Potentially Polluting Activities and the Control of Environmental Risk: Underground Storage Tanks and Aquifer Protection (Pima County)

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Early national concern over water pollution focused on the contamination of surface water, with one of the first laws being enacted in 1899 (the Rivers and Harbors Act), followed by the Federal Water Pollution Control Act of 1948 (62 Stat. 1155, 33 U.S.C. §§ 466 to 466g). Little progress was made until, in 1972, the United States Legislature passed the Clean Water Act (CWA; 33 U.S.C. §1251 et seq.) regulating "point-source" discharges (such as from factories) into navigable waters (surface water) (Goplerud 1995). However, there has been considerable evidence that groundwater is also at risk from a variety of sources such as industrial waste burial, fertilizers and pesticides used in agriculture, chemicals leeching out of landfills, mining by-products, and leaking underground storage tanks. Concern over land and groundwater contamination led Congress to enact a series of remedial statutes including the Safe Drinking Water Act in 1974, setting limits on contaminants allowed in drinking water (SDWA; 42 U.S.C. §300f et seq.); the Resource Conservation and Recovery Act in 1976, regulating the production, transportation and storage of hazardous waste (RCRA; 42 U.S.C. §6901 et seq.); the Comprehensive Environmental Response, Compensation and Liability Act in 1980, authorizing the cleanup of abandoned hazardous waste sites (CERCLA; 42 U.S.C. §9601 et seq.); and Subtitle I added to RCRA in 1984, regulating underground storage tanks (42 U.S.C. §6991 et seq.).

Underground storage tanks (USTs) typically are used to store gasoline, diesel fuel, waste oil, aviation fuels, kerosene, cleaning solvents, and other volatile materials at automotive stations and large municipal fleet service yards. These substances contain chemicals that are toxic and carcinogenic when released into groundwater; when leaked, they produce vapors that migrate through soil and may collect in sewer lines and basements, causing fires and explosions, as well as poisoning human beings (ADEQ 1988a, 1989; EPA 1995).

In the 1950s and 1960s, the United States experienced a boom in the installation of USTs; by the early 1980s, many of these now old tanks were corroded and leaking, causing a significant increase in the number of serious contamination incidents. During a 1983 Senate hearing, Jack Ravan, the assistant administrator for water for the Environmental Protection Agency, estimated that 75,000–100,000 USTs were leaking 11 million gallons of gasoline annually into groundwater (Ninety-eighth Congress 1983; Hayward 1994). One gallon of gasoline can potentially contaminate up to 750,000 gallons of water (Hayward 1994). In 1984, in response to growing evidence of groundwater and soil contamination resulting from leaking USTs, Congress added Subtitle I to the RCRA. It directed the Environmental Protection Agency, which had been created by Congress with the enactment of the Clean Air Act of 1970 (42 U.S.C. §7401 et seq.), to develop a program to resolve the UST problem. In 1986, the Environmental Protection Agency (EPA) reported the results of a two-year UST study in which 433 tanks were tested: 35 percent were found to be leaking and 55 percent of the leaking tanks were involved in leakage of motor fuel into groundwater (Gauthier 1990). In 1991, David W. Ziegle, the EPA acting director of the Office of Underground Storage Tanks, estimated that there were more than 2 million USTs then in existence at more than 750,000 facilities in the U.S., with 100,000 confirmed leaks and an additional 300,000 confirmations anticipated in the near future (Trial 1991). Currently, it is estimated that more than 25 percent of USTs are leaking (Kohout 1995).

Because of the great expense and difficulty of remediation (remediation of a single site can cost in excess of $1 million when groundwater is involved), much of the RCRA Subtitle I statutes and

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pursuant EPA and state regulatory framework is focused on prevention. The RCRA statutes define USTs and determine which types of USTs are required to comply with standards; require owners of USTs to notify states of the existence of USTs on their property; require new tanks installed after 1988 to meet design, construction and installation standards; set standards for leak, cleanup and tank closures; and provide the EPA authority to issue administrative orders or pursue federal civil actions to enforce these statutes (42 U.S.C. § 6991-6991i). The EPA chose to design a set of rules defining a minimum standard for protecting the environment while allowing states and counties the freedom to pass more stringent regulations (Taylor 1991) and has statutory authority to delegate regulatory authority to the states by approving state UST programs (42 U.S.C. 6991c.) In Arizona, the threat posed to groundwater and soil by leaking USTs is considered to be of statewide concern and counties are prohibited from enacting regulation (A.R.S. §49-1010). However, Arizona has also chosen to require that state regulations be no more stringent than federal regulations (Chap 231 H 2196 1995 Legislative Enactment).

The Arizona Department of Environmental Quality (ADEQ) was established by the Arizona Environmental Quality Act of 1986 and began operations July 1, 1987. Prior to this, environmental concerns were handled through the Department of Health Services. In 1988, the EPA assisted in funding the ADEQ to develop a state program to enforce federal UST regulations through the Office of Water Quality (A.R.S. §49-1001 et seq.). The ADEQ's Underground Storage Tank Section was established in September 1990, with 60 full-time employees (ADEQ 1991).

In Pima County, as of October 20, 1995, there were 1,629 tanks in use at 546 facilities registered with the Arizona Department of Environmental Quality; almost all of the tanks were in the metro Tucson area. There were 618 leaks reported at 534 facilities between May 1985 and October 1995; as of October 1995, 399 cases were still being remediated. Forty-one of these cases impacted groundwater and 241 cases were confined to soil contamination. Contaminants beneath the downtown Tucson area, leaking over the years from aging USTs, have seeped into the perched groundwater; there is evidence of gasoline in the vadose zone, and halogenated volatile organic compounds have been discovered in the soil and shallow groundwater. Diesel contamination has been found in one of the city's production wells southeast of the downtown area, Well B-78A, which has been closed (ADEQ 1995b).

The UST Program and Protecting Groundwater in Arizona

Groundwater constitutes over 60 percent of Arizona's water supply (as of 1990; ADWR 1990). At present, the sole source of drinking water for the city of Tucson is groundwater obtained from a deep regional aquifer which underlies the Tucson Basin. Although in most areas the water table now lies 50 or more feet below the surface, dropping water levels from overpumping have left shallower pockets of water perched above the deep aquifer in many areas. Such perched water may be totally isolated from the deeper aquifer or there may be some leakages. Contamination from the surface can directly reach water in the deep aquifer by percolating through the layers of soil, sand, and gravel above it (the vadose zone) or it can reach areas of perched water and may seep into the aquifer if there are any connections. In addition, wells drilled into the deep aquifer and passing through areas of contaminated perched water may provide a conduit for the contaminated water to "cascade" along the well shaft and contaminate the deeper water (Gregory Hess, personal communication 1996).

The federal and state regulations comprising the UST program fall into two categories: regulations controlling the activity (storage of petroleum products in tanks) to minimize contamination from the activity; and regulations imposing liability for the costs of damages, including stipulating actions to be undertaken in case of accidental contamination. The object is to induce tank owners to exercise care in the operation and maintenance of their tanks. The regulations impose two types of costs on a tank owner/operator: the cost of preventative measures and, to some degree, the cost of repairing damage to human health and the environment from accidental spills.

Technical Requirements for USTs

The cost of preventative measures is borne directly by businesses that use underground storage tanks as part of their operations. To some degree, this cost may be passed on to the consumers of a business's product in the form of higher prices, with these prices incorporating the cost of reducing the probability of contamination incidents.

Technical requirements apply to both new and existing tanks. Areas addressed are tank construction, piping, spill and overflow prevention devices, leak detection, rules for installation and closures, upgrade requirements, and rules for operation and maintenance. The three main safeguards against leaks are leak detection, spill and overfill devices, and corrosion protection (A.R.S. §49-1009).

Tanks and piping installed after December 22, 1988 must comply with all safeguards at installation. Existing tanks and piping, installed before December 22, 1988, must comply with leak detection regulations no later than December 1993; spill, overfill, and corrosion protection compliance must be accomplished no later than December 22, 1998.

Postregulation USTs with double walls and leak monitoring and tank gauging systems cost two to three times the price of the preregulated UST. Nationally, it has been reported that the majority of the owners of the leaking USTs have opted to buy aboveground storage tanks (ASTs) because of the extensive monitoring procedures and insurance requirements for USTs. ASTs do not fall under the same safety regulations as USTs but they also pose certain problems in regard to esthetics, corrosion protection, fire concerns, vapor emissions, thermal expansion and contraction, and vulnerability to vandalism (Safety & Health 1994; Civil Engineering 1994). Figures for AST installations in Arizona have not yet been obtained.

In addition to regulating the design and construction of USTs, the law addresses tank installation and closure, to minimize contamination during these procedures, as well as operation and maintenance (A.R.S. §§49-1002, 1003, 1004, 1008, 1009).

Inspectors from the ADEQ's UST Inspections and Compliance Unit are authorized to carry out compliance checks to encourage owners/operators to adhere to UST regulations. Sites to be inspected are prioritized by UST age, capacity, number of USTs at the site, and content (hazardous substances or not). Underground Storage Tank News (Winter 1994/1995) reported approximately 24,000 active USTs in the state (1,639 in Pima County) at 3,900 UST facilities (546 in Pima) (Christman 1995; UST Section Database). Currently, 81 percent of all tanks in operation in Pima County were installed prior to 1988 (UST Section Database). The Inspections and Compliance Unit has 21 case managers (Pima Association of Governments 1994).

Liability When Damage Has Occurred

Leakage from underground storage tanks first impacts the surrounding soil. Once in the soil, the contaminants can percolate through the soil until they intersect with water. Rain passing through the soil can also capture the contaminants and carry them faster into groundwater supplies. Contaminants in the soil can potentially cause damage to human health depending on exposure, as well as to animals and vegetation. The threat to groundwater, and potentially to drinking water, depends on how deep the water table is, where drinking water wells are located, how much rain there is, and how quickly the contaminants can penetrate the soil. If drinking water becomes contaminated from spills or leakages, public water systems, which are required under the SDWA to test and treat water, are burdened with increasing treatment costs. The probability of health damages from ingesting contaminated water can increase if testing is inadequate and the SDWA regulations are not enforced. The UST statutes require owners of USTs to clean up any contamination from leaks or spills in order to reduce the potential water treatment cost increases and cost of expected health damages.

State and federal regulations require extensive procedures for reporting leaks and spills as well as for undertaking corrective actions as quickly as possible in order to minimize impact. The average cleanup cost for a site contaminated by a leaking UST in 1993–1994 was estimated to be approximately $225,000 (Ameden 1995). Cleanup costs increase as contamination spreads into the surrounding soil, and costs skyrocket if groundwater is contaminated (EPA estimates in 1991 ranged between $50,000 and $1 million). Owners/operators are required to notify ADEQ within 24 hours of confirming a release and to begin cleanup within that time as well. Petroleum products must be removed from the UST system to prevent further release. Next, the owner must ascertain the extent to which the petroleum has spread, begin collection, and file a progress report no more than 20 days after the release report. Owners must investigate the extent of soil and groundwater contamination, report this to ADEQ, and submit a corrective action plan for meeting environmental standards (EPA 1995).

When Damage Has Occurred, How Clean Is Clean?

As soil and groundwater is cleaned, a major issue is how clean is clean? The EPA sets standards for the level of contaminants acceptable in soil and groundwater based on risks to human health. Originally, the statutes required that the same standard be applied to all sites being remediated: the higher the level of cleanliness required, the greater the cost of achieving it. However, funds for cleanup have been limited. Discontent in the regulated community with the burdensome costs of remediation prompted the ADEQ to develop more flexible and cost-effective guidelines for determining the level of cleanliness required for soil at any site. A similar set of flexible guidelines for determining standards for groundwater cleanup may also be developed in the near future.

In August 1994, the ADEQ Cleanup Policy Task Force began developing a general soil remediation policy applicable to all ADEQ programs, intended to be as flexible as possible to reduce remediation costs. On January 3, 1995, the ADEQ adopted its interim policy on soil remediation based on task force recommendations. Laws passed in the 1995 legislative session mandated the development of risk-based, consistent soil remediation rules. The ADEQ adopted emergency interim rules on December 15, 1995 (§49-151,152; §49-1026) which were sent for approval to the secretary of state. Legislation requires that final rules be adopted by August 1, 1996 (ADEQ 1995c).

The new soil remediation rules, if approved, would allow sites to be classified according to future use as either industrial or residential. Once classified, owners can choose to clean the site to predetermined contaminant concentration levels; these health-based guidance levels, specified by the Arizona Department of Health Services and based on the toxicological characteristics of each specific substance, bear no relationship to the characteristics of a given site. Residential standards (permissible concentration levels) are stricter and more protective than industrial standards; if there is potential for groundwater contamination at the site, standards stricter than the residential ones could be imposed, especially for benzene, toluene, ethylbenzene, and xylenes. Alternatively, owners can have a site-specific risk assessment study carried out to determine standards of cleanup for either residential or industrial use; such assessments include consideration of potential harm to groundwater (McAllister 1996). Copeland and colleagues profiled three cases involving the remediation of petroleum-contaminated sites in Arizona and California where site-specific risk assessments were carried out: two of the cases involved remediation of sites for industrial uses, and the last case involved property that a school planned to purchase. In the first case, the risk assessment study concluded that the contaminated soil did not threaten health or groundwater and therefore no remediation was necessary; the cost of the study was $11,000 and the cost of carrying out remediation to predetermined levels would have been $120,000, with a savings of $109,000. In the second case, the risk-assessment study also found that no remediation was necessary; the study cost $15,000 and remediation would have cost $500,000 with a savings of $485,000. In the case of property that was to be purchased by a school, the findings were that remediation was necessary and the cost was $125,000; however, the $13,000 risk assessment study did result in reductions in remediation costs (Copeland et al. 1995/96).

Who Pays? Financial Responsibility and the State Assurance Fund

Subtitle I of the RCRA establishes that UST owners are to be held liable both for remediation costs in the event of a spill, leak, or overflow and for third party bodily injury and property damages (40 C.F.R. Part 280 Subpart H, 1988, amended Dec. 23, 1991; § 280.98 b). To insure that owners/operators can meet this double requirement to some degree, they must demonstrate financial responsibility by providing financial assurances of these funds. (All owners had to meet these requirements by Feb. 18, 1994.) Specifically, marketing facilities or facilities with a throughput of more than 10,000 gallons are required to have some way of providing $1 million per release; smaller facilities (throughput of less than 10,000 gallons) must be able to provide $500,000 per release (Alspach 1990; UST News Fall 1992; 40 C.F.R. § 280.93). Owners of 1–100 USTs would be responsible for no more than $1,000,000 per year no matter how many releases occurred; owners of more than 100 USTs would be annually liable for no more than $2,000,000. In cases where the state must intervene to remediate a site, it is empowered to sue the owner for the costs incurred (when a responsible party is available).

The Arizona UST program is funded from both state and federal sources. In 1986, amendments to CERCLA established the federal UST Trust Fund; revenue is generated by a 1 cent per gallon federal tax on petroleum products, and grants from this fund are then distributed to the states (Douglas Wheeler, personal communication 1995; Taylor 1991). The EPA grants are deposited in Arizona's Leaking Underground Storage Tank (LUST) trust fund to be used by Arizona to assist with the cost of remediating both abandoned sites (often belonging to businesses that failed during the oil crises or ensuing recessions) and sites where the owner is insolvent.

In 1989, concerned that meeting federal financial responsibility requirements would be a serious hardship for smaller operations, the ADEQ and state legislature began to develop state sources of funding (ADEQ 1989). The resulting 1990 amendments to the Arizona Underground Storage Tank Act (H.B. 2011) created the Arizona Underground Storage Tank Revolving Fund which is divided into three separate accounts (A.R.S. § 49-1015): the regulatory account (A.R.S. § 49-1015 A-D), the state assurance fund (SAF) (A.R.S. § 49-1051 to § 49-1056) and the grant account (A.R.S. § 49-1071 to § 49-1073). By mid-1992, rules governing financial responsibility and the SAF were adopted (A.A.C. R18-12-300 to R18-12-321; A.A.C. R18-12-601 to R18-12-610; ADEQ 1993) and the SAF program began processing applications September 22, 1992.

Although the state can access the SAF for state-initiated cleanups and legal actions, the fund is to be used primarily to assist owners with the costs of mitigating public health and environmental damages resulting from leakages (for costs incurred after Sept. 15, 1989) and to provide a means of partially meeting the financial responsibility provisions. Revenue for the SAF is obtained from a 1 cent per gallon state excise tax on gas and petroleum products that flow through regulated tanks in a given calendar year (A.R.S. § 49-1031 to § 49-1036). In practice, the state has an 18 cents per gallon tax on gasoline and petroleum products, 1 cent of which is designated for this fund (Christman 1995). This tax revenue is split between the SAF and the grant account: nine-tenths of net revenues are credited to the SAF and one-tenth is credited to the grant account, which is capped at $5,600,000. When this limit is reached, all funds are credited to the SAF. The SAF program terminates December 31, 2003 (A.R.S. § 49-1056); the 1 cent tax will continue to be levied but will be directed to the state's general fund.

There were 3,118 sites with LUSTs in Arizona, as of December 31, 1995, requiring remediation: 423 or 13.6 percent were in Pima County, and 1,688 or 54.1 percent were in Maricopa County. It is estimated that cleanup costs for these sites could reach $467 million. National figures show that one in four USTs are leaking. Tara Roesler, the current Arizona underground storage tank section program manager, projects that an additional 2,007 of the 24,000 tanks in Arizona are leaking but unreported, which would require an additional $304 million to clean up. Roesler estimates that it will take 24.5 years to generate the funds necessary for cleanup using the 1 cent tax; however, the program ends in 2003. According to Roesler, 20 percent of the SAF's annual revenue covers personnel and claims administration, with the remainder being spent for cleanup (Kohout 1995b).

Claims made to the SAF and funds paid out, inception to date, December 31, 1995. The SAF program began processing applications September 22, 1992.

Application Data		
Applications received[1]		2,241.00
No. of sites with leaking UST on which applications received[1]		1,130.00
Total amount requested	$120,290752.37	
Reductions against applications[2]	$33,653,965.10	
Net amount requested		$86,636,787.27
Estimated additional work at these sites[3]		$115,149,089.95
Projected net amount requested at these sites		$201,785,877.22
Maximum amount fund is liable for on these applications		$198,980,000.00
Average application amount		$53,677.26
Payment Data		
Application amount paid to date		$46,363,714.65
Number of applications processed to date[1]		1,681.00
Number of sites with leaking USTs on which payments made[1]		877.00
Unencumbered cash balance		$33,035,367.16

Source: ADEQ report filed with EPA administrator, L. Glascoe.
[1]On one site, remediation can be done in stages with an application filed for SAF reimbursement at each stage; one site can have numerous applications filed for reimbursement.
[2]Not all costs are reimbursable by the SAF.
[3]ADEQ estimates how much more money may be requested on pending applications.

Changes were made in the laws governing the SAF during Arizona's 1995 Special Legislative Session to protect the fund. Prior to this legislation, owner/operators who submitted applications could request coverage up to $130,000 with a $5,000 deductible (or $145,000 for costs incurred in 1991 and before) or coverage up to $1 million with a $25,000 deductible (A.R.S. §49-1054, prior to 1995 amendments). The concern was that owner/operators did not have the correct incentives to hold cleanup costs to a minimum, since no matter what the total cost, up to the limit of the coverage, they would necessarily have to pay the deductible. The new law replaces the deductible with a 10 percent co-payment required from the applicant; the SAF will reimburse 90 percent of approved costs up to a limit of $250,000 for costs incurred before Jan. 1, 1992; $225,000 for costs incurred between January 1, 1992 and July 1, 1996; and $1 million for all claims after that time (A.R.S. §49-1054, amended HB 2001, Forty-second Legislature, Fourth Special Session 1995).

Not all costs of remediation will be reimbursed from the SAF. All applications are reviewed and only "reasonable and necessary" costs are considered (A.R.S. §49-1054). Another concern is that previously, owner/operators would have work carried out on their sites and, upon submitting applications to the SAF, find that not all costs were reimbursable. In order to protect owner/operators from incurring unnecessary costs, ADEQ will now require preapproval plans to be submitted and will inform applicants, based on these plans, which costs are reimbursable and which are not (Les Glascoe, personal communication 1996; Dulaney 1996).

The EPA must approve the use of SAF funds as a means for partially meeting financial responsibility requirements. At present, the EPA has approved allowing owner/operators to declare eligibility for $225,000 of SAF coverage as part of establishing financial responsibility. Many owner/operators have been able to obtain some form of private insurance to complete the total required coverage, but the insurance has had a $225,000 deductible. The allowable coverage may be increased to $1 million if EPA approval is granted (Les Glascoe, personal communication 1996). Subsequent to the imposition of the original financial responsibility regulations, small independent station owners found themselves unable to obtain liability insurance to satisfy the financial responsibility requirements, as insurance companies have shown great reluctance to enter this market. In addition, in the event of contamination, owner/operators who have not met financial responsibility requirements will not be eligible for SAF money.

Conclusion

There is no reason to expect the demand for petroleum storage to decline. The historical inability to prevent leakage from USTs, combined with their ubiquity, represents a significant threat to groundwater. In Pima County, significant impacts are from petroleum contamination in soil and shallow groundwater beneath the downtown Tucson area, gasoline from 23 leaking 12,000-gallon tanks at the city of Tucson's Price service center which threaten south-side wells (Bagwell 1993), a plume (area of contamination) of diesel fuel discovered in the regional aquifer beneath the center, and one city drinking water production well, Well B-78A, closed due to petroleum contamination. However, 81 percent of the USTs currently operating in Pima County were installed prior to 1988 (when technical regulations became effective) and may be expected to leak. The deadline for upgrade/replacement is 1998.

For most UST sites, since leaks generally result in subsurface contamination, exposure would generally result from inhaling vapor emissions from subsurface soils. Petroleum constituents can also leach through soils into groundwater. The EPA has typically downplayed the long-term cancer risk of petroleum constituents in groundwater because, while in the short run human exposure can cause nausea and dizziness, typically people can smell gasoline in water and will not consume it over a long period of time. However, contaminated drinking water increases costs for consumers who must find alternative drinking supplies and increases the costs of testing and treatment as mandated by the SDWA.

The statutes governing the use of underground storage tanks address the costs of increasing expected health damages due to contamination and the increased costs of supplying safe drinking water by imposing these costs on owner/operators of USTs through technical, monitoring and maintenance requirements (to reduce contamination incidents), and through requiring soil and groundwater cleanup to prevent drinking water contamination. Funds for cleanup come from private parties as well as from state funds. It is important to note that the state funds used are generated by a tax on petroleum products so that consumers as well as suppliers share in the cost of protecting health and the environment.

The success of preventative measures depends very much on how quickly existing tanks can be upgraded, how safe technology can make new tanks, how effectively monitoring for leaks and spills is carried out, and how safely the tanks are used. At present, owner/operators who do not comply with preventative measures are excluded from applying for SAF money in the case of accidents; however, because of the limited staff of the Inspections and Compliance Unit, inspection cannot be enforced.

Once contamination occurs, the level of cleanup required by statute has been costly to achieve. The financial burden on private parties and the drain on state funds has led to increasing flexibility in determining how clean a site should be in order to be protective of health and the environment. To this end, when determining how much remediation is necessary, either predetermined standards may be used, which are based on the future use of a site and the potential threat to groundwater posed by contamination, or a site-specific risk assessment may be carried out to establish the level of cleanup, which may be less costly to achieve than complying with predetermined standards.

Comparing the costs of remediation efforts, even with more flexible means of determination, to the costs of prevention has led many regulators to express the belief that a greater percentage of limited manpower and funds should be spent on reduction and prevention of contamination (upgrading, monitoring, and inspection of facilities) and a smaller percentage on remediation of contamination.

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