BENEFICIAL REUSE OF FOUNDRY SAND:
A REVIEW OF STATE PRACTICES AND REGULATIONS

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In partnership with
American Foundry Society
Association of State and Territorial Solid Waste Management Officials

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1.0 BACKGROUND

Every year foundries generate between nine and 13 million tons of sand that is unfit for continued use in the mold-making process. Only a small percentage of this used foundry sand is characterized as hazardous waste, with the overwhelming majority qualifying as non-hazardous industrial waste. Although some sand is currently "beneficially reused" – industry experts estimate that approximately one million tons is beneficially reused outside of the foundry – foundries typically discard this material in municipal or private landfills.[1] Given the potential for reusing a substantial amount of the non-hazardous sand in a variety of ways, including roadbeds, construction fill, and cement, it is likely that much of the sand currently disposed of in landfills is "beneficially reusable."

A variety of factors contribute to the low level of sand reuse. These factors affect each of the stakeholders who can play a role in beneficially reusing this waste.

- For states, developing a regulatory structure that simultaneously ensures environmental protection and encourages appropriate beneficial reuse can be very challenging. Also, the lack of an established process for evaluating and permitting reuses can be a significant barrier.

- Prospective end users may not know that foundry sand is reusable. They may incorrectly assume that foundry sand may not perform properly from an engineering standpoint, or that it may contain unacceptable concentrations of toxic constituents.

- Finally, foundries may not be aware of the many potential uses for their sand, or may not have considered simple operational changes that could have dramatic effects on the characteristics of sand (e.g., waste stream segregation) and thus enhance their ability to find alternatives to landfill disposal.

[1] Foundry sand estimates are from Dr. Paul J. Tikalsky of Pennsylvania State University, collated from FIRST (Foundry Industry Recycling Starts Today) data.

1.1 PURPOSE OF THIS REPORT

The foundry industry has frequently cited the beneficial reuse of foundry sand as one of its most important environmental issues. To address this concern, the U.S. Environmental Protection Agency (EPA) assembled a workgroup of representatives from industry, states (the Association of State and Territorial Solid Waste Management Officials, ASTSWMO), and the U.S. Departments of Transportation and Agriculture. The workgroup recommended that EPA research existing state beneficial reuse programs, conduct case studies examining "real-world" reuses of foundry sand, conduct a scientific characterization of foundry sands, and suggest approaches to encourage increased future reuse.

In response to the workgroup's recommendations, EPA researched regulations, statutes, guidance documents, policies, websites, and other publicly available information regarding beneficial reuse of foundry sand, industrial waste recycling, and solid waste designation in 18 states. These states have the largest numbers of foundries in the country and have active industrial waste recycling programs or initiatives. EPA also conducted four case studies of ongoing or recently completed projects involving the beneficial reuse of sand.

Additional testing data are needed to more fully characterize the composition of foundry sand, and tests are being conducted. In the interim, this report is intended to serve as a national reference for all stakeholders potentially involved in the beneficial reuse of foundry sand.

- **For states**, the document provides regulators with information to facilitate the process of determining appropriate beneficial reuses. It is a resource for understanding existing guidance and/or regulations developed by other states, which can serve as a model for developing beneficial reuse policy.

- **For foundries**, it is a resource for: (1) understanding existing guidance and/or regulations developed by different states; and (2) identifying reuses that are alternatives to sand disposal and working with states to take advantage of them.

- **For potential end users,** the document is a resource for exploring the potential use of foundry sand as an alternative to virgin raw materials.

This report was prepared by the Metal Casting Industry Performance Partnership Program, created and led by the Sector Strategies Division within EPA's Office of Policy, Economics, and Innovation. The program is a cooperative effort involving EPA, the American Foundry Society, and a number of state governments. It aims to reduce pollution and increase the reuse and recycling of used materials in the metal casting sector, including foundries.

1.2 SUMMARY OF KEY FINDINGS

EPA's research on state programs and insights gained from case studies highlight several key findings related to sand reuse. When considered together, these findings suggest that there is significant opportunity for expanding beneficial reuse of foundry sand:

- **Used foundry sand is a high volume industrial waste that can be more widely reused as an alternative to landfill disposal.** A brief look at three factors supports this finding: (1) foundries generate substantial volumes of used sand that is non-hazardous, consistent in composition, and available in ample supply; (2) foundry sand exhibits physical and engineering characteristics comparable to those of virgin raw materials used in a variety of applications, such as asphalt manufacturing, road embankment construction, and soil amendments (see Exhibit 1-1 for a list of potential beneficial reuses); and (3) landfill capacity should not be used for materials that can be beneficially reused.

- **Many states are receptive to recycling/reuse proposals from industry, provided they are backed by sound science demonstrating that reuse will not result in adverse environmental impacts.** The quantity and quality of testing and scientific data provided to the state in support of reuse proposals are critical factors affecting the state's ability to develop protective beneficial reuse permits, policies, and regulations. Because developing the necessary data to support a new reuse can be extremely burdensome for an individual foundry, efforts on the part of state agencies or trade associations to sponsor the necessary research can significantly contribute to the expansion of reuse opportunities.

- **Simple, straightforward regulations that streamline the process for approving reuses can enhance the opportunities for safe, beneficial reuse of foundry sand.** The key factor in increasing foundry sand reuse appears to be the strong support and encouragement of the state regulatory agency. This support can be seen in some states' efforts to streamline the approval process for reuse projects. States use a range of alternatives to simplify project approvals, including issuing general permits that cover multiple reuse projects, allowing certain reuse projects to proceed with only prior notification, and providing waste exemptions for qualifying by-products.

- **Cost savings is the primary motivating factor for reuse of foundry sand.** In determining whether to pursue opportunities to reuse sand, a foundry weighs the cost of transporting sand to a landfill and tipping fees against the costs of preparing sand for reuse, which may include segregating sand from other by-products, and transporting it to the reuse location. End users weigh the cost of virgin raw material against the cost of obtaining and using foundry sand, including testing that must be performed on end products, lead time required for project approval, and the effect on sales of a negative perception of products containing an industrial by-product.

Exhibit 1-1

BENEFICIAL REUSES OF FOUNDRY SAND

Foundry sand can be suitable for a variety of beneficial reuses. Terminology for defining uses varies across states. For the purposes of this report, EPA has developed definitions for common uses of sand in consultation with industry experts. The following are uses of foundry sand approved in one or more states:

Structural Fill

Foundry sand can be used as support for structures such as roadways, parking lots, buildings, and pieces of equipment. "Encapsulated" structural fill may involve the use of a liner, cap, or cover, generally made of a clay material, which prevents water from percolating through the foundry sand and minimizes the potential for leaching.

Manufacturing Another Product

Foundry sand is useful as a raw material in manufacturing other products, such as controlled, low-strength material (CLSM or flowable fill), asphalt, cement, concrete, grout, lightweight aggregate, concrete block, bricks, roofing materials, plastics, paint, glass, ceramics, and rockwool. Specific examples of these uses include:

- *Flowable fill*: Flowable fill is a liquid-like material that self-compacts and is used as a substitute for conventional soil backfill. The product is easily transported and can be readily re-excavated. The typical mixture contains sand, fly ash, portland cement, and water. Foundry sand can readily be substituted for virgin sand in flowable fill mixtures.

- *Cement and Concrete*: Sand is a component of Portland cement and concrete. Portland cement requires sand with a silica content of at least 80 percent, which most foundry sands meet. It also requires certain minerals such as iron and aluminum oxides, which are found in many foundry sands. Cement and additional sand or gravel are components of concrete, allowing further reuse of foundry sand.

Soil Manufacturing and Amendment

Commercial soil blending operations can use foundry sand to produce horticultural soils, topsoil, potting soil, and turf mixes. These soil products are typically mixtures of sand or gravel with peat, fertilizers, and/or top soil. Foundry sand can also improve the performance of agricultural soils, and can be used as a composting ingredient.

Landfill Uses

Foundry sand can be used as a cover for the working face of an active landfill, for road construction within the active cell, or as a substitute for virgin aggregate in the construction of drainage layers for landfill leachate collection systems.

Pipe Bedding and Backfill

Foundry sand can serve as backfill for trenches created by the installation of storm and sanitary sewer lines.

- **Foundry sand consolidators create economies of scale that can overcome some of the barriers to increased beneficial sand reuse.** In many cases, foundry sand reuses involving a single foundry or end user may not be economically or operationally feasible, particularly when transportation costs are prohibitively expensive or when individual foundries generate relatively small quantities of sand. "Middlemen" can make sand reuse possible through consolidating and preparing sand from multiple foundries for reuse by multiple end users.

- **Heightened awareness among stakeholders can substantially increase the volume of foundry sand beneficially reused.** Information sharing among federal, state, and local government agencies, foundries, and potential end users can: (1) increase both the supply of foundry sand available as a raw material and the demand for it as a substitute for virgin raw materials; (2) provide state regulators with more information about the characteristics of foundry sand, and with examples of how they can structure their programs to encourage increased sand reuse while protecting against any potential negative environmental impacts; (3) increase foundries' awareness of the opportunities for reuse; and (4) educate potential end users about the comparability of foundry sand to virgin raw materials as an input to their products.

1.3 ORGANIZATION OF REPORT

This report presents the results of EPA's research into state practices and regulations regarding the beneficial reuse of foundry sand. Chapter 2 provides a brief overview of the foundry industry and a description of the composition of foundry sand. Chapter 3 describes the range of approaches to regulating the reuse of non-hazardous industrial wastes across 18 states. (Appendix A provides additional information on industrial waste programs in these states.) Chapter 4 is a more in-depth review of the guidance and regulations developed by seven states that specifically address beneficial reuse of foundry sand in their guidance and/or regulations. EPA also conducted four case studies of ongoing or recently completed projects involving the beneficial reuse of sand to identify factors that affect the potential for sand reuse. Chapter 5 includes brief descriptions of each case study, plus an overview of the findings from the case studies. (More detailed descriptions of the case studies are included in Appendix B.)

2.0 THE FOUNDRY INDUSTRY

In 2000, the domestic foundry industry reported over 27 billion dollars in sales.[2] The industry produces castings for a wide array of products ranging from engine blocks to construction and farming equipment to golf club heads. Foundries typically utilize temporary molds constructed of sand and other materials, and are classified as either ferrous or non-ferrous, depending on the type of metals used. Ferrous foundries produce parts cast from iron and steel. Non-ferrous foundries may use aluminum, beryllium, cobalt, copper, zinc, lead, tin, nickel, magnesium, or titanium.

The majority of foundries are located close to their major markets, which are in large part the industrial/automobile manufacturing belt in the central United States. Foundries in six states – Ohio, Michigan, Illinois, Wisconsin, Pennsylvania, and California – make up over half of all foundries in the United States.[3]

2.1 SAND USE WITHIN FOUNDRIES

Foundries produce ferrous and non-ferrous castings, and in the process generate large quantities of waste sand that can no longer be used in the casting process. Non-reuseable sand accounts for 55 to 90 percent of the total waste stream of a facility. Nationally, only two percent of foundry sand is considered hazardous.[4] The remaining 98 percent is a non-hazardous industrial by-product that can be reused in a variety of products or disposed of in non-hazardous landfills.

The U.S. foundry industry uses approximately 100 million tons of sand per year. Roughly 90 percent is reused for making molds within the foundries, but 9 to 13 million tons of

[2] American Foundry Society.

[3] U.S. EPA. 1998. "Sustainable Industry: Metal Casting Industry Profile." U.S. EPA Office of Policy, Industry Sector Policy Division.

[4] U.S. EPA. 1998. *Metal Casting Industry Sector Notebook*. U.S. EPA Office of Compliance.

this sand is no longer useable in the casting process. Of this sand, approximately one million tons are recycled for other uses every year; the remaining 8 to 12 million tons are landfilled.[5]

Many foundries have invested in sand reclamation systems that can recover up to 95 percent of sand used in the casting process. These systems represent an important environmental and economic opportunity for foundries, helping to control production costs and to reduce the amount of waste for disposal. Even with this increase in sand reclamation, there is a limit to the number of times sand can be effectively reused in the casting process, eventually resulting in a large amount of used sand that could be beneficially reused elsewhere.

2.2 COMPOSITION OF FOUNDRY SAND

Casting processes used by foundries involve a variety of sands, inorganic and organic binders, and other additives. They generate residues in the sand, including metals from the castings and compounds from binders used to form the sand into molds. The presence of these residues and the mixing of used sand with dust and other fine-grained foundry waste materials can limit the reusability of foundry sand.

Foundries use screening systems and magnetic separators to segregate reusable sand from other wastes and to separate particles of varying sizes. By carefully monitoring the casting process and used sand, foundries can ensure that their sand is largely free of excess contaminants and qualifies as a non-hazardous industrial by-product.

2.3 POTENTIAL CONTAMINANTS IN FOUNDRY SAND

Several studies have been conducted to characterize foundry sand and evaluate the likely environmental impacts of reusing sand. These studies primarily rely on tests of the potential for various constituents to leach from the sand, such as the Toxicity Characteristics Leaching Procedure (TCLP), which measures constituent concentrations dissolved in an acidic solution that has been in contact with the sand.[6]

2.3.1 Metal and Other Inorganic Contaminants

In general, TCLP results show that metal concentrations in foundry sand are below regulatory thresholds, such as those specified for hazardous waste by the Resource Conservation and Recovery Act (RCRA).[7] Many of the leachate concentrations measured were

[5] Foundry sand estimates are from Dr. Paul J. Tikalsky of Pennsylvania State University, collated from FIRST (Foundry Industry Recycling Starts Today) data.

[6] The TCLP is the most commonly used leach test, however, several states use the Synthetic Precipitation Leaching Procedure (SPLP). In addition, a number of states use other tests, such as a totals analysis, which is an analysis of the composition of the sand itself.

[7] E.S. Winkler and A.A. Bolshakov. 2000. "Characterization of Foundry Sand Waste." Chelsea Center for Recycling and Economic Development, University of Massachusetts at Lowell.

lower than federal drinking water standards, indicating it is generally safe to reuse these sands. Studies of foundry sand also indicate that metal contaminant concentrations are on the same order of magnitude as those in virgin sand and sandy soils.[8]

On the other hand, mixed foundry by-products from non-ferrous foundries (which contain a combination of sand, dusts, and slag) have occasionally been found to have metal leachate concentrations above RCRA thresholds.[9] For example, some foundry dusts have been found to have higher concentrations of metals relative to sand. Comparisons of the total metal content of sand to TCLP results found no direct correlation.

2.3.2 Organic Contaminants

The binder system is the primary source of organic contaminants in sand. The primary organic contaminants from foundry sand cores are acetone and 1,1,1-trichloroethane, and a number of aromatic compounds, as shown in Exhibit 2-1. Green sand casting, which generally does not involve the use of organic binders, has been shown to have lower potential for leaching organic compounds than chemically bonded systems.[10]

Depending on the curing and pouring process, some of the organic binder constituents may be altered from their original composition. The more reactive organic compounds commonly used in binders and resins are of special concern, because they can be transformed into new hazardous compounds under incomplete combustion conditions.[11] However, testing has not indicated that these reactive compounds are found at significant concentrations in sand.

For example, of the 45,000 compounds tested in the ground water in the vicinity of foundry landfills in Wisconsin, none was found to be above 1 μg/L (ppb).[12] Several contaminants were found in trace quantities at less than 1 ppb in laboratory leachate tests, with the phenolic urethane and the phenolic isocyanate binder systems contributing the highest organic compound content, but no contaminants exceeded EPA drinking water standards. In aluminum foundries, which cast at a lower temperature, less of the organic binder is burned off, increasing the potential for residual organic contaminants to be present in the sand.

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[8] Winkler and Bolshakov 2000.

[9] Winkler and Bolshakov reviewed studies of different leachate tests, including the following: (1) field leachate from landfills or sand reuse projects; (2) TCLP; and (3) EP [extraction procedure]. Both TCLP and EP are acetic acid extractions, but the TCLP extraction is performed at a lower pH, which tends to lead to higher extraction values.

[10] In some cases, starches and sea coal are added to green sands, which can lead to production of polycyclic aromatic hydrocarbons upon heating.

[11] In recent years, foundries have made efforts to reduce the use of these elements in their binder systems.

[12] As reported in Winkler and Bolshakov 2000.

Exhibit 2-1

PRIMARY ORGANIC COMPOUNDS FOUND IN FOUNDRY SAND CORES

Acetone[1]	Formaldehyde[2]
Benzene[1]	Isopropylbenzene[1]
2-chlorophenol[2]	1- and 2-Methylnaphthalene[1,2]
m/p-Cresol[2]	Naphthalene[1]
1,2-Dichlorobenzene[2]	Phenol[2]
1,4-Dichlorobenzene[2]	Tetrachloroethane[2]
Diethylbenzenes[1]	Toluene[2]
Dimethylnaphthalenes[1]	1,1,1-Trichloroethane[1]
2,4-Dimethylphenol[2]	1,2,4-Trimethylbenzene[1]
Ethylbenzene[2]	1,3,5-Trimethylphenol[2]
p-Ethyltoluene[1]	Xylenes[1,2]

Sources:
[1] Winkler and Bolshakov, "Characterization of Foundry Sand Waste," October 2000. Chelsea Center for Recycling and Economic Development, University of Massachusetts at Lowell.
[2] Michigan Department of Environmental Quality test results, Duane Roskoskey, October 2002.

3.0 REGULATORY ENVIRONMENT FOR REUSE OF INDUSTRIAL WASTE

EPA estimates that 7.6 billion tons of non-hazardous industrial waste are generated and disposed of annually in the U.S.[13] Promoting recycling is a stated priority for EPA's Office of Solid Waste and Emergency Response for Fiscal Year 2003.[14] Accordingly, EPA is emphasizing the importance of waste reduction and more efficient and sustainable use of resources. Looking to the future, the Agency anticipates that "many materials that are now considered wastes will instead be used to produce new materials and products. As this shift happens, it is likely that current distinctions between wastes and materials (which are in large part regulatory in nature) will become less meaningful. This could argue for government policies that more effectively promote, and reduce unnecessary regulatory constraints on, more efficient use of these materials."[15] For the foundry industry, such policies would translate into the development of regulatory approaches that encourage increased beneficial reuse of foundry sand. Although states play a primary role in establishing industrial waste regulations and guidance, there is a role for EPA to provide coordination and assistance at the national level to help achieve such a shift in waste management policy.

The anticipated shift in waste and materials management, along with opportunities for more effective regulatory approaches, suggests that the timing is well suited for stakeholders to focus on industrial waste reuse generally, and foundry sand reuse specifically. Because the majority of used foundry sand is considered non-hazardous industrial waste, it is important for foundries and end users of this material to understand existing state approaches to regulating waste reuse as they search for viable reuse opportunities. In addition, looking across different industrial waste reuse programs can highlight regulations or requirements that are particularly

[13] U.S. EPA. http://www.epa.gov/industrialwaste/, updated 6/24/02, as viewed July 9, 2002.

[14] U.S. EPA. http://www.epa.gov/swerrims/Mission.htm, as viewed July 9, 2002.

[15] U.S. EPA. "Beyond RCRA: Prospects for Waste and Materials Management in the Year 2020, A Draft White Paper," February 2001, p. 8.

informative, even transferable, to states wishing to refine their regulatory approaches to encourage increased reuse of industrial by-products.

This chapter provides a framework for understanding approaches used by states to regulate non-hazardous industrial solid waste reuse. It presents an overview of industrial waste reuse programs in 18 different states. The criteria used in selecting these states included:

- States with the largest number of foundries (and, thus, of greatest relevance to this effort, since they represent the greatest potential for reuse of foundry sands).

- States with active industrial waste reuse programs (although many more states than those included in this review have active industrial waste programs).

- States that have developed guidance specific to the beneficial reuse of foundry sand or have actively worked with the foundry industry on this issue.

This combination of criteria, along with previous knowledge of certain state programs and suggestions from participants in the Metal Casting Industry Performance Partnership, led EPA to focus on the states listed in Exhibit 3-1.

Exhibit 3-1

STATES SELECTED FOR REVIEW OF INDUSTRIAL WASTE REUSE REGULATIONS

• Alabama	• Maine	• Pennsylvania
• California	• Massachusetts	• Rhode Island
• Illinois	• Michigan	• Tennessee
• Indiana	• Minnesota	• Texas
• Iowa	• New York	• West Virginia
• Louisiana	• Ohio	• Wisconsin

3.1 FEATURES OF INDUSTRIAL WASTE REUSE PROGRAMS

The underlying concept of all the state reuse programs reviewed is to ensure the protection of human health and the environment by identifying and minimizing potential risks of reusing industrial wastes. This goal is accomplished through one or more of the following approaches: requiring risk assessments for each proposed reuse project; developing general concentration thresholds (both for leachate from the industrial waste and for contaminants in the waste itself) applicable to specific reuses; and implementing other requirements designed to prevent an unacceptable level of risk, such as restrictions on the siting of reuse projects and sampling and testing, notification, and reporting requirements.

The rules and guidance for industrial waste reuse vary significantly across the states reviewed. Some states have a single set of requirements for all industrial by-products or wastes, while others have developed specific regulatory requirements for individual types of industrial wastes (e.g., foundry sand, waste tires, fly ash). Of the 18 state programs described in this report, 11 states rely on requirements established for industrial solid wastes generally. The remaining seven specifically address the beneficial reuse of foundry sand in their rules or policies. (These programs are discussed in greater detail in Chapter 4.)

Exhibits 3-2 and 3-3 summarize the characteristics of state industrial waste reuse programs. Exhibit 3-2 indicates whether the state programs reviewed are general or specific to foundries, and focuses on their sampling requirements, constituent concentration thresholds, waste classification categories, and authorization processes. Exhibit 3-3 presents information on program requirements for siting and for frequency of industrial waste sampling and testing. Detailed descriptions of the state programs are presented in Appendix A.

3.1.1 Initial Sampling and Testing Requirements

All 18 states require an initial characterization of the industrial waste demonstrating that it qualifies as non-hazardous. This characterization typically involves a leachate test, with TCLP being the most frequently specified test. Five of the states (Louisiana, Maine, Pennsylvania, West Virginia, and Wisconsin) also require an analysis of the composition of the waste itself (totals analysis). In addition, a sampling and analysis plan (SAP) consistent with EPA's *Test Methods for Evaluating Solid Waste*, SW-846, is explicitly required by five states - Indiana, Maine, Michigan, Pennsylvania, and West Virginia - although several others require elements of an SAP.[16]

3.1.2 Constituent Concentration Thresholds

As Exhibit 3-2 illustrates, all but three of the states reviewed have developed concentration thresholds to which the initial testing results must be compared. Those states without established thresholds (Louisiana[17], Massachusetts, and Rhode Island), use the testing results as a starting point for evaluating the potential risks of an industrial waste reuse project.

[16] U.S. EPA, *Test Methods for Evaluating Solid Waste*, Document Number SW-846, Chapter Nine. EPA periodically updates sections of SW-846; an up-to-date version can be found at http://www.epa.gov/epaoswer/hazwaste/test/sw846.htm.

[17] Louisiana has no leachate thresholds, but does have allowable lifetime metal loadings (lbs./acre).

Exhibit 3-2

CHARACTERISTICS OF STATE INDUSTRIAL WASTE REUSE PROGRAMS

	Scope of Program	Testing Methods Required*	Individual Constituent Thresholds?	Basis of Leachate Thresholds (DWS, State DWS, RCRA) **	Waste Classification Categories?	Streamlined Authorization Process***
AL	General	TCLP	Yes	50 % of RCRA TC Levels	No	Prior Notice
CA	General	TCLP	Yes	RCRA TC Levels	No	--
IL	Foundry	TCLP	Yes	DWS	Yes (only 1 reuse category)	Prior Notice; Waste Exemption
IN	Foundry	TCLP	Yes	Variable % of RCRA TC Levels	Yes	Prior Notice; Waste Exemption
IA	Foundry/ Fly Ash	TCLP	Yes	90% of RCRA TC Levels	No	Waste Exemption
LA	General	TCLP, Totals	No#	--	Yes	General Permit
MA	General	TCLP, others##	No	--	No	--
ME	General	TCLP, Totals	Yes	Not specified	No	General Permit
MI	General	TCLP	Yes	10% of RCRA TC Levels†	Yes	--
MN	General	TCLP	Yes	RCRA TC Levels	No	--
NY	General	TCLP	Yes	RCRA TC Levels	No	--
OH	Foundry	TCLP	Yes	Up to 30x State DWS	Yes	Prior Notice; Waste Exemption
PA	General	TCLP, Totals	Yes	Variable % of RCRA TC Levels	No	General Permit
RI	General	Unspecified leachate, others††	No	--	No	--
TN	Foundry	TCLP	Yes	10x DWS	No	Prior Notice; Waste Exemption
TX	General	TCLP, other†††	Yes	Unknown	Yes	Prior Notice
WV	General	TCLP, Totals	Yes	DWS	No	--
WI	Foundry/ Fly Ash	TCLP, Totals	Yes	Variable multiple of DWS	Yes	Prior Notice; Waste Exemption

* TCLP: Toxicity Characteristic Leaching Procedure
Totals: Totals analysis to determine waste composition

** DWS: Federal Drinking Water Standards
RCRA TC Levels: Resource Conservation and Recovery Act Toxicity Characteristic threshold concentrations

*** Some states have developed streamlined authorization procedures for specific types of waste and reuses. These include:
Waste exemption – material is exempt from non-hazardous industrial waste regulations and can be freely reused.
Prior notification required for reuse – in some cases prior notice is combined with a requirement for some degree of review and approval.
General permits – these permits may be issued authorizing a particular type of reuse for qualified applicants.

Louisiana has no leachate thresholds, but does have allowable lifetime metal loadings (lbs./acre).

In Massachusetts, requirements for additional tests depend on the specific situation.

† This basis applies to incorporation of waste into asphalt or concrete. Michigan applies a one in one million risk factor for uncontrolled uses.

†† Rhode Island requires representative waste characterization, including physical and chemical analyses, but does not specify testing methods.

††† Seven-day distilled leachate test required for some class definitions.

Exhibit 3-3

OTHER REQUIREMENTS OF STATE INDUSTRIAL WASTE REUSE PROGRAMS

	Siting Requirement Considerations									Waste Sampling and Testing Frequency
	Potable Wells	Ground Water	Surface Water	Wetlands	Floodplain	Soil Type	Critical Habitat	Residential	Other	
AL				X	X			X	a	4 times per year
CA	----------Not Applicable----------									Not specified
IL	----------Not Applicable----------									Every year
IN				X	X		X		b	Every 2-5 years
IA	----------Not Applicable----------									4 times per year to every year
LA	X	X	X	X	X	X	X		c	Every year
ME	X	X	X	X			X			Not specified
MA	----------Not Applicable----------									Not specified
MI	----------Not Applicable----------									Every year
MN		X	X	X	X	X		X	b,d	Not specified
NY	----------Not Applicable----------									Variable
OH	X		X	X	X			X	e	Every year
PA	X	X	X	X						Every year
RI	----------Not Applicable----------									Every year
TN	X	X	X		X	X				Every 2 years
TX	----------Not Applicable----------									Not specified
WV		X	X		X	X				Every year
WI		X	X	X			X		d	Every 1-5 years

a. Less than 5 feet above an aquifer
b. Karst topography
c. Sensitive ecologic areas within 1,000 ft
d. Air emissions
e. Leach field

3.1.3 Waste Classification Categories

Seven of the state programs reviewed have created waste classification categories in an effort to encourage beneficial reuse. These categories are defined by ranges of contaminant thresholds for specific reuses and/or waste types. The underlying logic is that reuse projects involving "cleaner" wastes, smaller volumes of waste, and activities that are less "risky" should have fewer restrictions placed on them. For example, there are fewer restrictions on using an industrial waste for manufacturing another product, which has a very low potential for causing adverse environmental impacts, than on applying waste to agricultural soils.

States face trade-offs in deciding whether to establish a waste reuse classification system. While a classification system requires an up-front investment of resources on the part of regulators, it can streamline the process for reviewing and authorizing reuse projects. And while states that do not develop a classification system retain a higher degree of control in evaluating each beneficial reuse project on its own merits, each reuse activity or project will likely require

additional state resources to determine whether the proposed reuse of material from a specific facility is appropriate.

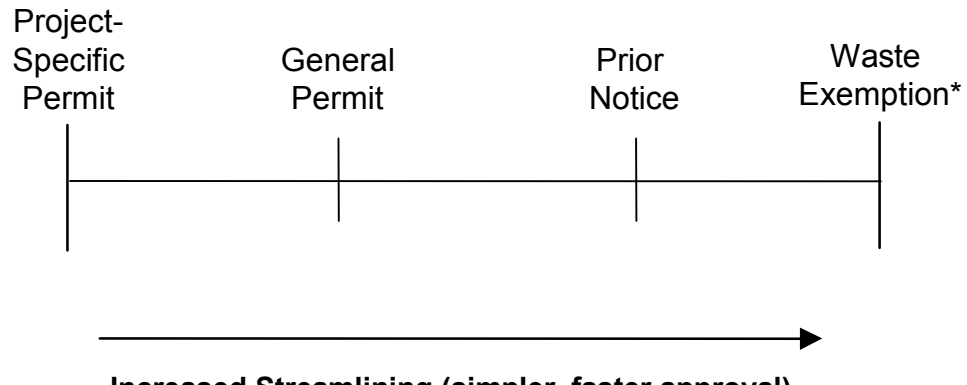
3.1.4 Authorization Process for Reuses

States use a variety of approaches for approving reuse of non-hazardous industrial waste. A key distinguishing factor across state programs is the extent to which they provide streamlined authorization processes, which can greatly reduce the effort required for a foundry and an end user to initiate and sustain a reuse project. Streamlined processes allow for other than case-by-case review of proposed reuses, thereby simplifying standardizing the review process, which can lead to a shorter and more predictable timeline for project approval. They also can lead to improved and more transparent decision-making by providing clear criteria for determining appropriate reuses.

Ten of the state programs reviewed have codified specific standards that define streamlined procedures, depending on the reuse activity, volume of waste to be reused, and contaminant concentrations present in the waste. These procedures range from general permitting to exempting wastes meeting strict criteria from industrial waste regulations. Specific streamlined procedures available in individual states are summarized above in Exhibit 3-2 (see far right column). The full spectrum of state approaches to project authorization is illustrated in Exhibit 3-4 and examples of these approaches are cited in Exhibit 3-5.

Exhibit 3-4

OPTIONS FOR STREAMLINING THE AUTHORIZATION PROCESS



* Exemption from classification as an industrial waste.

Exhibit 3-5

EXAMPLES OF TECHNIQUES FOR STREAMLINING THE AUTHORIZATION PROCESS

State	Authority	Website	Description
Waste Exemption			
Illinois	35 Illinois Administrative Code Part 817 – Requirements for New Steel and Foundry Industry Wastes Landfills	http://www.ipcb.state.il.us/Title_35 / main.htm	Sand meeting the leachate concentration thresholds can be reused without notifying the state (unless the sand is reused in land applications).
Tennessee	Beneficial Use of Nontoxic Spent Foundry Sand - Policy	http://www.state.tn.us/environment /swm/SWPolicyManual.pdf	Sand from iron and aluminum foundries meeting leachate concentration thresholds can be reused in certain uses without review or notification from the state, although the foundry must maintain project records on-site.
Prior Notice			
Alabama	Chapter 335-13-4.26(3) (Permit Requirements for Disposal of Foundry Wastes)	http://www.adem.state.al.us/Regulations/regulations.htm	Prior to reuse, an applicant must "certify" the foundry waste by submitting a completed Solid/Hazardous Waste Determination Form and a TCLP analysis for metals. No response or approval from the state is required.
Indiana	Foundry Sand Waste Classification Guidelines	http://www.in.gov/idem/land/pubsforms/guidance.html	Once the state has classified foundry sand as Type III or Type IV based on TCLP or totals testing, no additional state approval is required prior to reuse.
General Permit			
Louisiana	Title 33, Environmental Quality Part VII, Solid Waste, Subpart 1, Chapter 11, Section 1103 (C).	http://www.deq.state.la.us/planning /regs/ title33/index.htm	Land application only: "The administrative authority may issue a single beneficial-use permit for multiple beneficial-use locations provided that the permit application includes required information for each location, each location meets the standards provided in this Chapter, and the same solid waste stream (from a single generation site) is disposed of at all locations. The multiple locations will be considered as one facility and each location will be a unit of the facility."
Pennsylvania	Regulation: Chapter 287 of the Pennsylvania Code, Residual Waste Management - General Provisions General Permits relevant to foundry sand: WMGR016, WMGR019, WMGR021.	http://www.pacode.com/secure/data /025/chapter287/chap287toc.html http://www.dep.state.pa.us/dep/deputate/airwaste/wm/MRW/docs/ GP_BU_PERMITS.htm	"*General permit*—A regional or Statewide permit issued by the Department for a specified category of beneficial use or processing of solid waste, the terms and conditions of which allow an original applicant, a registrant and person or municipality that obtains a determination of applicability, to operate under the permit if the terms and conditions of the permit and certain requirements of this article are met."

Waste Exemption

The most streamlined procedure is to grant an exemption from non-hazardous industrial waste management requirements when the material meets specified, stringent thresholds. Indiana and Iowa both exempt waste from notification requirements if it is certified to meet state reuse standards and is being used in a listed, state-approved activity.

Several states provide an exemption under more limited conditions. For example, in Ohio industrial waste material can be reused to manufacture another product without prior notification if it meets leachate thresholds equivalent to 30 times the state drinking water standards (DWS). To be reused in construction of roads and parking lots, though, the waste must meet leachate thresholds equivalent to five times the state DWS. In Wisconsin, wastes meeting specific thresholds are exempt from notification for a single reuse category – manufacturing another product.

Prior Notice

Many states have streamlined authorization procedures for industrial waste reuse that allow projects to proceed with only prior notification. In Ohio, prior notification is required for all transportation embankment projects, with certain large projects also requiring a degree of departmental review and approval.[18] Illinois and Alabama both require notification of any reuses on their approved lists, with Alabama also requiring departmental approval.

General Permits

States also issue general permits that allow multiple qualified applicants to engage in particular reuses. States implement this approach in several different ways. For example, Pennsylvania issues general permits that cover a particular reuse; any producer of waste material meeting the specified thresholds can apply to join the permit. Maine issues general permits that allow end users to receive by-products from generators without additional approval from the State. In Louisiana, most approvals are on a case-by-case basis, but permits can be issued for a specific reuse of waste material from multiple sources at multiple locations.

3.1.5 Other Common Requirements

In addition to the initial characterization of the waste, states frequently include siting and/or sampling and testing requirements in their programs to ensure that industrial waste reuse will be safe (see Exhibit 3-3).

[18] For projects in Ohio involving reuse of foundry sand and bottom ash, there is no need for prior notice if leach tests of the material consistently meet Ohio drinking water standards. However, facilities are required to submit project summaries to Ohio EPA.

Siting Requirements

Ten states place restrictions on the location of industrial waste reuse projects, such as minimum distance from ground-water, surface-water, and drinking-water sources; floodplains and wetlands; protected ecological and environmentally sensitive areas; and property fencelines.

Sampling and Testing Requirements

All state programs reviewed have requirements for the frequency of waste sampling and testing. These requirements can include follow-up sampling and testing to confirm that the waste's composition has not changed. This sampling may be conducted annually or if the process generating the waste changes. Typically, state programs also have requirements for notifying the relevant state agency of the reuse activity (*e.g.*, prior to initiating reuse project, annual reports of project status and conditions, and updates following any changes to the reuse process). There also may be requirements for notifying the public.

4.0 TAILORED REGULATION OF SAND REUSE

With costs for landfilling used sand typically ranging from $10 to $50 per ton in tipping fees plus transportation costs, foundries have a significant financial incentive to pursue alternatives to landfill disposal. States are also motivated to stretch their limited resources by streamlining the authorization process for reuses. For example, developing clear requirements for collecting, preparing, and submitting data can improve the quality of documentation that supports proposed reuses and reduce the need for follow-up submissions. In addition, some programs allow sand that meets stringent concentration thresholds to be reused without pre-approval from the state. In some cases programs even provide exemptions from the industrial waste regulations for qualifying sand (see discussion of streamlined authorization in Chapter 3). Of the 18 state programs EPA reviewed, seven have guidance or regulations specific to beneficial foundry sand reuse, including Illinois, Indiana, Iowa, Ohio, Tennessee, West Virginia, and Wisconsin.

While states' approaches to regulating foundry sand reuse are similar to those used for regulating industrial waste reuse in general, sand reuse programs specifically consider the characteristics of foundries and used sand, and the likely reuses. The many binders, curing processes, raw materials, and metals used in the casting process all affect the composition of foundry sand. The variation in sand composition across foundries poses a challenge in devising guidelines and/or regulations that provide for environmentally safe sand reuse. States have strived to tailor foundry sand reuse requirements by emphasizing areas of concern (such as particular metals and binder types used by foundries) and addressing likely reuse scenarios.

4.1 STATE APPROACHES TO REGULATING SAND REUSE

The set of regulatory tools selected by a given state reflects the trade-offs inherent in balancing the desire to encourage sand reuse with the need to protect human health and the environment. It is important to look beyond differences in a single program feature, such as leachate thresholds, and examine the full set of program requirements for sand reuse across states. Three major approaches to reviewing programs and policies are available to states wishing to amend an existing program or establish a new one.

4.1.1 Addressing Different Types of Foundries and Foundry Sand

Certain foundry operations and sand types are more likely to cause environmental concern than others. States vary in how they choose to address these. For example, Iowa's regulations address reuse of all types of sand; Tennessee's address reuse of sand from ferrous and aluminum foundries; and Wisconsin's address reuse of sand from ferrous foundries.

4.1.2 Combining Concentration Thresholds and Other Regulatory Requirements

States combine concentration thresholds and other regulatory requirements in a variety of ways to ensure that sand reuse is environmentally safe. For example, while leachate concentration thresholds in Illinois are among the most stringent, wastes meeting these thresholds are then exempt from industrial waste management requirements and can be reused in any way without regulatory oversight. Tennessee's leachate concentration thresholds are less stringent than Illinois', but applicants must submit reuse reports every two years and, in some cases, undergo a project review by the state. Wisconsin has less stringent leachate concentration thresholds than Tennessee, but requires both additional testing and annual reuse certification.

4.1.3 Balancing Allowable Reuses and Regulatory Requirements

In developing programs, states strike a balance between the potential risks associated with a reuse and the stringency of regulatory requirements. For example, reuse of sand in a "less-risky" activity, such as manufacturing another product, is commensurate with a reduced regulatory burden for the applicant. Similarly, meeting more stringent regulatory requirements, such as lower concentration thresholds and more frequent sampling and testing of sand, will create a wider range of reuse possibilities, in terms of both the types of reuse and the volume of sand that may be used in a project.

4.2 COMPARISON OF STATE REQUIREMENTS FOR SPECIFIC REUSES

Comparing requirements for specific reuses of foundry sand provides additional insight into the approaches adopted by states. The following section presents requirements for the four broad categories of reuses across the seven states with programs that specifically address foundry sand reuse:[19] (1) manufacturing another product, (2) structural fill, (3) pipe bedding and backfill, and (4) soil manufacturing, soil amendments, land applications, and composting.

[19] Regulatory requirements across states for a fifth reuse category – landfill uses – are not included in this comparison because states generally require only that the sand be non-hazardous, and some states do not consider landfill applications as "beneficial reuse."

4.2.1 Reuse in Manufacturing Another Product

Description

In general, states define the beneficial reuse of foundry sands as a raw material in the manufacture of another product to include the following products:

- asphalt;
- bricks;
- cement;
- concrete block;
- flowable fill;
- grout; and
- lightweight aggregate.

Regulatory Requirements

Of all reuses, manufacture of another product is the most inert and poses the least environmental risk; consequently, it is one of the least stringently regulated reuses. As shown in Exhibit 4-1, in several states the foundry sand need only qualify as non-hazardous (e.g., meet RCRA toxicity characteristic (TC) levels using TCLP - Wisconsin) or marginally non-hazardous (90 percent of RCRA TC levels - Iowa). However, in most states the maximum allowable leachate concentration for constituents of concern ranges from values equivalent to federal drinking water standards to 30 times these values.

The process of obtaining approval for this type of reuse varies across states. For example, Iowa, Ohio, and Tennessee do not require the foundry to provide notification or seek agency review/approval prior to the start of the reuse project, so long as the sand meets the established concentration thresholds. However, in West Virginia, foundries must submit a Beneficial Use Plan and gain agency approval prior to reuse.

Exhibit 4-1

REUSING FOUNDRY SAND AS A RAW MATERIAL IN MANUFACTURING ANOTHER PRODUCT – COMPARISON OF MAXIMUM ALLOWABLE LEACHATE CONCENTRATIONS (in mg/L) AND OTHER REQUIREMENTS

CONSTITUENT THRESHOLDS							
RCRA METALS	**IL***	**IN***	**IA***	**OH**	**TN**	**WV**	**WI***
Arsenic	0.05	0.50	4.5	1.5	-	0.05	5.0
Barium	2.0	10.0	90.0	60.00	20.00	1.0	100
Cadmium	0.005	0.10	0.90	0.15	0.05	0.01	1.0
Chromium, Total	0.1	0.50	4.5	3.0	1.00	0.05	5.0
Lead	0.0075	0.50	4.5	1.5	0.50	0.05	5.0
Mercury	-	0.02	0.18	0.06	0.02	0.002	0.2
Selenium	0.05	0.10	0.90	1.00	0.50	0.01	1.0
Silver	-	0.50	4.5	-	-	0.05	5.0
OTHER CONSTITUENTS							
Benzene	0.005	-	0.45	-	-	-	0.5
Chloride	250.0	250	-	-	-	-	-
Copper	5.0	2.5	-	-	13.00	1,500 (totals limit)	-
Cyanide (Total)	-	0.20	-	0.60	2.00	0.60	-
Fluoride	4.0	-	-	12.0	-	12	-
Formaldehyde	-	-	-	-	300.0 (totals limit)	-	-
Iron	5.0	1.5	-	-	-	-	3.0
Manganese	0.15	0.05	-	-	-	-	-
Molybdenum	-	-	-	-	-	18 (totals limit)	-
Nickel	-	0.20	-	-	1.0	200 (totals limit)	-
Nitrate	10.0	-	-	-	-	-	-
Phenols (Total)	-	0.30	-	10.5	15.00	10.5	-
pH	-	6.0-9.0	5.0-10.0	-	-	-	-
Sodium	-	2,500	-	-	-	-	-
Sulfates	400.0	2,500	-	-	-	-	-
Sulfide (Total)	-	5.0	-	-	-	-	-
Zinc	5.0	2.5	-	-	-	2,800 (totals limit)	-
Basis for Thresholds	U.S. DWS	10% of RCRA TC levels	90% of RCRA TC levels	30x Ohio DWS	10x U.S. DWS	1% of RCRA TC levels	RCRA TC levels
OTHER REQUIREMENTS							
Monitoring Frequency for Sand	Annually	Every 2 - 5 years	Quarterly – Annually	Annually	Every 2 years	Annually	Every 1 - 5 years
Submission of Regular Reports	For each project	No	On-site records	On-site records	On-site records	No	Yes
Siting Requirements	N/A	Floodplain, Wetlands, Critical Habitat	N/A	SW, Potable Wells, Wetlands, Leachfields	GW, SW, Floodplain, Certain Soil Types, Potable Wells	GW, SW, Floodplain, Certain Soil Types	GW, SW, Wetlands, Critical Habitat

Notes:
* IN, IL, IA, and WI have concentration limits for additional constituents.
IN – The maximum allowable concentrations apply to Type IV waste classification.
WI – TCLP limits are Category V thresholds.
WV – based some of its thresholds on Ohio's Policy 400.007.
RCRA TC: RCRA Toxicity Characteristic thresholds. RCRA TC thresholds are approximately equivalent to 50 - 200 times federal drinking water standards (DWS); DWS are approximately equivalent to 0.5 – 2.0 percent of RCRA TC thresholds.
GW: Ground water
SW: Surface water

4.2.2 Reuse as Structural Fill

Description

Structural fill is one of the most common beneficial reuses of sand specified in the state programs reviewed. States tend to define structural fill in engineering terms, such as building or equipment supportive base or foundation, foundation backfill, road base, and sub-base. Illinois and Iowa do not use the general term "structural fill," but rather identify several specific uses considered to be "structural fill."

Regulatory Requirements

As shown in Exhibit 4-2, the constituent concentration requirements for reuse as structural fill are generally equivalent to those for reuse in manufacturing another product. However, Wisconsin requires that foundry sand meet Category 4 standards for reuse as structural fill, while the less stringent thresholds for Category 5 apply for reuse in manufacturing another product. In Ohio, foundry sand must meet more stringent leachate thresholds (ranging from the Ohio drinking water standards to 20 times these standards) to qualify for use as structural fill, compared to 30 times the Ohio drinking water standards for use as a raw material in manufacturing another product.

Reuse of sand as structural fill also tends to require a more intensive application/approval process. For example, Iowa requires foundries to obtain approval for use of sand in structural fill projects but not for manufacturing another product. Similarly, Tennessee requires review and notification prior to use in structural fill but not for use in manufacturing another product.

Exhibit 4-2

REUSING FOUNDRY SAND AS STRUCTURAL FILL - COMPARISON OF MAXIMUM ALLOWABLE LEACHATE CONCENTRATIONS (in mg/L) AND OTHER REQUIREMENTS

CONSTITUENT THRESHOLDS							
RCRA METALS	**IL***	**IN***	**IA***	**OH**	**TN**	**WV**	**WI***
Arsenic	0.05	0.50	4.5	1.0	-	0.05	-
Barium	2.0	10.0	90.0	40.00	20.00	1.0	10.0
Cadmium	0.005	0.10	0.90	0.1	0.05	0.01	0.025
Chromium, Total	0.1	0.50	4.5	2.0	1.00	0.05	-
Lead	0.0075	0.50	4.5	1.0	0.50	0.05	0.075
Mercury	-	0.02	0.18	0.04	0.02	0.002	0.01
Selenium	0.05	0.10	0.90	1.00	0.50	0.01	-
Silver	-	0.50	4.5	-	-	0.05	-
OTHER CONSTITUENTS							
Benzene	0.005	-	0.45	-	-	-	-
Chloride	250.0	250	-	-	-	-	-
Copper	5.0	2.5	-	-	13.00	1,500 (totals limit)	-
Cyanide (Total)	-	0.20	-	0.40	2.00	0.60	-
Fluoride	4.0	-	-	8.0	-	12	-
Formaldehyde	-	-	-	-	300.0	-	-
Iron	5.0	1.5	-	-	-	-	3.0
Manganese	0.15	0.05	-	-	-	-	-
Molybdenum	-	-	-	-	-	18 (totals limit)	-
Nickel	-	0.20	-	-	1.0	200 (totals limit)	-
Nitrate	10.0	-	-	-	-	-	-
Phenols (Total)	-	0.30	-	7.0	15.00	10.5	-
pH	-	6.0-9.0	5.0-10.0	-	-	-	-
Sodium	-	2,500	-	-	-	-	-
Sulfates	400.0	2,500	-	-	-	-	-
Sulfide (Total)	-	5.0	-	-	-	-	-
Zinc	5.0	2.5	-	-	-	2,800 (totals limit)	-
Basis for Thresholds	U.S. DWS	10% of RCRA TC levels	90% of RCRA TC levels	Ohio DWS to 20x Ohio DWS	10x U.S. DWS	1% of RCRA TC levels	RCRA TC levels
OTHER REQUIREMENTS							
Monitoring Frequency for Sand	Annually	Every 2 - 5 years	Quarterly – Annually	Annually	Every 2 years	Annually	Every 1 - 5 years
Submission of Regular Reports	For each project	No	On-site records	On-site records	On-site records	No	Yes
Siting Requirements	N/A	Floodplain, Wetlands, Critical Habitat	N/A	SW, Potable Wells, Wetlands, Leachfields	GW, SW, Floodplain, Certain Soil Types, Potable Wells	GW, SW, Floodplain, Certain Soil Types	GW, SW, Wetlands, Critical Habitat

Notes:
***** IN, IL, IA, and WI have concentration limits for additional constituents.
IN – The concentration limits apply to Type IV waste classification.
OH – Maximum allowable concentrations and other requirements (e.g., reporting) vary according to the volume of foundry sand that is used in the project.
WI – TCLP limits are Category 4 thresholds.

4.2.3 Reuse as Backfill and Pipe Bedding

Description

Backfill and pipe bedding are unencapsulated fill, but specific definitions vary across the seven states. Ohio allows foundry sand to be used as pipe bedding or as fill for "empty borrow pits created during road construction or other construction activities." Tennessee allows foundry sand to be used as fill in "abandoned or closed mines or strip mine areas." Wisconsin's guidance broadly defines unencapsulated fill as "unconfined geotechnical fill material." It includes fill "as part of the construction of a building, parking area, utility trench, or other structural improvement, where the industrial by-product is not structurally confined."

Regulatory Requirements

Compared to the previous two uses, Ohio and Wisconsin have more stringent concentration thresholds for backfill. The other five states have the same thresholds for most uses, including backfill. In Ohio, foundry sand must meet 20 times the Ohio drinking water standards, at a minimum, and may be required to meet a lower threshold (the Ohio drinking water standards or five times the standards), depending on the specific project characteristics. In Wisconsin, the used sand must meet at least Category 3 standards, which are substantially more stringent than the Category 5 standards established for using sand in manufacturing another product.[20] In addition, to classify as Category 3, foundry sand must meet thresholds for three additional constituents (aluminum, antimony, and beryllium). In Illinois and Indiana, all foundry sand meeting the established concentration thresholds is exempt from state regulations and can be reused in any manner. Tennessee requires review and notification prior to use. Exhibit 4-3 summarizes the regulatory requirements applicable for use as backfill.

[20] Wisconsin uses five categories of waste, with Category 1 having the most stringent requirements and Category 5 having the least stringent.

Exhibit 4-3

REUSING FOUNDRY SAND AS BACKFILL – COMPARISON ACROSS STATES OF MAXIMUM ALLOWABLE LEACHATE CONCENTRATIONS (in mg/L) AND OTHER REQUIREMENTS

CONSTITUENT THRESHOLDS							
RCRA METALS	**IL***	**IN***	**IA***	**OH**	**TN**	**WV**	**WI***
Arsenic	0.05	0.5	4.5	1.0	-	0.05	0.05
Barium	2.0	10.0	90.0	40.0	20.00	1.0	4.0
Cadmium	0.005	0.10	0.90	0.10	0.05	0.01	0.005
Chromium, Total	0.1	0.50	4.5	2.0	1.00	0.05	0.10
Lead	0.0075	0.50	4.5	-	0.50	0.05	0.015
Mercury	-	0.02	0.18	0.04	0.02	0.002	0.002
Selenium	0.05	0.10	0.90	1.0	0.50	0.01	0.10
Silver	-	0.50	4.5	-	-	0.05	-
OTHER CONSTITUENTS							
Benzene	0.005	-	0.45	0.10	-	-	-
Chloride	250.0	250	-	-	-	-	-
Copper	5.0	2.5	-	-	13.00	1,500 (totals limit)	-
Cyanide (Total)	-	0.20	-	0.40	2.00	0.60	-
Fluoride	4.0	-	-	8.0	-	12	8.0
Formaldehyde	-	-	-	-	300.0	-	-
Iron	5.0	1.5	-	-	-	-	1.50
Manganese	0.15	0.05	-	-	-	-	0.25
Molybdenum	-	-	-	-	-	18 (totals limit)	-
Nickel	-	0.20	-		1.0	200 (totals limit)	-
Nitrate	10.0	-	-	200.0	-	-	-
Phenols (Total)	-	0.30	-	7.0	15.00	10.5	12.0
pH	-	6.0-9.0	5.0-10.0	-	-	-	-
Sodium	-	2,500	-	-	-	-	-
Sulfates	400.0	2,500	-	-	-	-	-
Sulfide (Total)	-	5.0	-	-	-	-	-
Zinc	5.0	2.5	-	-	-	2,800 (totals limit)	-
Basis for Thresholds	U.S. DWS	10% of RCRA TC levels	90% of RCRA TC levels	Ohio DWS to 20x Ohio DWS	10x U.S. DWS	1% of RCRA TC levels	U.S. DWS to 2x U.S. DWS
OTHER REQUIREMENTS							
Monitoring Frequency for Sand	Annually	Every 2 - 5 years	Quarterly – Annually	Annually	Every 2 years	Annually	Every 1 - 5 years
Submission of Regular Reports	For each project	No	On-site records	On-site records	On-site records	No	Yes
Siting Requirements	N/A	Floodplain, Wetlands, Critical Habitat	N/A	SW, Potable Wells, Wetlands, Leachfields	GW, SW, Floodplain, Certain Soil Types, Potable Wells	GW, SW, Floodplain, Certain Soil Types	GW, SW, Wetlands, Critical Habitat

Notes:
***** IN, IL, IA, and WI have concentration limits for other constituents.
OH- Category 2 waste is the least stringent category in which foundry sand used for this application may fall.
WI- Concentration thresholds based on Category 3 requirements.

4.2.4 Reuse in Soil Blending, Land Applications, and Composting

Description

This category includes the following four related uses: soil blending ingredient, soil amendment, direct surface or subsurface application to land, and composting. These uses serve to improve the characteristics and performance of agricultural or horticultural soil. They involve mixing sand with soil prior to being applied, or direct application to land.

Regulatory Requirements

As shown in Exhibit 4-4, these reuses typically have the most stringent state requirements. Although four of the seven states do not explicitly allow land application and soil blending, facilities can seek state approval for these and other beneficial reuses by applying for a waiver or by proposing a reuse project for review. Following are the beneficial reuses specifically addressed by three states:

- ***Soil blending.*** Only **Ohio** specifies the beneficial reuse of foundry sand as an ingredient in commercial soil blending. Under the Ohio policy, the sand may constitute no more than 50 percent of the mixture, and the blended soil may be used only for growth of trees or ornamentals (excluding sod farms).[21] The mixture may not be used for growth of crops intended for human consumption. Thus, it may not be applied to grazed pastures, to home fruit/vegetable gardens, or to agricultural crops or fruit trees.

- ***Soil amendment.*** **Indiana** is the only state that identifies this beneficial reuse of foundry sand. The state defines "soil amendment" as "foundry sand that has been mixed with one or more other materials to form a product, which could then be sold, re-mixed, applied to land, or otherwise used as soil or as soil substitute…" Unlike Ohio, Indiana does not limit the volume of sand that may be incorporated into agricultural or horticultural soils.

- ***Land application.*** Only **Indiana** specifically allows direct surface and/or subsurface application of foundry sand to land. The sand must be evenly applied on lands intended for agricultural and/or horticultural use.

- ***Composting.*** **Ohio** and **Tennessee** allow this reuse, but not use as a post-composting additive or in land application.

[21] Permits for unrestricted use in soil blending can be obtained in Ohio on a case-by-case basis.

Exhibit 4-4

REUSING FOUNDRY SAND FOR SOIL BLENDING, LAND APPLICATIONS, AND IN COMPOSTING - COMPARISON ACROSS STATES OF MAXIMUM ALLOWABLE CONCENTRATIONS AND OTHER REQUIREMENTS

CONSTITUENT	Leachate Standards (mg/L)		Total Metals (mg/kg) Soil Standards	
	OH	TN[1]	IN[2]	IN[3]
RCRA METALS				
Arsenic	0.25	-	41	75
Barium	10.00	20.00	-	-
Cadmium	0.025	0.05	39	85
Chromium, Total	0.50	1.00	2,000	3,000
Lead	0.25	0.50	300	840
Mercury	0.01	0.02	17	57
Selenium	0.25	0.50	100	100
Silver	-	-	-	-
OTHER CONSTITUENTS				
Benzene	-	-	-	-
Copper	-	13.00[4]	750	4,300
Cyanide (Total)	0.20	2.00[5]	-	-
Fluoride	4.0	-	-	-
Formaldehyde	-	300.0		-
Molybdenum	-	-	75	75
Nickel	-	1.00	210	420
Nitrate	-	-	-	-
Phenols (Total)	3.5	15.00	-	-
pH	-	-	> 6.5[6]	-
Zinc	-	-	-	-
Basis for Thresholds	5x U.S. DWS (except for cyanide)	10x U.S. DWS	Based on Federal guidelines that govern the land application of sewage sludge 40 CFR 503	

OTHER REQUIREMENTS	IN	OH	TN
Monitoring Frequency for Sand	Every 2 – 5 years	Annually	Every 2 years
Submission of Regular Reports	No	On-site records	On-site records
Siting Requirements	Floodplain, Wetlands, Critical Habitat	SW, Potable Wells, Wetlands, Leachfields	GW, SW, Floodplain, Certain Soil Types, Potable Wells

Notes:

[1] Land application is not a specified use.

[2] Maximum allowable concentrations to use as a soil amendment. Concentrations are in mg/kg on a dry weight basis.

[3] Maximum allowable concentrations to use in land applications. Concentrations are in mg/kg on a dry weight basis.

[4] The concentration limit is a maximum contaminant level goal (MCLG) in the federal DWS.

[5] Concentration value is based upon modified TCLP extraction test; refer to ASTM method D3987-85.

[6] The pH requirement applies to soils with a cadmium concentration over 2 mg/kg dry weight.

IN- Use as a soil amendment or in a land application also requires that the sand meet Type III criteria (TCLP results of 10% of RCRA values).

OH- Soil blending and composting are allowed; plan approval is required for land application on a case-by-case basis.

5.0 PURPOSE OF CASE STUDIES

Four beneficial reuse projects were selected as case studies to demonstrate the breadth of reuse activities for foundry sand and the implementation of industrial by-product reuse regulations in different states. Exhibit 5-1 lists the location, type of reuse, and major participants for the case studies. In each of the four states, non-hazardous foundry sand must meet certain contaminant criteria to be certified for reuse. Each state specifies how the sand can be used. In most cases, the alternatives to reuse are to store or dispose of the foundry sand in a company-owned monofill or to send it to a landfill, where it is frequently used as daily cover.

Exhibit 5-1

BENEFICIAL FOUNDRY SAND REUSE CASE STUDIES

State	Type of Reuse	Participants
Ohio	Soil Amendment	Kurtz Brothers, Inc., Ford Foundry, and Dugan's Garden Center
Wisconsin	Structural Fill for Embankments	Waupaca Foundry and Wisconsin Department of Transportation
Michigan	Asphalt	Resource Recovery Corporation and Asphalt Paving, Inc.
West Virginia	Parking Lot Construction	HK Casting and Weston Ford

These case studies are success stories. They show how foundry sand can be reused under set guidelines with no adverse environmental impacts. Economic and operational considerations are also important elements of these reuse efforts that affect both the initial feasibility of a project and, ultimately, its sustainability. This chapter presents an overview of the case studies and summarizes their findings, focusing on the factors that were seen to facilitate beneficial reuse of sand and those that are barriers.

5.1 OVERVIEW OF FOUNDRY SAND REUSE CASE STUDIES

Following are brief descriptions of the four case studies. Appendix B provides more detailed descriptions that explore the state regulatory framework governing sand reuse, the performance of the sand (including environmental performance), and the economic and operational effects of reuse from the perspectives of the foundry and the end user.

5.1.1 Soil Amendment – Ohio

Kurtz Brothers, in Ohio, has been a leader in the reuse of foundry sand for the past 20 years. The company produces a variety of soil blend products that are sold directly and through garden centers throughout Ohio. The Ford Foundry in Brookpark, Ohio, has been the largest sand supplier to Kurtz for the past 15 years, providing over 240,000 tons of sand to Kurtz in 2001.

As part of an agreement with the state, Ford conducts sand leachate tests annually, and Kurtz conducts quarterly leachate and total metals tests on its soil products made with foundry sand. Kurtz also submits an annual report to the Ohio EPA, describing the test results and any problems that arose with the reuse. The major barrier to Kurtz's increasing reuse of sand is the high transportation costs associated with expanding the network of foundries supplying sand.

5.1.2 Structural Fill – Wisconsin

The Waupaca Foundry provides sand for structural fill in Wisconsin Department of Transportation (DOT) highway embankment projects. Ten months worth of excess sand (80,000 tons) was used in the latest project. Waupaca's sand was certified as meeting required Category 2 or 3 standards. The sand is mixed with bentonite clay so it is relatively impermeable. The embankment requires only a clay cap; no liner is needed. The leachate volumes from the embankment will be measured twice each year.

From Waupaca's perspective, two key factors contributed to the project's success: (1) Waupaca's process improvements minimized any additional screening required prior to reuse; and (2) the ability to have off-site storage near the project minimized transportation costs.

5.1.3 Asphalt – Michigan

The Resource Recovery Corporation (RRC), a foundry-owned collaborative effort, undertakes reuse projects with the sand and other foundry residuals collected from member foundries. By consolidating sand, RRC can provide a consistent, reliable supply to its end users. RRC produces fine aggregate for use in making asphalt. In 2001, RRC sent over 31,000 tons of processed foundry aggregate to Asphalt Paving, Inc. (API). API began to use foundry processed aggregate in its product in 1997 and had used over 125,000 tons of this material as of December 2001.

RRC's processing facility is located at an Allied Waste System landfill. As a result, RRC is able to complement its processing capability with long-term storage for future use and or disposal of residuals.

5.1.4 Parking Lot Construction – West Virginia

Since West Virginia approved foundry sand reuse in 2000, HK Casting has completed two projects reusing 21,000 tons of sand as sub-base for parking lots. The foundry produces 5,000 – 6,000 tons of sand a year, and the parking lot projects have reused all of its stored excess sand.

HK was a key player in working with West Virginia to develop the state's reuse policy. The additional testing requirement for reusing HK's sand for beneficial reuse is to conduct a totals analysis for four metals. The TCLP test was already required for disposal of reused foundry sand in a municipal landfill, although HK's sand must meet stricter leachate standards to be reused.

For each project, HK submits a reuse plan to the state that includes the use, location, and amount of sand proposed for reuse. The state inspects the proposed reuse site to ensure that it meets all requirements. It also has the authority to inspect and monitor the site any time before, during, or after the beneficial reuse project.

5.2 SUMMARY OF FINDINGS

The fundamental finding from the four case studies is that all of these projects have safely and successfully reused foundry sand following different state regulations or guidance. In addition to there being no violations of state regulations, none of the state representatives reported any significant public concern over foundry sand reuse or any legal challenges.

5.2.1 Differences in State Reuse Programs

All four states require that leachate tests be performed on a regular basis. These tests address the potential for metals and additional contaminants (e.g., phenol and cyanide) to leach from the sand. Beyond the minimum requirements, there is some variability among the states, both in the parameters tested and in the thresholds specified. Chapters 2 and 3 as well as Appendix A provide a more in-depth discussion of these differences.

Three states (West Virginia, Ohio, and Michigan) base their thresholds on the federal hazardous waste guidelines (40 CFR 261.24), which establish thresholds for classification of waste as hazardous based on leachate characteristics determined through the TCLP.[22] State limits for various beneficial reuses are set at varying ratios relative to the federal regulatory levels. West Virginia has the most stringent requirements: for all beneficial reuse projects, the

[22] EPA Test Method 1311, specified in EPA SW-846.

TCLP results for foundry sand must be at least 100 times less than the federal hazardous waste thresholds. In Michigan, the limit for foundry sand to be considered for contained uses, such as asphalt or concrete, is set at 10 percent of the federal guidelines, or 10 times the threshold for an inert material suitable for general reuse (whichever is higher). Wisconsin tests for a set of parameters similar to those in the TCLP, but has adopted threshold values for each contaminant separately, rather than applying a set ratio to values set under the federal hazardous waste guidelines.

Most of the states have a category system that relates the characteristics of foundry sand to allowable beneficial reuses. Michigan, Ohio, and Wisconsin have systems based on contaminant levels in the sand, where reuse opportunities increase as the material meets stricter contaminant standards. West Virginia has a single-tier system: sand must meet the same strict threshold for all reuses. The differences among these states relate primarily to what threshold levels are chosen for different types of reuse. For example the acceptable thresholds for capped transportation embankments, an approved use in all four states, vary considerably – in many cases by more than a factor of 10.

5.2.2 Factors Affecting the Beneficial Reuse of Foundry Sand

The key motivating factor for reusing foundry sand, both for the foundry and the end user, is cost savings. Without reuse, foundries must pay for disposal of their sand, and the end user must purchase virgin material. In determining whether to reuse foundry sand, foundries weigh these disposal costs against the costs of segregating sand suitable for reuse from other by-products and transporting it to the location of a reuse activity. For the end user, the cost of virgin material is weighed against the cost of obtaining and using the foundry sand, including any testing that must be performed on products containing foundry sand, any potential delays associated with the reuse approval process, and any potential effect on sales of products containing an industrial by-product.

One foundry mentioned that it prefers to reuse sand rather than send it to a landfill to minimize the potential liability associated with becoming a future responsible party at a landfill site. The Wisconsin Department of Transportation included "civic duty" as part of the rationale for reusing foundry sand in its construction projects, noting that encouraging reuse rather than landfilling was everybody's responsibility. While important, these advantages are clearly secondary to economic considerations. They were cited as significant only when the costs of reusing foundry sand were comparable to the costs of using virgin material.

Looking across all four case studies, five factors appear to be critical to the long-term success of beneficial reuse activities. These case studies also suggest three factors that represent barriers to beneficial reuse of foundry sand. These factors are listed in Exhibit 5-2 and discussed below.

Exhibit 5-2 FACTORS AFFECTING THE BENEFICIAL REUSE OF FOUNDRY SAND	
Factors Contributing to Successful Reuse Projects	**Barriers to Reuse**
C Streamlined regulatory process C Proximity of foundry to reuse location C Temporary storage facilities C Reliable sand supply C Consistent sand quality	C Difficulty of finding new reuse opportunities C Aesthetics of sand C Large volumes of sand required for certain reuse projects

Factors Contributing to Successful Reuse Projects

Streamlined Regulatory Process

Several interviewees emphasized the importance of a streamlined approval process designed to facilitate the reuse of industrial by-products. For example, before the promulgation of current regulations in Wisconsin, an activity involving the beneficial reuse of sand could not be initiated without the submittal of a formal request with extensive documentation to the Department of Natural Resources (DNR). This type of notice was required for each individual foundry sand reuse project. Under the current regulations, once a foundry has its sand certified as meeting particular contaminant criteria, the sand can be used in multiple projects involving activities for which the sand is qualified without approval by the DNR unless very large volumes of material are used. The foundry is required to re-certify the quality of its sand twice a year and notify the DNR how it is being reused.

Proximity of Foundry to Reuse Location

Transportation is generally the largest expense associated with reuse, comparable to landfill costs in many areas even over short distances. Based on these case studies, the maximum feasible distance from a foundry to a project is 25 to 50 miles. Resource Recovery Corporation (RRC) in Michigan, a cooperative formed by local foundries to promote reuse of their sand, is the only exception to this finding. Member foundries transport their sand up to 90 miles to RRC, which processes the sand and ships it additional distances to end users.

Temporary Storage and Reliable Supply

Temporary storage sites and a reliable sand supply go hand in hand. Together they ensure that when sand is needed for a project, it is available. Temporary storage sites can be a dedicated area at the reuse site or a monofill at the foundry from which sand can be removed as

necessary to meet high demand. A reliable sand supply guarantees that the material required for completing a project will be available when it is needed.

Consistent Sand Quality

Several end users mentioned the need for strict quality control at the foundry to provide homogenous material without random metal scraps or large chunks of casting cores. This need for consistent quality also affects the viability of reuse from the perspective of the foundry.

For example, Waupaca Foundry initially had to filter its sand so that it could be reused in construction projects. This represented an additional step that significantly increased the cost of reuse. With process improvements over the last 10 years, however, Waupaca no longer needs to put its sand through additional filters in order to have a homogeneous by-product, which has made reuse much more financially attractive.

Barriers to Reuse

Finding New Reuse Opportunities

From the foundries' point of view, one of the primary difficulties is that the reuse opportunities are generally limited to activities on each state's "pre-approved" list. For example, when Waupaca Foundry submitted its application for reusing sand in pre-approved construction activities, it also submitted an application to use blended foundry sand and baghouse dust as liner material in manure pit construction (a reuse not on Wisconsin's pre-approved list). Wisconsin DNR denied the manure pit reuse application because of uncertainty about the environmental impact of this activity. DNR would not approve this reuse unless Waupaca could provide permeability and leachate test results on the proposed pit design. Such research and testing is often not economically feasible for an individual foundry, making it difficult for a foundry acting alone to develop new reuses.

The ability of foundries to develop new uses is also limited by transportation costs. For a reuse project to be economically feasible, it must be located relatively close to the foundry or the transportation costs become prohibitive. As noted above, these case studies suggest that distances of up to 50 miles are feasible for projects involving a single foundry.

Aesthetics of Foundry Sand

Officials in several states mentioned that the dark brown or black color of foundry sand prevents its use in situations where it is not covered. Wisconsin's DNR noted that a Category 2 foundry sand, (such as that produced by Waupaca could theoretically be used as an anti-skid agent on roads in winter, but the sand's dark color might be aesthetically disturbing to the general public. A related issue is the stigma that can be associated with end products containing reused industrial by-products.

Large Volumes of Sand Required for Certain Reuse Projects

Many reuse projects require volumes of sand that exceed the amounts a small foundry can supply on a reliable basis. The Wisconsin DOT noted this as a concern in some of its projects. While the need for of large quantities of sand makes it difficult for small foundries to compete for projects, this creates opportunities for organizations that consolidate sand from multiple foundries for reuse, such as Kurtz Brothers and RRC.

5.2.3 Further Opportunities for Foundry Sand Reuse

To identify new reuse opportunities, foundries need to actively expand markets for current uses or pursue markets for new uses. Larger foundries and "middlemen," such as Kurtz Brothers and RRC, who consolidate and prepare sand for reuse, have the resources and knowledge to increase the reuse market. RRC is actively exploring additional uses for sand and other foundry residuals through research and development. It is especially interested in working with the Michigan Department of Environmental Quality to expand the list of pre-approved uses.

Foundries involved in these case studies have considered additional reuse possibilities on their own. For example, Waupaca indicated that it is hoping to expand into more "value-added" reuse products (e.g., concrete, flowable fill, and asphalt), while maintaining its market in reusing foundry sand in road embankment construction. However, this foundry's experience submitting an application for a new reuse activity not on the state's "pre-approved" list illustrates the challenges of attempting to expand the reuse market. It seems more likely that efforts involving multiple foundries, or organizations that consolidate sand from multiple foundries, will have the necessary resources to successfully expand sand reuse into new areas.