Chapter 2
The Historical Context for Examining Industrial Pollution

Abstract The early focus of environmental quality was on air and surface water pollution. Land disposal and its impacts were essentially unregulated; in fact, such impacts were eventually exacerbated due to the focus on surface water protection. An understanding of groundwater contaminant transport was not developed until the 1970s and 1980s. For most of the twentieth century, pollution definitions were rudimentary and expressed in terms of "conventional pollutants," such as suspended solids, bacteria, dissolved oxygen, and nutrients. A chemical definition of pollution did not really first appear until US Environmental Protection Agency established its 64-chemical Priority Pollutant list in 1976. Early regulation of pollution was nuisance-based and enforced on a case-by-case basis using riparian rights and common law notions. By contrast, today environmental statutes and regulations provide a highly structured framework for discharge compliance and remediation of legacy contamination.

Keywords Environmental regulation · Pollution · Nuisance · Legacy contamination · Manufactured gas plants · Wastes

Introduction

Pollution today is highly regulated: Wastewater and air discharges are tightly permitted against precise numerical quality standards, and solid/chemical waste landfilling is carefully controlled. Even stormwater runoff is controlled, and even some natural background conditions are viewed as unacceptable (Mukherjee et al. 2006). Science allows us to understand pollution, technology is available to control it, and society demands as little of it as possible.

So why is there so much left? One reason is that past practices have left a legacy of contamination that we still deal with today. This is partly because pollution regulation during those past practices was very different.

As we deal with legacy pollution, we question, who should pay the bill? The Congress solved that problem with the vast liability net of Superfund, which bills anyone still standing today who touched the waste historically. Those entities fend off the bills by sending them to insurance companies, arguing that past re-

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leases were accidents and that they have insurance for accidents. Whether coverage applies depends on what was expected and intended in the past—and that depends on what scientific knowledge and regulations existed for pollution in the past.

This chapter examines the historical context for pollution views so that a "reasonable person" test might be applied to that "expected/intended" question. Although this chapter is about *all* historical industry pollution, it uses as an example, a now-forgotten but once fundamental industry—manufactured gas. The industry made gas from coal and oil, and flourished circa 1850–1950, at the end of the Industrial Revolution and just before the advent of modern environmental concerns. The manufactured gas industry represents a common duality of necessity and unwanted baggage, and it was one of the best environmental players from the Industrial Revolution. Manufactured gas represented celebrated progress every time a new plant opened. This chapter shows that even an industry as advanced as manufactured gas left a legacy of pollution, because:

- The definition of pollution was so different.
- Pollution regulation was very different.
- Pollution was viewed as temporary, because it was believed that nature would "self-purify."

To understand this historical context appropriately, this chapter considers two important concepts: objectivity and consensus. A number of objective measures of pollution exist to chronicle their changes over time, such as:

- Ability to measure pollution
- Pollution-control practices
- Scientific description of pollution mechanisms
- Laws
- Regulatory controls (e.g., discharge permits)
- Environmental quality standards

Consensus, rather than exception, is important because it represents what a reasonable person both knew and should have known. Any issue will have exceptional views, but it is only reasonable to expect someone to believe the consensus view. This is especially true with an issue of science, such as pollution, which must also pass through the scientific method before entering consensus. Some exceptional views do not pass that test, so it is not reasonable to argue that any exceptional view should be adopted (e.g., "should have been known") before it is widely accepted.

A more difficult issue straddling consensus versus exceptional views is the type of "person" in "reasonable person" category. A factory worker, a plant manager, an engineer, and a university professor might be expected to have different levels of knowledge about a particular issue, especially something as technical as pollution. As a rule of thumb, specialists (e.g., the engineer or professor) might be expected to be more aware of exceptional views, but all persons should still be expected to believe no further than the consensus view.

Perhaps the most important difference in views between the past and present is that essentially none of today's hazardous waste issues were considered or even understood to be an issue during the MGP era. This means that an MGP operator could not have expected or intended the type of damage being addressed today, because an awareness or understanding of that damage did not exist. In addition, the cause of nuisance-type impacts was poorly understood, and the practical ability to predict when such problems might occur was limited.

To the extent that impacts from pollution were understood in that former era, the issue was whether there was any tangible indication of a harmful effect, typically detectable by sight, smell, or taste. The environment was viewed as having the ability to attenuate impacts from wastes through "self-purification." The focus of the time was on surface water bodies, and land disposal of wastes was favored.

Protection of Surface Water

Consistent with historical understanding at the time, some early statutes existed that concerned discharges into surface water, but they were not universally applied. For example, an early New York statute from the Civil War era made it unlawful to "throw or deposit any gas-tar" or "refuse" of "gashouses or gas factories" into "certain waters" (New York Legislature 1845). In 1881, the law was modified to prohibit the throwing of "gas-tar, or the refuse of a gas house or gas factory, or offal, refuse, or any other noxious, offensive, or poisonous substance into any public waters" (Parker 1907). After amendments over the years, these and other early laws were amended to include caveats such as "destructive" (e.g., New York Legislature 1892; State of New York 1900) or "injurious" to fish (e.g., State of New York 1912, 1913; New York Environmental Conservation Law 1972). Such caveats reflect "reasonable use" concepts applied at the time, as discussed below.

An example of the way statutes with environmental elements were enforced during the MGP era is described by Andreen (2003) for the 1899 Rivers and Harbors Act, which is often cited as the prevailing federal water quality control law prior to the 1972 Clean Water Act (CWA). Section 13 of the Rivers and Harbors Act prohibits the "discharge of *any refuse matter of any kind, whatever,*" except municipal sewage into navigable waters. [Emphasis added.] The US Army Corps of Engineers, the statutory enforcer of the act, for decades, interpreted Section 13 to apply only to the discharge of materials that could impede navigation. By this law, nuisance was interpreted as a solid material that might interfere with boat traffic. The enforcement of this law did not expand until the 1960s, when the US Supreme Court ruled that Section 13 applied more generally to industrial pollution.

Although many of these early statutes were broadly worded, history shows that these statutes were not in practice enforced to prohibit all discharges to surface waters. For example, more than 50 MGPs were observed in detail in a 1919 report by the New York State Department of Health (NYSDOH), and discharges were noted, but no laws were claimed to have been violated.

Land Disposal, Landfilling, and Their Regulation

In contrast to even mild surface water regulation, there were no comparable statutes governing the disposal of wastes on land, historically. This is not surprising, given the limited understanding of the impacts of land disposal of wastes during the MGP era. This limited understanding of contamination and the almost total focus on surface water had the unintended consequence of causing the environmental problems on land and in groundwater that are the subject of today's cleanup actions.

Through the mid-twentieth century, most regulation and literature on land disposal of waste focused on the sanitary landfilling method of municipal waste disposal, a practice which began in the 1930s (Moore 1920; Eddy 1934, 1937; Cleary 1938; Civil Engineering 1939; APWA 1966; Mantell 1975; Wilson 1977). Sanitary landfilling involved compaction and daily soil cover of the waste. It was developed to ensure efficient land use and to keep wastes covered to avoid disease vectors such as rats and insects.

The US Public Health Service (USPHS) endorsed the sanitary landfilling methods in 1940 (Phillips 1998), but it was not until 1959 that the American Society of Civil Engineers (ASCE) published technical standards for it (ASCE 1959), after most MGPs had been closed. These standards were not systematically followed: A 1973 survey indicated only about 15 % of solid waste disposal in the USA followed the standards, with "almost all of the balance [being] disposed of simply by open dumping" (Baum and Parker 1973). Until the 1970s, open dumps with burning and incineration were the primary methods of solid waste "management" (Phillips 1998).

The literature on land disposal of industrial wastes was more limited than that for municipal waste during the first half of the twentieth century, but the practice was widely accepted. By the 1950s, industrial waste land disposal was addressed somewhat widely in the technical literature, but more in terms of how to do it, not whether to do it (Rudolfs et al. 1952; Stone 1953; Powell 1954; Black 1961; Rosengarten 1968; Snell and Corrough 1970; Overcash and Pal 1979). The petroleum industry, for example, issued manuals of practice that described combined treatment/surface water discharge and land disposal options (API 1951), as did the pesticide industry (NACA 1965) and the National Safety Council in terms of generally acceptable practices for industry (Gurney and Hess 1948). As late as the 1970s, the US Environmental Protection Agency (USEPA) estimated that more than 90 % of all hazardous industrial wastes were land disposed (USEPA 1977).

In 1967, the US chemical industry consisted of 2,030 manufacturing plants, generating an average of 33,000 t of process waste per year per plant (Holcombe and Kalika 1973). The vast majority of these wastes consisted of fly ash (52 %), sludge (39 %), and filter residue (4 %), with tars and off-specification product each contributing about 2 %. Land disposal was the ultimate fate of 72 % of these wastes, with another 10 % put in lagoons, 8 % incinerated, and "other" at 10 %. The majority (58 %) of this land disposal was onto plant property with the other 42 % onto public land.

It was not until the 1970s that a scientific understanding came into existence that would allow the recognition of the potential dangers of land disposal. In earlier decades, some reports of impacts from leaks, spills, or disposal on land existed, but these reports were anecdotal without systematic explanation. Without such predictive understanding, an MGP operator could not have expected that leaks, spills, and disposal activities would cause harm. A scientific understanding of the cause–effect relationship of subsurface contamination was required but did not begin to develop until the advent of groundwater contaminant modeling in the 1970s (Konikow and Bredehoeft 1978).

This lack of scientific knowledge about land disposal effects is described in a comprehensive 1960 MIT study on land disposal sponsored by the Federal Housing Authority (FHA). That study concluded that contemporary knowledge of groundwater contamination from industrial land disposal was "not satisfactory" in terms of understanding concepts of: (1) permissible concentrations in groundwater; (2) migration of contaminants into and through groundwater; (3) the ability of soils to attenuate the contamination; and (4) the ability to predict contamination (Stanley and Eliasson 1960). Moreover, the study gave organic chemical industry wastes (the category applicable to MGP wastes) almost the lowest priority (18 out of 20) for groundwater contamination research needs.

In 1976, growing awareness of the need to address the impacts of land disposal led the Congress to enact the first modern federal statute addressing solid and hazardous waste, the Resource Conservation and Recovery Act (RCRA). Intended for "cradle-to-grave" waste control for operating facilities, RCRA established the framework for the existing US system of managing and controlling land disposal of many industrial wastes (U.S. Congress 1976; USEPA 2001).[1]

A further turning point was the 1978 Love Canal incident, which triggered a heightened level of technical investigation and public concern, eventually leading to the enactment of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, aka Superfund) and similar state laws that regulate hazardous waste cleanups. Thousands of tons of chemical waste had been buried in the 1940s and 1950s in the Love Canal, located in Niagara Falls, New York (USEPA 1996). In 1978, heavy rains pushed some of this chemical waste upward and into the basements of homes and onto the ground surface, leading to a massive cleanup, control, and relocation effort (New York Times 1978; USEPA 1996). The incident served at the time to demonstrate our scientific and regulatory ignorance of the environmental and public health impacts from historical land disposal of wastes.

Partly in response to the Love Canal incident, the US Congress completed a comprehensive study of industrial waste disposal in the USA. This study (the "Eckhardt Report") found that (1) 94 % of the wastes disposed on the land by the industries surveyed was dumped on site; (2) few states at the time required any regulation of such disposal; (3) the total number of hazardous waste generators was

[1] The Toxic Substances Control Act (TSCA), also enacted in 1976, provided USEPA with authority to address the production, importation, use, and disposal of specific chemicals, including PCBs, asbestos, radon, and lead-based paint.

estimated at 272,000, using up to 30,000 disposal sites; and (4) the CWA had been responsible for shifting a large portion of industrial pollution over to land disposal (U.S. Congress 1979). The important lesson to be learned from Love Canal and the Eckhardt Report is that, even in 1980, tremendous ignorance remained as to the full dimensions of groundwater and other problems created by historical land disposal of chemical wastes, including ignorance of the technical characterization of the sources, health threats, natural resource threats, remedies, and appropriate regulatory frameworks.

Love Canal and the Eckhardt Study were part of the growing recognition in the late 1970s that many waste disposal practices of the past had created problems for the present. Even with this recognition, it took more time to understand the problem. For example, the USEPA did not issue its first RCRA regulations until 1980, despite the law's enactment in 1976. The 4-year delay reflects the learning curve about hazardous wastes at the time. Industry did not change practices during that period because it awaited forthcoming regulations. For the first time, in 1980, through CERCLA and RCRA, individual chemical contamination was broadly regulated in terms of the potential for health effects, using risk assessment and risk-based environmental concentration standards. The transition had been made from nuisance-based responses to a more comprehensive legislative, scientific, and regulatory framework for environmental management.

The environmental laws and regulations enacted in the 1970s reflect a modern understanding that even trace amounts of certain chemicals may pose a potential human health threat many years after their release into the environment. The results of this radical change in scientific understanding are the enforcement actions brought today under Superfund.

Understanding of Pollution

Understanding of pollution was very different during the MGP era than it is today. For example, during that time, the consensus understanding of pollution in general was that:

- Waste discharges were allowable: The concept of "reasonable use" prevailed, which meant that waste discharges were only precluded if they created a nuisance.
- Pollution was temporary: Self-purification by nature was expected. Thus, legacy contamination like cleaning up hazardous waste sites could not have been anticipated.
- The definition of pollution was limited to what we call "conventional pollutants" and did not include specific chemicals.

Understanding evolved, as demonstrated by changes in the ability to measure contaminants, environmental standards, waste discharge permits, and available treatment technology.

Waste Discharges were Allowable and Nuisances Hard to Predict

In the 1950s, more than 50% of all wastewater discharges were totally untreated (NEIWPCC 1951). In the 1920s, the sewage from all six million people in New York City was discharged with no treatment (U.S. Engineer Office 1925). By contrast, most waste discharges from MGPs throughout the twentieth century were treated with what was at the time advanced technology. Waste discharges were generally allowable unless they caused a nuisance. Nuisances were judged in terms of recognizable impacts within the context of the "reasonable use" of waterways.

During the MGP era, the sanitary engineering notion of "reasonable use" was applied to define whether a waste discharge was a nuisance. The concept of reasonable use was derived from common-law notions of riparian rights. Although different in the western USA, riparian rights derive from property rights, which include the right to use, but not own, water associated with owned land.

Unfortunately, the notion of riparian rights had a circular nature that resulted in much debate (USPHS 1917). This debate was due to the fact that each riparian landowner had a right to reasonable use of a waterway for both consumption and waste discharge. Since this same right was also afforded to the next downstream landowner, too much waste discharge (or consumption) by the upstream landowner might violate the consumption rights of the downstream landowner. This conundrum was balanced by considering whether the upstream use was reasonable in terms of the downstream needs.

Local practice and the nature of a use sometimes also influenced what was "reasonable." As long as the upstream use, including waste discharges, did not cause a nuisance to downstream needs, upstream activities were considered reasonable. If a waste discharge created a downstream nuisance, such as the inability to provide water to livestock or the need to filter downstream water for subsequent use, it might be called "pollution," and a lawsuit might be filed. There was no inherent preclusion of waste discharges until modern environmental regulation was instituted.

Essentially, views regarding pollution during the MGP era were the opposite of what they are today. There was no assumption that all discharges would cause harm. Although discharges were curtailed if they caused a nuisance, there was generally no way a priori to predict if a discharge would cause a nuisance. That is because a nuisance condition depended on both the nature of the discharge in terms of the receiving water and other needs/uses of the receiving water. In practice, whether harm occurred was judged by whether there was a complaint.

Pollution was Temporary

Waste load allocation studies are a common step currently used by environmental engineers for determining waste discharge limits. These determinations are based on two concepts: one newly evolving at the time of the 1972 CWA, stream classifications, and one left over from the reasonable use period of water quality control, self-purification. The notion of self-purification was underpinned by observations that oxygen-consuming organic wastes in water would be purified by biodegradation and natural reaeration, while settleable pollution (sediment contamination) would be biodegraded and buried by clean settling solids. A reliance on dilution was also a consideration.

The 1950s and 1960s saw the first comprehensive stream studies and stream quality classifications. Stream classifications, essential for water quality management, were water quality targets based on intended use and the practicalities of local conditions. In a way, these were an evolutionary clarification of reasonable use considerations. Classifications generally ranged from "drinkable" to "waste conveyance." As noted by one of the leading sanitary engineers of the time, "disposal of wastes is one recognized best usage for waters in New York State" (Rudolfs 1952). The fact that the government recognizes several different classifications for surface waters means that all water is not expected to be pristine.

Pollution Definition Limitations

During the MGP era, pollution was defined in terms of what environmental engineers call "conventional parameters," which comprised the limits of pollution understanding until the advent of concerns with specific chemicals. These included:

- Coliform bacteria: an indicator of human waste and for waterborne disease
- Suspended solids: mostly an aesthetic issue, but sometimes simply an indicator of waste
- Dissolved oxygen (DO): important for balanced life in waters
- Biochemical oxygen demand (BOD): the result of a test that examines organic material decay that affects DO in waters
- Nutrients (e.g., nitrogen and phosphorus): affect algal growth, which can impact aesthetics and oxygen balances in water

These were the definitions of surface water quality. The definition of groundwater quality was limited to taste and odor, along with bacterial quality for groundwater used for drinking. The limited historic understanding with regard to protecting groundwater from bacterial quality is reflected by local ordinances nationwide, requiring only minor separation of cesspools from drinking water wells—most often 20–100 feet (USPHS 1913, 1915, 1917). After the passage of modern environmental laws in the 1970s, chemical-specific quality definitions for groundwater, soils, and sediments were also established. This focus on chemical pollution did not start until USEPA established its original 64 "Priority Pollutants" in 1976 (dioxin, was originally delayed and now there are now 129) as a result of a Natural Resources Defense Council (NRDC) lawsuit to enforce Section 307 ("toxic chemicals") of the 1972 CWA.

Evolution of Pollution Understanding

The nuisance-based view of pollution persisted until the passage of the 1972 CWA. The CWA changed this view by requiring (1) permits for all wastewater discharges and (2) universal wastewater treatment. The newly required levels of treatment were best practicable treatment (BPT) and best available treatment (BAT), targeted for 1977 and 1983 nationwide application, respectively. USEPA had little trouble defining BPT and BAT for municipal wastewater treatment, but the agency took decades to define them effectively for industrial wastewaters because (1) technology at the time had not been aimed at industrial wastewater and (2) industrial wastewaters were so diverse, which defied a simple solution.

The second paradigm change required by the 1972 CWA was wastewater discharge permits. USEPA or state designees issued permits under the National Pollutant Discharge Elimination System (NPDES) program starting around 1974. For the first time, a permit was required for every discharge. This contrasted with the few earlier state programs that focused primarily on sanitary protection and had not been universally applied. The NPDES agencies issued permits with quantitative limitations on the discharge of certain wastes after consideration of the receiving water quality classification and its ability to assimilate the waste. The first round of NPDES wastewater permits rarely contained chemical-specific requirements. Moreover, the permits did not and still do not require zero discharge.

Over time, but generally not until the 1970s, views on environmental quality became more sophisticated. This evolution was due to:

- *Improvements in the ability to measure pollution*. Pollution measurement changes are chronicled very clearly by the 22 editions of *Standard Methods for the Examination of Water and Wastewater*, published since 1905 jointly by the American Public Health Association, American Water Works Association, and Water Environment Federation. This chronicle demonstrates not only measurement improvements but also changing definitions of pollution.
- *Improvements in the ability to control pollution*. Textbooks, published scientific papers, and proceedings from the Purdue Conferences document changes in wastewater control technology and its practice over time. For example, James Patterson, chairman of Environmental Engineering department of the Illinois Institute of Technology, published a textbook on industrial wastewater treatment technology in 1975 focusing on "22 major industrial pollutants," the most specific of which for MGP-type contamination was "oily wastes" (Patterson 1975). The textbook offered the same technologies used by the MGP industry 50 years earlier. Many other similar examples exist in the literature. The point is twofold: (1) Wastewater treatment technology was rudimentary even as late as the 1970s and (2) the MGP industry was at the forefront of available technology.
- *Improved knowledge and societal understanding of the impacts of pollution*. Although water quality standards have existed since 1914, they remained rudimentary until the 1970s (USDOI 1968; McDermott 1973). The first water quality standards were limited to a single parameter—bacteria—consistent with the

historical understanding of the impacts from pollution noted above. Today, environmental standards for hundreds of chemicals exist for many media.
- *Increasing load of pollution in the environment* over time, due to increasing population and relative to the ability of nature to abate pollution and self-purify.

The Gas Manufacturing Trade

As noted in the introduction to this chapter, the MGP era represents the historical context for pollution in the last part of the Industrial Revolution. To complete the story against this backdrop, this section describes the industry's common practices for wastewater control, for which the industry was one of the leaders of its time.

The American Gas Association, established in 1919, and numerous local trade groups (e.g., the Western Gas Association, New England Association of Gas Engineers) provide a rich literature on the challenges of making and selling gas during the MGP era. Only a small part of this literature addressed pollution control in the industry, because the main focus of the trade groups, as with any industry during the Industrial Revolution, was in making their product.

Odor was the predominant environmental complaint about MGPs during their operation, but tar, the primary MGP by-product, is the industry's environmental legacy often at issue today. The composition of MGP tar is highly variable, but in general, it contains hundreds of chemicals, including about 10 % naphthalene and 0.1 % benzene. Tar is viscous (i.e., molasses consistency) and dense (i.e., sinks through water). Today, tar is viewed as a contaminant by many states because it serves as a source to contaminate groundwater through dissolution of its constituents, soils via chemical adsorption of its constituents and absorption, and air by volatilization of its constituents. Historically, MGPs attempted to reclaim tar from wastewater as a means of pollution control and because tar was a valuable commodity—more valuable than the plant's coal feedstock—and was used in dyes, road paving, roofing, personal care products, chemical manufacturing, and wood treating, among others.

Membership in MGP trade groups did not impart any particular knowledge about pollution control, because membership could not ensure understanding of or even exposure to information. Nevertheless, the MGP trade groups disseminated information about pollution control, such as offering a standardized design for tar separators (Sperr 1921), which was adopted by many MGPs around that time. Contemporaneous commentary about environmental impacts of MGP wastes would be a function of local conditions, however, and thus highly variable. That is why generalizations such as those posed by Willien (1920) or Hansen (1916) were not met with universal agreement within the MGP industry. Pollution knowledge was still anecdotal, not mechanistic, which led to a lack of consensus.

Actual knowledge and practice during the early MGP era were as follows:

- Many plants recovered tar from an early date. For example, some MGP records reveal tar recovery equipment before 1900.

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