD is considered a hazardous substance, see Section 7.4.2 for further discussion) that causes pollution may be strictly liable for civil penalties up to $25,000 per day. Criminal penalties ranging up to one year's imprisonment may be imposed for an owner's or operator's failure to report an unintentional discharge of hazardous substances or for the falsification of required reports.

Process Wastewater Requirements

California has a federally-approved NPDES permit pretreatment management program and the authority to issue general permits. The regional water quality boards implement the NPDES permit program, subject to EPA review. California's water quality regulations adopt by reference all applicable federal NPDES and pretreatment regulations and, therefore, cement kiln facilities are subject to these requirements.

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[56] PCS is a computerized management information system which contains data on the NPDES permit-holding facilities. PCS tracks permit status, permit limits, discharge monitoring reports, violations, and enforcement activities.

[57] Cal. Water Code §§ 13300-13306 and §§ 13261, 13385, 13387.

[58] Cal. Water Code § 13340.

[59] Cal. Water Code §§ 13350-13371.

Water Quality Standards

The California Water Resources Control Board has adopted state-wide water quality principles and guidance that the regional boards may make more stringent. In addition, each regional board has adopted water quality standards for specific water body segments, and these water quality standards are included in the region's water quality control plan. State water quality policy requires long-range resource planning, including ground-water and surface water management programs, and control and use of reclaimed water. Wastewater discharges must be treated to protect existing and anticipated beneficial uses of such water. California's ground-water protection policy includes closely regulating a number of potential sources of ground-water degradation, such as waste management facilities.

Stormwater Management Requirements

In November 1991, the California Water Resources Control Board adopted a General Industrial Stormwater Permit to comply with the federal requirements for stormwater discharges. In so doing, California decided against issuing general permits to specific industrial categories, and instead established a general permit that applies to all industrial stormwater dischargers. Cement kiln facilities are subject to both the stormwater requirements of this general permit and to the federal effluent limitations for materials storage pile run-off. Cement kiln facilities will be required to develop pollution prevention plans, implement best management practices to control stormwater discharges, and establish monitoring programs.

Michigan

The Michigan Water Resources Commission Act authorizes the Water Resources Commission to issue permits that regulate the discharge of all pollutants to the waters of the state.[60] As in California, these permits are to assure compliance with the CWA and the NPDES program. Michigan has been delegated authority to administer the NPDES permit program for industrial facilities and to conduct its own pretreatment program. The state office issues NPDES permits that apply the federal effluent limitations, including the numeric limitations for run-off from materials storage piles (see 40 CFR 411).[61] These permits contain pH and total suspended solids limitations for treated process waters, treated quarry ground water and quarry stormwater. The state, however, has not been delegated by EPA the authority to issue general permits. Therefore, cement plants must submit individual applications to comply with the new federal requirements for stormwater discharges associated with industrial activity.

Regional DNR offices conduct inspections and enforce permits.[62] Some cement plants are considered major dischargers and are inspected annually. Like California, Michigan uses PCS to meet the information, inspection, and enforcement needs of its water quality program. The violations discovered most often for all industrial facilities, including cement plants, are effluent limitation violations and permit compliance schedule violations. Monitoring and recordkeeping violations occur less frequently. About 80 percent of all industrial and municipal dischargers are found to be "significantly in compliance" with their permit requirements. An additional 10 percent are found to be out of compliance, with less serious violations. The remaining 10 percent are out of compliance, with more serious violations. Overall, industrial facilities are in better compliance today than in the past due to increased environmental

[60] Mich. Comp. Laws §§ 323.1-323.13.

[61] Personal communication with Pete Ostlund, Chief of Industrial Permits Section, Surface Water Quality Division, Michigan Department of Natural Resources, September 15, 1992.

[62] Personal communication with Tom Rohrer, Chief of Enforcement Unit, Surface Water Quality Division, May 24, 1993.

awareness. The cement manufacturing industry is not generally considered to have major compliance problems.[63]

The type of enforcement action taken depends on the severity of the violation. When a facility is found to be out of compliance, DNR first issues a verbal or written notice of noncompliance. If no remedial action occurs, a formal notice of violation is issued. Negotiated settlements bring most facilities into compliance. These settlements include penalties and schedules to return a facility into compliance. For more serious violations, emergency situations, and excessive recalcitrance on the part of the facility, DNR is authorized to issue abatement orders, revoke permits, and file civil and criminal actions.

Water Quality Standards

The state's water quality standards provide, as a minimum, that all waters be protected for agricultural use, navigation, industrial water supply, public water supply at the point of water intake, warm-water fish, and wading. Areas that must be suitable for swimming include all of the Great Lakes, their connecting waterways, and all inland lakes. The swimming rule does not apply in mixing zones, areas where a point source discharge is mixed with a receiving water. The overall aim is that all waters outside mixing zones must be suitable for swimming during the summer months. No degradation of waters may occur without a demonstration that such an activity would not be unreasonable and would promote the public interest. Dissolved solids must not exceed concentrations that are or may become injurious to any of the above designated uses.

Ground-Water Protection

Michigan also has established ground-water quality regulations to protect the public and to maintain the quality of ground waters in all usable aquifers for individual, public, industrial, and agricultural water supplies. These regulations establish the following:

- the goal of non-degradation of ground-water quality in useable aquifers;
- the requirements for hydrogeological study before permitting a discharge into ground waters;
- water quality parameters (e.g., metals, organic compounds, and toxic materials); and
- a ground-water monitoring system based on the hydrogeological study, local conditions, and the type of discharge for new and existing waste management facilities.

Pennsylvania

Pennsylvania's Clean Streams Law authorizes the Department of Environmental Resources (DER) to establish a program to prevent water pollution and to improve the purity of Pennsylvania's waters.[64] Pennsylvania has full authority to administer the federal NPDES permit program and to issue general permits. Unlike Michigan, DER's six regional offices issue individual permits. DER adopts the federal effluent limitations for cement plants and is implementing the federal requirements for stormwater discharges. An important feature of the state's NPDES program is that it applies both to streams and to ground water.

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[63] *Ibid*.

[64] 35 Pa. Stat. § 691.

The six regional offices conduct monitoring and enforcement activities, and have approximately 55 inspectors to regulate about 4,500 sewage and industrial dischargers.[65] Regional staff conduct annual inspections and respond to emergencies, pollution events, and complaints. Inspections include observations of treatment unit operation, effluent sampling, identifying problems, recommending solutions, and citing violations. During the past few years, Pennsylvania has made a considerable effort to enhance its monitoring program through automating the effluent limits data and the discharge monitoring using PCS. Monitoring data for all NPDES dischargers are reviewed on a routine basis.

Compliance and enforcement actions rely on both on-site monitoring and inspection data. Violations may result in notices, orders issued on site, penalty assessments, and civil and criminal actions. If environmental damage or willfulness was not involved, an attempt is made to obtain voluntary compliance. Usually a notice of violation requests correction by a specific date or the submittal of a compliance schedule. In more serious situations, higher level administrative, civil, or criminal actions may be the first step.

Water Quality Standards

Pennsylvania has established designated water uses and water quality criteria.[66] These designatd water uses include: support of warm-water fish; potable water supply, after treatment; industrial, livestock, and wildlife water supply; and irrigation, boating, fishing, water-contact sports, and aesthetics. In addition, specific water quality criteria for pH and total dissolved solids apply state-wide unless other numeric criteria are established for specific water body segments. In general, the pH limit is a range between 6.0 and 9.0, and the limit for total dissolved solids is 500 milligrams per liter on a monthly average with a maximum limit at any time of 750 milligrams per liter.[67]

Pennsylvania participates with the neighboring states of New Jersey, New York, and Delaware, as well as with the federal government, in the Delaware River Basin Compact. This agreement requires cooperative efforts to preserve the water's recreational and fish-producing value. The Delaware River Basin Commission, composed of the governors of the signatory states (or their designees) and the Secretary of the Interior, establishes comprehensive water quality standards. These standards impose limitations for pH and total dissolved solids that are more stringent than those imposed by Pennsylvania's water quality standards. Five cement facilities are located within the Delaware River Basin and are therefore subject to the Delaware River Basin Commission's water quality standards.

Ground-Water Protection

Pennsylvania has developed a Ground Water Protection Strategy to protect ground-water resources from contamination through the application of best demonstrated control technologies, the use of BMPs, monitoring of permit compliance, detection of ground-water contamination, and assessment and remediation. The Commonwealth's ultimate goal is non-degradation of ground-water quality. While the state does not have ground-water quality standards, ground-water protection is considered when establishing permit requirements for wastewater and stormwater discharges or solid and residual waste management facility design standards.

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[65] A total of 5,614 inspections were conducted in FY 91 of industrial and municipal dischargers. See Pennsylvania Department of Environmental Resources 1992 Water Quality Assessment.

[66] 25 Pa. Code § 16.

[67] 25 Pa. Code § 93.6.

Stormwater Management Requirements

Unlike Michigan, Pennsylvania has been delegated NPDES general permit authority by EPA. Cement kiln facilities can apply for coverage under Pennsylvania's general permit for discharges of stormwater associated with industrial activities. Cement plant operators are required to apply for individual stormwater discharge permits from DER for run-off from materials storage piles because they are subject to the Cement Manufacturing Point Source Category effluent limitations. The general permit, however, authorizes other stormwater discharges at a cement facility. The general permit requires that the owner of a facility develop and implement a Preparedness, Prevention, and Contingency Plan; comply with effluent limitations (e.g., pH between 6 and 9); and conduct annual monitoring.

Texas

In Texas, cement facilities subject to the federal NPDES permit program must receive an NPDES permit from EPA Region VI as well as an industrial discharge permit from the Texas Natural Resources Conservation Commission (Commission). Texas has not been delegated authority by EPA to administer the NPDES permit program for industrial facilities. Though cement facilities need dual endorsement, the requirements are similar. As Texas does not have any categorical effluent limitations for cement plants, both EPA Region VI and the Commission utilize the effluent guideline limitations for cement plants (40 CFR 411). These limitations are used as a minimum baseline, subject to more stringent limits, if necessary, to meet state water quality standards.

Unlike the other states, dual enforcement authority exists because both EPA Region VI and the Commission are responsible for compliance monitoring. EPA Region VI is responsible for monitoring compliance with the federal effluent limitations and the federal stormwater requirements. Per an agreement with EPA, the Commission will be primarily responsible for enforcement of the federal standards.[68] In addition, the Commission must identify alleged Texas Water Code violations and bring violators into compliance with the statutes.

The Commission has 14 field offices that conduct inspections (a 15th office will be added in 1994). Together these offices have approximately 50-70 inspectors.[69] The Field Operations Division, located at the Commission's headquarters in Austin, coordinates inspection activities among these field offices. The frequency of inspections is established based on the type of facility. The field offices inspect all major facilities annually. Cement plants, however, are not considered major facilities because they do not discharge large quantities of effluent.[70] After inspecting all major facilities, time and budget permitting, the offices will inspect other, minor dischargers such as cement plants. The offices will consider minor dischargers a high priority for inspection if they have received a complaint or if the facility has a past record of violations. Inspectors review a facility's compliance with the terms of its permit, observe treatment facility operations, and sample effluent discharges.

The Commission takes enforcement actions based on results of inspections by the field offices, monitoring data included in the monthly effluent report (Texas also uses PCS to manage discharger information), and public complaints. In a manner similar to that used in other states, minor violations are handled by the field office. These offices send out notices of violations and require the permittee to return to compliance within 30-60 days. The field offices refer to headquarters all severe and continuing violations. The Commission coordinates enforcement activities with EPA Region VI for violations at facilities with NPDES permits. In addition, the

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[68] Personal communication with Everett Spenser, EPA Region VI, Enforcement Branch, September 9, 1993.

[69] Personal communication with Rick Ruddell, Watershed Management Division, and Earnest Heyer, Field Operations Division, May 16, 1993.

[70] *Ibid*.

Commission meets with EPA Region VI staff on a quarterly basis to discuss enforcement activities and noncompliance reports. Commission and EPA Region VI personnel do not consider cement plants to have had major compliance problems.[71]

Water Quality Standards

As in the other states, Texas establishes both narrative and numeric water quality standards. The state has three major categories of water quality designations: (1) contact (e.g., swimming) and noncontact (e.g., boating) recreation; (2) domestic water supply; and (3) five subcategories of aquatic life (i.e., limited quality, intermediate quality, high quality, exceptional quality, and oyster waters).[72] The domestic water supply and aquatic life designations are of special concern to cement facility operators, as both impose limits on concentrations of heavy metals, as well as toxic and chemical materials. In addition, the State has numeric criteria for each classified segment of a given water body.

Ground-Water Protection

A state ground-water protection policy was adopted in 1989 that sets nondegradation of ground-water resources as its goal. The policy recognizes the variability of Texas' aquifers, the importance of maintaining water quality for existing and potential uses, the protection of the environment, and the maintenance and enhancement of the long-term economic health of the state. Discharges of pollutants, disposal of wastes, and other regulated activities must be in a manner that will maintain present uses and not impair potential uses of ground water or pose a public health hazard. The State legislature is currently debating proposals that would require ground-water monitoring for disposal facilities located in the Edwards Aquifer region.

Texas is the only state (of the four states included in this report) to have its Wellhead Protection Program approved by EPA. The Wellhead Protection Program identifies the roles of state and local agencies and attempts to coordinate the state's existing ground water and well water protection legislation. A wellhead protection program attempts to protect ground water surrounding a well or wellfield that supplies a public drinking water system. A wellhead protection program promotes the use of best demonstrated technology to prevent contamination.

Stormwater Management Requirements

No requirement exists under Texas regulations for the permitting of stormwater discharges. However, cement facilities are subject to the numeric limitations for run-off from materials storage piles found in the federal effluent limitations. These numeric limitations are incorporated as baseline requirements in the Texas Industrial Discharge permit and the federal NPDES permit.

As Texas does not have NPDES authority, EPA will administer the new stormwater requirements, including the issuance of general permits. However, EPA must incorporate the Texas hazardous metal effluent limitations (e.g., for cadmium, lead) as part of any stormwater permit, to comply with Texas water quality standards.[73]

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[71] Everett Spenser, EPA Region VI, Enforcement Branch, September 9, 1993, and Rick Ruddell, Watershed Management Division, and Earnest Heyer, Field Operations Division, Texas Natural Resources Conservation Commission, May 16, 1993.

[72] Tex. Admin. Code tit. 31, § 307.7.

[73] 57 Fed. Reg. 41236.

7.3 SOLID WASTE MANAGEMENT

Three general approaches are used in managing CKD at cement plants: recycling, beneficial use, and land management. While the least wasteful method for managing CKD would be to recycle it to the raw feed, excessive alkali content in the dust limits the amount of CKD that can be directly recycled without upsetting the proper functioning of the kiln (see Chapter 3, Section 3.1.1). When recycling can not be used to manage all CKD, the CKD may be disposed or stockpiled on site in waste management units or sold off site for beneficial use. Beneficial uses of CKD include applications as soil amendments, material additives, liming agents, road sub-bases, or waste stabilization agents. Various solid waste management requirements exist for disposal and stockpiling of CKD. In addition, some states require a permit before allowing off-site beneficial uses of CKD.

Under federal law, the Bevill Amendment (Section 3001 of RCRA) temporarily excludes CKD from regulation as a hazardous waste under Subtitle C of RCRA, pending study. While temporarily excluding CKD from regulation as a hazardous waste, the Bevill Amendment did not preclude CKD regulation under other provisions of federal or state law. Currently, CKD is subject to federal criteria as a non-hazardous solid waste under Subtitle D of RCRA. In addition, CERCLA provides the federal government with the authority and resources to respond to situations in which CKD wastes are or may be released into the environment such that they pose an imminent and substantial danger.

Because nothing prevents states from imposing more stringent hazardous waste requirements, states (such as California) may, and in some cases do, characterize CKD as a hazardous waste. Pennsylvania, on the other hand, classifies CKD as a residual waste. Pennsylvania regulates CKD less stringently than if CKD was considered a hazardous waste but still requires comprehensive waste management practices. Michigan and Texas characterize CKD as an industrial, non-hazardous solid waste and subject CKD to management requirements that vary from those of the other states.

7.3.1 Federal Controls

The Resource Conservation and Recovery Act

The Resource Conservation and Recovery Act of 1976 (RCRA), as amended, is the primary statute governing the management of solid and hazardous waste.[74] The principle objectives of RCRA are to:

- Promote the protection of human health and the environment from potential adverse effects of improper solid and hazardous waste management;
- Conserve material and energy resources through source reduction and waste recycling;
- Reduce or eliminate the generation of hazardous waste as expeditiously as possible; and
- Improve solid waste management practices.

Special requirements for hazardous wastes are found in Subtitle C of RCRA. Subtitle C provides a statutory framework for tracking all hazardous and toxic wastes from "cradle to grave," that is, from their generation to their final disposal, destruction, or recycling.

Under Section 3006 of RCRA, EPA may authorize states to administer and enforce a state hazardous waste program in lieu of the federal Subtitle C program. In order to receive authorization, a state's program must contain hazardous waste management regulations at

[74] 42 U.S.C. §§ 6901 to 6992K.

least as stringent as federal Subtitle C standards. A state's enforcement provisions must also provide at least equivalent penalties to those required in RCRA and enforcement activities performed by EPA. EPA has approved the state-level programs for implementing the Subtitle C hazardous waste management system of all four of the states analyzed in this report.

Pursuant to regulations issued by EPA (40 CFR Part 261), solid wastes that meet EPA hazardous waste criteria with respect to "toxicity, persistence, degradability in nature, potential for accumulation in tissue, and other related factors such as flammability, corrosiveness. . ." are subject to RCRA's Subtitle C requirements. Generators of these wastes are generally required to comply with labeling, storage, transportation, and disposal requirements.

In 1980, however, Congress enacted the Bevill Amendment, which temporarily exempted certain categories of high volume solid wastes (including CKD) from regulation as a hazardous waste under Subtitle C of RCRA, pending study and a Regulatory Determination. While temporarily excluding CKD from regulation as a hazardous waste, the Bevill amendment did not exempt CKD from regulation under other provisions of federal or state law. Currently, CKD is subject to regulation as a non-hazardous solid waste (hereafter referred to as solid waste) under Subtitle D of RCRA.[75] Subtitle D established a cooperative framework for federal, state, and local governments to control the management of solid waste. The actual planning and implementation of solid waste programs are state and local functions.

The broad definition of solid waste in the federal regulations includes industrial waste such as CKD. "Solid waste" is defined as "any garbage, refuse, sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations . . . "[76] According to RCRA, all solid wastes must be disposed in compliance with EPA's criteria.[77] A facility that meets the criteria is classified as a sanitary landfill.[78] A facility that fails to meet the criteria is classified as an open dump; disposal of solid waste in open dumps is prohibited.

EPA cannot take action against a person disposing of non-hazardous wastes in an open dump or against a state for failing to close open dumps, other than terminating certain grant funds available to a state under RCRA. No statutory authority exists to enforce or adopt a federal Subtitle D program in lieu of a state's program. However, EPA may respond to a waste management situation that presents "an imminent and substantial endangerment to health or the environment" under the authority of Section 7003 of RCRA.[79] Actions sanctioned by Section 7003 include injunctions to order a violator to stop the activity, as well as administrative orders requiring cleanup to protect public health and the environment.

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[75] 42 U.S.C. §§ 6942 - 6949a.

[76] 40 CFR § 257.2.

[77] 42 U.S.C. § 6944.

[78] On October 9, 1991, EPA revised the minimum criteria for municipal solid waste landfills. 56 Fed. Reg. 51016. As a result of EPA's concern about industrial waste, EPA is considering a second phase of criteria revisions that would address industrial solid waste management facilities and practices. This second phase of criteria revisions could affect the management of CKD.

[79] 42 U.S.C. § 6973.

Boiler and Industrial Furnace Rule

The Boiler and Industrial Furnace (BIF) Rule also directly affects the regulatory status of CKD generated by cement kilns burning hazardous waste as fuel.[80] Under the normal operation of RCRA Subtitle C, any remaining solid residue derived from the burning or processing of listed hazardous waste is itself a listed hazardous waste (40 CFR 261.3(c)(2)(i)). However, Bevill Amendment status of CKD is not automatically lost if hazardous waste is burned at a cement kiln. EPA amended the Bevill exclusion for CKD to specify that such "co-combustion residues" may retain their excluded status on a case-by-case basis. Cement kilns must process at least 50 percent by weight normal cement production raw materials to qualify. In addition, the owner or operator must demonstrate that the hazardous waste does not significantly affect the residue by meeting either of two alternate criteria: the toxic constituents in the waste-derived residue must not be significantly higher than the levels of such constituents in normal residue or exceed specified health-based limits. As part of the process of developing its Regulatory Determination, EPA may make modifications to the positions outlined in the BIF rule. [Note to reader: EPA recently granted a stay to the two-part test.

As part of the enforcement actions against cement kilns for violations of BIF regulations, discussed in the air pollution control section above (Section 7.1.1), EPA is seeking penalties from four facilities for BIF rule violations relating to CKD. EPA has alleged that three facilities failed to perform adequate testing of CKD to determine if it should be characterized as hazardous waste. EPA alleges that the other facility stored hazardous CKD without a permit.

Comprehensive Environmental Response, Compensation, and Liability Act

Run-off, leachate, and other air and water emissions from CKD can be subject to the regulatory and liability provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, or Superfund). Superfund provides the federal government with the authority and resources to respond to situations in which pollutants or contaminants are or may be released into the environment such that they pose an "imminent and substantial danger to the public health or welfare...."[81]

CERCLA authorizes EPA to respond to immediate threats to the environment or human health in situations in which a responsible party cannot act or cannot be readily identified. In such situations, EPA can proceed with necessary containment or removal actions. Where conditions allow, the Agency can also undertake more detailed remedial actions. Section 106 provides authority for administrative orders necessary to protect public health and the environment.

In those situations in which responsible parties that can respond "properly and promptly" can be identified, EPA is authorized to establish what remedial actions are required and to oversee the responsible parties' cleanup efforts. In all cases, the owners and/or other responsible parties are liable for the costs of cleaning up the hazardous waste problem, and for correcting damages to natural resources. Two cement kiln facilities are currently listed on the NPL and are discussed in detail in the Damage Case Evaluation (Chapter 5), above. These two NPL sites are as follows:

- Holnam Incorporated, Mason City, Iowa; and
- Portland Cement Company, Salt Lake City, Utah.[82]

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[80] 56 Fed. Reg. 7134 (Feb. 21, 1991).

[81] 42 U.S.C. § 9604.

[82] A third site, Lehigh Portland Cement Company's Mason City, Iowa, plant was placed on the NPL on August 30, 1990. In litigation, Lehigh identified a number of concerns regarding the hazard ranking score. After reviewing the issues regarding the calculation of the score on the hazard ranking system, the Agency decided not to contest Lehigh's challenge to the listing decision.

7.3.2 State Controls

In the area of solid waste, significant differences in CKD management exist between the states, specifically with respect to how states characterize CKD waste. California characterizes CKD as a hazardous waste. Pennsylvania, on the other hand, classifies CKD as a residual waste, regulating CKD less stringently than if it was considered a hazardous waste, but still requiring comprehensive waste management practices. Michigan and Texas characterize CKD as an industrial, non-hazardous solid waste and therefore, subject CKD to fewer management requirements than either California or Pennsylvania. A summary of the four states' solid waste management controls can be found in Exhibit 7-4, and a discussion of individual state's solid waste management requirements follows.

Exhibit 7-4

Summary of State Solid Waste Management Controls

States	California	Michigan	Pennsylvania	Texas
CKD Classification	Hazardous waste; moratorium on enforcement	Industrial solid waste	Residual waste	Industrial solid waste
Permit required	Yes; design standards, siting restrictions, and operating requirements	Yes; design standards, siting restrictions, and operating requirements	Yes; design standards, siting restrictions, and operating requirements	No[a]; notification to State of waste management activities
Ground-Water Monitoring	Monitoring system designed to provide best assurance of earliest possible detection of a release from facility	Monitoring system to evaluate ground water at the solid waste facility boundary; number and location of wells will vary depending on hydrogeological study	Sufficient number of monitoring wells to be representative of water quality (at least one upgradient and three downgradient wells)	Technical guidelines on ground-water monitoring systems, but monitoring not required
Reporting Requirements	Permit will include frequency of reporting of ground-water sampling results; annual hazardous waste report	Quarterly ground-water sampling results	Quarterly and annual reporting of sampling results; biennial residual waste report and source reduction plan	Notification to State of waste classification and waste management activities
Beneficial Use Approvals Required	No	Sometimes; for uses that could be considered disposal and do not involve a licensed waste management facility (e.g., use as fill material)	Yes; general permits may be issued on a regional or state-wide basis for a particular use	No

[a] On-site management of industrial non-hazardous waste does not require a permit. CKD transported off site must be managed in a permitted facility.

California

In addition to assigning responsibilities to the California Water Resources Control Board and the regional water resource control boards to regulate water discharges, the Porter-Cologne Act gives the boards specific authority to regulate discharges of waste to land.[83] The

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The listing was vacated by mutual consent in October, 1992. Removal of Lehigh's Mason City site from the NPL does not affect clean-up at the site. For further discussion of this site, see Section 5: Documented and Potential Damages from Management of CKD.

[83] Cal. Water Code §§ 13172, 13226-13227.

boards also have the authority to manage landfills and waste piles. This aspect of the California water pollution control law complements the state's Hazardous Waste Control Law. Under the Hazardous Waste Control Law, the Department of Toxic Substances Control (Department) manages California's hazardous waste program. The California Water Resources Control Board and the California Environmental Protection Agency's Department of Toxic Substances Control are presently revising their regulations to make them more consistent.

Currently, CKD is considered a non-RCRA hazardous waste under California's Hazardous Waste Control Act but may be reclassified as a "special waste." California defines a "special waste" as "a waste which is a hazardous waste only because it contains an inorganic substance or substances which cause it to pose a chronic toxicity hazard to human health or the environment ..."[84] The waste must meet all of the criteria and requirements of a special waste as specified in Sections 66261.122 and 66261.124 of the state's hazardous waste regulations; for example, the waste must not exhibit the characteristics of corrosivity, ignitability, reactivity, or toxicity (presumably, "acute" toxicity), as defined by the state.[85] The hazardous waste management regulations specifically list CKD as a waste that may be classified as a special waste.[86]

For CKD to be classified as a special waste, the owner or operator of a cement plant must submit an application to the Department. The application must contain the following information:

- Address where the waste is generated;
- Description of the waste that includes its source, physical state, quantity, and rate of generation; and
- Chemical analysis data.[87]

A representative CKD sample can be used in the chemical analysis because the plant continuously uses the same kinds of raw materials with respect to their origin, composition, and properties.

Upon written approval by the Department, a cement plant operator may manage CKD as a special waste, allowing it to be disposed in a landfill that is not permitted or operated under the more stringent hazardous waste requirements. As a special waste, the landfill does not have to comply with the hazardous waste facility design, closure and post-closure care, and financial assurance requirements.[88] However, the waste management facility must comply with any waste discharge requirements issued by the regional water quality control board.[89] The owner or operator of a facility also must have been granted a variance that allows for the disposal of special wastes. Unless specifically waived by a variance, the owner or operator of a

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[84] Cal. Admin Code tit. 22, § 66260.10 (also referred to as the California Code of Regulations).

[85] A solid waste considered hazardous under California's more stringent corrosivity or toxicity characteristics definition might not be considered a hazardous waste under the federal RCRA Subtitle C hazardous waste characteristics definition.

[86] Cal. Admin. Code tit. 22, § 66261.120.

[87] Cal. Admin. Code tit. 22, § 66261.124.

[88] Cal. Admin. Code tit. 22, § 66261.126(a).

[89] As stated above, in addition to regulating water discharges, regional water quality control boards are authorized to regulate discharges of waste to land. Cal. Water Code §§ 13172, 13226-13227.

waste management facility that accepts special waste is subject to the hazardous waste enforcement, manifesting, and reporting requirements.[90]

Even if a cement plant's CKD was to be classified as a special waste, the owner or operator of the plant is subject to all of the requirements that apply to a generator of hazardous waste.[91] As a generator of hazardous waste, the owner or operator must analyze the CKD and obtain an identification number. Manifesting and other reporting requirements also apply, as do requirements and limitations for storing hazardous waste. Owners or operators may, however, obtain a variance from any or all of these requirements. In practice, because the state has never enforced the management of CKD as a hazardous waste, the majority of cement plants in California have not applied to reclassify their CKD as a special waste, nor do they manage it as a hazardous waste.[92] Only one cement plant began the process of having CKD reclassified as a special waste, but it never provided the Department with all of the required studies.[93] Therefore, the Department has never made a determination on whether CKD could be reclassified as a special waste.

In response to potential CKD enforcement concerns, the Governor of California signed a bill in October 1992 that places a one year moratorium on the enforcement of hazardous waste requirements for CKD that fails the California hazardous waste corrosivity characterization test.[94] This bill, effective January 1, 1993, and extending through January 1, 1994, authorizes a study on the health-based effects of CKD with funding by the California Cement Manufacturers Association. This study is subject to review by a committee consisting of California EPA, the Department of Toxic Substances Control, the State Water Resources Control Board, the California Cement Manufacturers Association, and an environmental organization. The study will analyze whether the hazardous waste corrosivity criteria, including testing protocols, should be applied to CKD. Due to procurement problems, this study remains at the bid stage and the California Cement Manufacturers Association will be asking the legislature for a one-year extension on the moratorium so the study can be completed.[95]

The moratorium only provides a temporary exemption from the enforcement of hazardous waste management requirements for CKD that fails the California hazardous waste corrosivity characterization test. One cement plant also failed California's hazardous waste characterization test because of the presence of lead in the CKD.[96] The Department, however, issued a letter in 1985 stating that the cement plant operator could treat the CKD as a non-hazardous waste because the lead had little potential to leach out of the CKD. Under this variance, the plant operator must wet the CKD and allow it to solidify prior to managing it in waste piles. The waste piles do not have liners or concrete pads. Ground-water monitoring

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[90] Cal. Admin. Code tit. 22, § 66261.126(c).

[91] Cal. Admin. Code tit. 22, § 66261.126(d).

[92] Personal communication with Chris Marxen, California Environmental Protection Agency, Department of Toxic Substances, Waste Evaluation Unit, and Fred Fontus, California Environmental Protection Agency, Department of Toxic Substances, Surveillance and Enforcement, September 10, 1993.

[93] Letter from Stanford Lau, Toxic Substances Control Division, to Ralph Mitchell, Lone Star Industries, Inc., July 20, 1988.

[94] Assembly Bill 3789, Cal. Health and Safety Code § 25141.1.

[95] Personal communication with Chris Marxen, California Environmental Protection Agency, Department of Toxic Substances, Waste Evaluation Unit, September 10, 1993.

[96] Personal communication with Fred Fontus, California Environmental Protection Agency, Department of Toxic Substances, September, 10, 1993.

wells near the waste piles consistently demonstrate no ground-water contamination has occurred from lead leaching from the CKD.

Recently, a weekly sample from newly-generated CKD at this cement plant demonstrated elevated lead levels. The plant immediately notified the Department. The plant segregated this CKD and will manage this batch of CKD as a hazardous waste.

The moratorium does not affect inspections or enforcement of other environmental requirements such as ground-water protection. Cement plants continue to be inspected annually.

Michigan

The Michigan Solid Waste Management Act authorizes the Michigan Department of Natural Resources (DNR) to manage industrial solid waste and hazardous waste disposal.[97] "Solid waste" is defined broadly to include "garbage, rubbish, ashes, incinerator ash, incinerator residue, street cleanings, municipal and industrial sludges, and solid commercial and solid industrial waste . . ."[98] CKD is considered a solid industrial waste under this definition, and is not characterized as a hazardous waste under Michigan regulations. CKD is considered a Type II solid waste.[99] DNR has become concerned about the potential environmental impact of past disposal of CKD in quarries and is studying CKD disposal practices at the three currently-operating cement plants.[100] DNR has discovered some ground-water contamination downgradient from CKD piles, but has no proof that the contamination originates from the CKD and is not the result of natural leachate from bedrock fractures. This situation continues to be monitored.

If the owner or operator wants to manage CKD on site, a construction permit and operating permit for landfills are required. The permitting process requires a separate license to operate a facility. The license application must be accompanied by an engineer's certification that construction was completed in accordance with the previously approved plans. A bond to cover the costs of closure and post-closure monitoring is also required. With regard to post-closure land use, the Department is in the process of reviewing a cement facility's closure plan to turn a limestone quarry containing CKD into an inland lake or marina.[101]

> The construction permit application is to be accompanied by the following:
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> - A hydrogeological report and monitoring program;
> - Engineering plans; and
> - An environmental assessment.

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[97] Mich. Comp. Laws §§ 401-436.

[98] Mich. Comp. Laws § 299.407.

[99] Wastes listed as hazardous or that demonstrate hazardous characteristics are classified as Type I wastes. Type III wastes are inert and essentially insoluble (e.g., demolition debris, rock, or dirt). Type II wastes are all the wastes that cannot be considered Type I or Type III and include garbage and rubbish. See Letter from Mindy Koch, Acting Chief, Waste Management Division, Department of Natural Resources, to Myron Black, LaFarge Corporation, dated September 27, 1991.

[100] Personal communication with Brad Venman, Michigan Department of Natural Resources, Waste Management Division, October 9, 1992. Currently, the cement plant located in Wayne County only grinds clinker delivered from Canadian cement plants. The kiln which was permitted to burn hazardous waste for fuel was shut down for economic reasons.

[101] Personal communication with Brad Venman, Department of Natural Resources, Waste Management Division, October 9, 1992.

Another option is to have CKD receive a "designation of inertness" from DNR.[102] This designation would exempt CKD from most solid waste management requirements (e.g., construction or operating permits). To be classified as inert material, the CKD must meet Toxicity Characteristic Leaching Procedure (TCLP) concentration limits. If the designation of inertness is approved for CKD, the owner or operator of the cement plant would be required to characterize the CKD a minimum of once per year. One facility failed this test because the leachable concentration of lead was too high.[103]

At another cement plant, DNR outlined three options for future CKD disposal: 1) transport the CKD to an off-site facility licensed to manage Type II wastes; 2) develop an on-site facility that is permitted and licensed; or 3) obtain a "designation of inertness" from DNR for the continued disposal of CKD in the on-site quarry.[104] If CKD is to be transported off site for disposal, the disposal must be consistent with county solid waste management plans.

DNR only requires beneficial use permits for certain uses. For example, no beneficial use approval is necessary when CKD is used to solidify liquid hazardous wastes because controls and reporting requirements exist and are the responsibility of the liquid hazardous waste management facility. Similarly, CKD used to solidify drilling muds and cuttings from oil and gas exploration activities or tank bottoms from oil and gas production facilities would not need to be permitted because the solidified wastes would be taken to a licensed landfill. DNR is more concerned about how CKD is ultimately disposed. Therefore, approval and reporting requirements would apply if the beneficial use of CKD involved activities such as river bank stabilization or restoration projects that would use CKD as fill. Historically, CKD has been used as fill along the Detroit River. Today, this type of use would receive close scrutiny.

Pennsylvania

Unlike California and Michigan, CKD is classified by Pennsylvania as a residual waste. The Pennsylvania Department of Environmental Resources (DER) defines "residual waste" as "[g]arbage, refuse, other discarded material or other waste including solid, liquid, semisolid, or contained gaseous materials resulting from industrial, mining and agricultural operations . . . if it is not hazardous."[105] Pennsylvania's definition of residual waste is similar to Michigan's definition of industrial waste.

The six regional DER offices conduct inspections; inspections based on the new residual waste regulations are pending.[106] Due to limited resources, inspections of hazardous waste management facilities and municipal waste management facilities are a higher priority than residual waste management inspections. The regulations explicitly state that DER does not have a duty to conduct a minimum number of inspections per year at a facility.[107] While no minimum number of inspections is required, the regulations recommend that DER conduct 12 inspections per year for each residual waste landfill. DER may conduct as many inspections as necessary for public health or safety reasons.

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[102] Mich. Comp. Laws § 299.408(3), Mich. Admin. Code §§ 299.4102(h) (viii) and 299.4301(3).

[103] Letter from Mindy Koch, Acting Chief, Waste Management Division, Department of Natural Resources, to Myron Black, LaFarge Corporation, dated September 27, 1991.

[104] Ibid.

[105] 25 Pa. Code § 287.1.

[106] Personal communication with Reno Vacheski, Pennsylvania Department of Environmental Resources, Region II, Waste Management Bureau, September 10, 1993.

[107] 25 Pa. Code § 287.421.

Currently, DER residual waste management enforcement is concentrating its efforts on obtaining compliance with notification requirements. These requirements mandate that residual waste generators provide to DER by March 1, 1993, basic information about their waste and its management. Approximately 67 percent of residual waste generators submitted the required report.[108]

In a manner similar to that of the other states, DER has administrative, civil, and criminal enforcement authority, including the authority to levy penalties.[109] The residual waste management regulations establish specific violations for which a civil penalty should be assessed (e.g., acceptance of waste not approved under a permit), but do not restrict DER from assessing penalties for violations not explicitly set forth.[110] These regulations also establish factors for determining penalty amounts (e.g., willfulness of violation). For most cases of noncompliance, DER plans to send a notice of violation and arrange for a meeting to discuss the violations,[111] at which a date will be established by which the violations must be abated. If the violations are not corrected, DER may seek consent orders, civil penalties, and in extreme situations, criminal penalties.

As a residual waste, CKD is regulated less stringently than it would be if classified as a hazardous waste, but is still subject to comprehensive waste management controls. Cement facilities are subject to the residual waste management requirements in Pennsylvania's Solid Waste Management Act and the new Residual Waste Management Regulations.[112] These new regulations, adopted in July 1992, reflect the increasing complexity of industrial waste management and afford greater protection of the State's ground water. These new regulations expand residual waste management requirements and replace older residual waste standards.

Cement plants that manage CKD are required to obtain a Residual Waste Processing and/or Disposal Permit.[113] This permit attempts to balance state-of-the-art environmental protection methods and the risks presented by particular wastes at a facility. This permitting process requires the following elements:

- Environmental assessment;
- Analysis of the waste(s);
- Source reduction strategy; and
- Plan for ongoing analysis of the waste(s).[114]

In establishing disposal requirements for a specific facility, a waste classification system is used to determine landfill design standards. A leaching analysis based on EPA's methods compares the amount of contaminants in the waste's leachate to ground-water parameters; this analysis determines the appropriate landfill design class.

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[108] Personal communication with Sam Sloan, Pennsylvania Department of Environmental Resources, Bureau of Waste Management, Division of Municipal and Residual Waste, September 10, 1993.

[109] Penn. Stat. §§ 6018.602-6018.606.

[110] 25 Pa. Code § 287.411.

[111] Personal communication with Reno Vacheski, Pennsylvania Department of Environmental Resources, Region II, Waste Management Bureau, September 10, 1993.

[112] 35 Penn. Stat. Ann. § 6018.102 and 25 Pa. Code § 287.

[113] 25 Pa. Code § 287.101.

[114] 25 Pa. Code §§ 287.121-287.134.

Depending on the results of the leach tests, CKD may be placed in one of three different types of landfills with various liner and other requirements (e.g., Class I landfills must comply with more stringent liner, siting, and operating standards than either Class II or Class III landfills). Under the industrial waste regulations, a waste that leaches more than 50 times the ground-water parameter for any of the contaminants it contains would be required to be disposed of in a Class I landfill. If the contaminants are greater than 25 times the ground-water parameters for metals and other cations, or more than 10 times the ground-water parameters for other contaminants, the CKD would be required to be disposed of in a Class II landfill. Other wastes, in general, could be disposed of in a Class III landfill.

A ground water parameter is one of the following:

- the maximum contaminant level goal (MCLG) under the Federal Safe Drinking Water Act;
- the primary or secondary maximum contaminant level (MCL); or
- for other contaminants, concentrations derived from the U.S. EPA's Integrated Risk Information System (IRIS).

The residual waste regulations require permits that include provisions for liners, leachate collection systems, monitoring wells, and disposal of leachate. Though similar to the federal Subtitle D criteria with regard to prohibitions on where facilities may be located (e.g., within the 100-year floodplain) the residual waste regulations are more stringent. Residual waste permits will be issued for up to 10 years, but DER must review these permits every five years. Facilities without permits must document planned closure procedures within a certain time frame.

Under the residual waste regulations, a cement facility must develop a source reduction strategy and update that plan every five years. The strategy must contain the following elements:

- the methods and procedures that will be used to achieve a reduction in the weight or toxicity of waste generated on the premises;
- the magnitude of the projected reduction; and
- a timetable for when the reductions will occur.

Every two years, a cement facility must file a report describing the types of waste generated, where the wastes are processed or disposed, and the facility's efforts to implement its source reduction plan. The report is intended to provide baseline data about industrial waste generation and source reduction in Pennsylvania.

Cement facilities may also be required to obtain a Residual Waste Beneficial Use Approval.[115] This approval is required if a cement plant plans to reuse constituents of residual waste for a particular beneficial purpose. This requirement is currently in effect. Past uses of CKD to make fertilizer and for use in soil stabilization, land reclamation, waste remediation, and sewage sludge dewatering would now be required to obtain DER beneficial use approval. On its own initiative, or at the request of other parties, DER may issue general permits for beneficial use on a regional or Commonwealth-wide basis. The general permit may establish concentration limits for contamination or place restrictions on the use. As of this date, DER has not received and approved any general permit applications or issued on its own initiative a general permit for the beneficial uses of CKD. Those cement plants using CKD for a beneficial purpose need to apply for a permit.

Texas

[115] 25 Pa. Code § 287.611.

The Texas Solid Waste Act grants the Texas Natural Resources Conservation Commission jurisdiction over hazardous and industrial waste management.[116] Under new waste classifica-tion regulations finalized in November 1992, owners or operators of a facility must submit a registration form to the Commission that makes a determination of their waste classification and assigns a waste code to their own wastes.

The Commission conducts inspections of all permitted non-hazardous waste management facilities annually.[117] Cement plants that burn hazardous waste for fuel are inspected annually and are permitted RCRA facilities. The majority of cement plants, however, do not burn hazardous waste and manage their CKD on site. These cement plants are exempt from permitting requirements (this permit exemption for facilities managing their CKD on site is discussed in greater detail below) and annual inspections. The Commission will inspect cement plants that are exempt from permitting requirements if there are complaints.

Texas has administrative and civil enforcement authority, including the authority to levy monetary penalties of up to $10,000 per day of violation. Generally, the Commission attempts to issue agreed upon Corrective Action Directives to encourage voluntary compliance and implementation of corrective action in an expedited manner. Administrative orders with penalties for violations are also issued. In situations where the Commission believes that an imminent and substantial endangerment to human health or the environment has occurred, an order may be issued without the facility's consent to facilitate immediate corrective action. No major enforcement or compliance problems are known to exist at cement plants.[118]

The Texas Solid Waste Management Regulations establish standards for all aspects of the management and control of industrial solid waste; CKD is considered a non-hazardous industrial solid waste. "Industrial solid waste" is defined as any solid waste resulting from or incidental to any process of industry or manufacturing.[119] Non-hazardous industrial solid waste is classified as follows:

- Class 1 wastes that may pose a substantial danger to human health and the environment because of hazardous characteristics;
- Class 2 wastes that are all wastes that cannot be considered Class 1 or Class 3; and
- Class 3 wastes that are inert and essentially insoluble (e.g., rock, bricks, or dirt).

CKD would be considered a Class 1 corrosive waste if it is a semi-solid or solid which, when mixed at a 1:1 ratio with water, produces a solution with a pH less than or equal to 2 or greater than or equal to 12.5. Based on EPA studies, some CKD could be classified as a Class 1 industrial waste under this standard. The cement facility owner or operator would then be required to manage the CKD only in permitted hazardous waste management facilities and would be subject to manifesting and reporting requirements.

Wastes are classified in the most protective manner unless knowledge and/or data demonstrate that a less conservative classification (Class 2 or 3) is applicable. If an owner or

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[116] Tex. Health and Safety Code § 361.

[117] Personal communication with Earnest Hire, Texas Natural Resources Conservation Commission, Industrial and Hazardous Waste Enforcement Section, September 10, 1993.

[118] *Ibid*.

[119] Tex. Admin. Code tit. 31, § 335.1.

operator considers its CKD to be a Class 2 or 3 waste, testing results must verify this position.[120] To be classified as a Class 3 waste, the cement kiln owner or operator must demonstrate that the CKD does not exceed maximum leachable concentrations (based on EPA's Toxicity Characteristic Leaching Procedure (TCLP)), or exceed Primary Drinking Water Standards or the Total Dissolved Solids limit of the secondary standards. To be considered a Class 2 waste, CKD must not fail the corrosivity test described above. Basically, a Class 2 waste is not as totally innocuous and inert as is required for a Class 3 waste, but also does not present the potential threat of a Class 1 waste.

The Industrial Waste Management Regulations exempt non-hazardous industrial waste (Class 2 or 3) disposal facilities from the requirement to obtain a solid waste facility permit if the waste is: 1) disposed on site; 2) the disposal site is located within 50 miles of the plant or operation; and 3) the waste is not "commingled" with waste from another source.[121] Off-site waste management units must be permitted.

Owners and operators of facilities that are exempt from the permitting requirement must still comply with the following industrial waste management requirements:

- Owners and operators must notify the Commission 90 days prior to the onset of disposal activities;
- Records must be kept of the description of the waste, quantities stored or disposed, and quantities shipped off site;
- The storage or disposal of waste must not cause a nuisance or endanger the public health or welfare; and
- Owners or operators must file a notice in the county deed records of the disposal.

In addition, owners or operators may be required to submit information on waste management methods, facility engineering plans, and the geology of the facility's location. An owner or operator is required to submit details of closure activities only if requested by the Texas Natural Resources Conservation Commission.

The Commission provides technical guidelines to advise owners/operators of on-site waste piles on appropriate liner materials and thickness, closure and post-closure care activities, and site selection criteria, but these guidelines are not requirements that can be enforced. For example, owners or operators are not expressly required to place liners under waste piles or to monitor ground water. In addition, no closure and post-closure care requirements exist for on-site non-hazardous industrial solid waste piles.

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[120] Owners or operators must use an approved testing method such as those described in "Test Methods for the Evaluation of Solid Waste, Physical/Chemical Analysis." In addition, the owner or operator must maintain documentation of the sampling procedures. The Commission may review a waste characterization at any time to determine if the waste has been appropriately classified.

[121] Tex. Admin. Code tit. 31, § 335.2(d).

CHAPTER SEVEN

EXISTING REGULATORY CONTROLS ON CKD MANAGEMENT

LIST OF EXHIBITS