HYDROCARBON FUELS IN GROUND WATER--INCREASED AWARENESS AND CONCERN IN NEW MEXICO

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Introduction

The New Mexico Environmental Improvement Division (EID) has become increasingly aware of the water contamination problems associated with the leakage and surface disposal of hydrocarbon fuels. The hydrocarbon fuels of concern include refined petroleum products such as gasoline, kerosene, gas oil (diesel fuel), fuel oils and lubricating oils. While there have been a number of contamination incidents involving discharges of hydrocarbon fuels to surface streams, this discussion will focus its attention on ground water contamination from hydrocarbon fuels. The following accounts are only two of many situations involving hydrocarbon fuels being brought to the attention of the EID.

The first example is:

> Following large inventory losses in May, June and July of 1981, an old gasoline storage tank at a newly rebuilt gasoline station was excavated. Gross contamination of the soil was encountered during the excavation and a large hole was discovered in the storage tank upon removal. A new underground tank was quickly installed. In October 1981, a resident of a home 60 meters west of the gasoline station complained of headaches and of smelling gasoline fumes. Explosive concentrations of gasoline vapors were detected underneath the house and the soil less than one meter below the ground surface. Backhoe excavations, aimed at reducing the amount of gasoline vapors in the soil, intercepted gasoline floating on the ground water. Company records indicated a loss of approximately 162,157 liters of unleaded gasoline from the old tank. Ground water sampled in the area contained benzene concentrations of 23.0 milligrams per liter (mg/l), 1,000 times higher than the New Mexico Water Quality Control Commission (NMWQCC) regulations ground water standard for benzene (Section

3-103). Legal negotiations for the cleanup of the gasoline and restoration of the aquifer have been underway since July 1982. Explosive concentrations of gasoline vapors, measured as recently as March 1983, have continued to collect in telephone manholes surrounding the station, attesting to the need for a prompt resolution to the problem.

A second example is:

> Diesel fuel contamination of ground water has been found in shallow domestic wells in the alluvium of the Rio Grande Valley near a railroad refueling facility. Diesel fuel has been spilled at the site for more than 30 years during refueling operations. The diesel fuel contamination has migrated more than 300 meters down gradient from the site due to the high permeability of the alluvium and the shallow water table (three meters). Present mitigation measures include catchment basins beneath the tracks, collection drains and a skimmer pump to remove the diesel fuel from atop the water table. Cleanup efforts were impeded, however, by a January 1983 spill of 190,000 liters of diesel fuel. The spill occurred when a railroad car derailed into an aboveground fuel storage tank. The storage tank ruptured, spilling the 190,000 liters of diesel fuel onto the ground.

These situations are not unusual. Week after week, the EID continues to receive information on leakages, spills and disposals of hydrocarbon fuels which have polluted ground or surface waters or which have the potential to impact these waters. As a result of having invested considerable time and money in situations like those described above, the EID is beginning a prevention and mitigation strategy to combat these contamination problems. This strategy involved answering four very important questions.

1. Why is hydrocarbon fuel contamination of ground water a problem?
2. What are the major sources of hydrocarbon fuel contamination?
3. How widespread is the problem of hydrocarbon fuel contamination in New Mexico?
4. What are some possible solutions to the problem?

Hydrocarbon Fuel Contamination of Ground Water Health and Environmental Concerns

The contamination of ground water by hydrocarbon fuels can cause serious environmental and health concerns. The importance of ground water in New Mexico cannot be overemphasized. Approximately 95 percent of the water supplied by public systems is from ground water sources and three-fourths of the state's population is supplied drinking water by these systems (NMWQCC 1982). It is imperative that ground water for present or potential future use be protected from contamination.

When a hydrocarbon fuel reaches ground water, it may be present as both a free-floating phase and as a dissolved or emulsified phase. The free-floating phase may be intercepted by subsurface features such as building foundations, sewer and water lines, and telephone and electric cables. The interception and subsequent collection of fuels at these features causes potentially explosive concentrations of vapors to collect in the subsurface (Yaniga 1982). This is the case in the first situation described above involving the leaking underground storage tank.

In the dissolved or emulsified phase, hydrocarbon fuels may cause objectionable odors and tastes in the water. Of greater concern, however, may be the health hazards resulting from long-term exposure to ground water contaminated with hydrocarbon fuels. Hydrocarbon fuels, such as gasoline, are a mixture of four basic types of hydrocarbon compounds--paraffins, olefins, naphthenes and aromatics (Bland and Davidson 1967). The aromatic hydrocarbons commonly found in gasoline include compounds such as benzene, toluene and xylenes, all of which are extremely soluble in ground water. Although the human toxicological data for

toluene and xylenes are not good, benzene has been causally linked to leukemia, aplastic anemia and other conditions affecting the blood and bone marrow in humans (McQuillan 1982). Ethylbenzene, which may constitute as much as 20 percent of some gasoline blends, may result in chronic respiratory disease and skin disease (U.S. Environmental Protection Agency 1980). In addition, gasoline may contain a variety of additives such as tetraethyl lead which may cause lead poisoning and 1,2-dichlorethane which may result in cancer of the liver. From the standpoint of preserving both health and safety, expedient removal of hydrocarbon fuels from ground water is necessary.

Major Sources of Hydrocarbon Fuel Contamination

There are five aspects of the petroleum industry to review when considering sources of potential contamination. These aspects are production, refinement, transportation, storage and handling, and disposal. This discussion will be confined to those aspects dealing with the refined petroleum products or hydrocarbon fuels. The protection of ground water from crude petroleum production is the responsibility of the Oil Conservation Division of the Energy and Minerals Department. It should be noted, however, that there are a large variety of potential ground water contamination problems associated with the production of large amounts of crude oil in New Mexico. These contamination problems are the result of leakages from surface impoundments and improperly completed or plugged production wells. At least 20 cases of ground water contamination from crude petroleum production have been documented in New Mexico (Boyer et al. 1980).

Refinement. There are currently six active gasoline refineries in New Mexico and numerous gas plants (which produce gasoline as a by-product of natural gas). Ground water contamination has been documented at two of the gasoline refineries and is suspected at the remaining four. Contamination at the gas plants has not been evaluated at this time. The ground water problems associated with these facilities are a result of improper surface disposal, spills and leakages. Additionally, there are several abandoned facilities in New Mexico. One abandoned refinery in particular has gasoline floating on the water table and is suspected of contaminating one nearby private well and potentially may contaminate many others. Benzene levels in the well have reached concentrations as high as 0.28 mg/l, 28 times higher than the NMWQCC ground water standard.

Transportation. The transportation of hydrocarbon fuels by pipeline, railroad and highway may potentially contaminate ground water as a result of leaks and accidental spills. The hydrocarbon fuels commonly released are gasoline and diesel fuel and may involve quantities as large as 40,000 liters.

Storage and Handling. Facilities which store and handle hydrocarbon fuels include bulk terminals, railroad refueling facilities, and private and commercial distribution outlets (e.g., gasoline stations). Surface spillage and disposal, combined with underground leakage, are responsible for ground water contamination in many areas of the state. There are 762 bulk fuel teminals distributed around the state, only one of which has been investigated in detail. Shallow ground water at this terminal is contaminated with hydrocarbon fuel constituents, including benzene and lead concentrations of 45 mg/l and 0.08 mg/l, respectively. Surface dis-

charges of tank bottom water, hydrostatic test water and spillage at this terminal are suspected to have caused the contamination of the subsoils and shallow alluvial aquifer. As the discharges of tank bottom water and hydrostatic test water have long been accepted bulk terminal practices, it is likely that some degree of water and/or soil contamination exists at all bulk terminals. There are five railroad refueling facilities in New Mexico. Two of the five facilities have been investigated and diesel fuel has been discovered floating on the water table at both. There are 2,750 commercial distribution outlets in New Mexico and an unknown number of private distribution outlets. Of main concern at these facilities are gasoline losses due to a failure, in part, of an underground tank and line system. Underground storage tanks may leak due to corrosion or, in the case of fiberglass tanks, as a result of improper installation (figure 1). Product losses aboveground may be due to leakage of aboveground storage tanks or negligent refueling practices. These fuel loss problems are also shared by private facilities which store fuel for their own use rather than retail. These facilities include airports, truck stops, trucking companies, construction companies, rental car agencies, bus companies, and car and truck dealerships.

Disposal. The disposal of "spent" hydrocarbon fuels occurs throughout the state both legally and illegally. Waste lubricating oils, kerosene and fuel oil are often disposed of at recycling facilities, at landfills and in septic tank systems where the water table is shallow and hydrocarbon fuel contamination is possible.

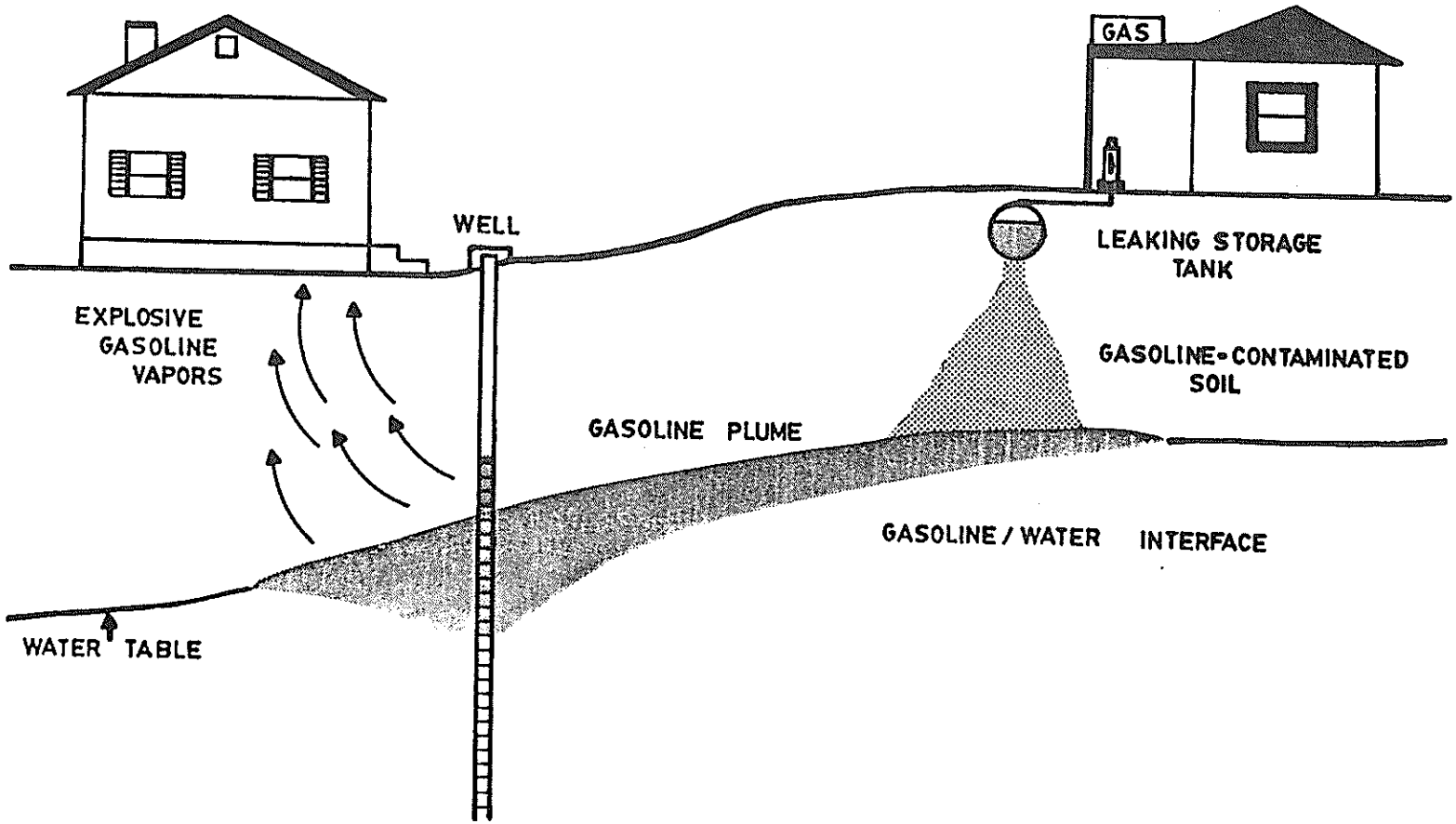

Fig. 1. Overview of Underground Gasoline Leakage and Subsurface Impacts to Soil and Ground Water

Hydrocarbon Fuel Contamination in New Mexico--Extent and Magnitude

In order to evaluate the extent and magnitude of hydrocarbon fuel contamination in New Mexico, it is necessary to consider the number and location of potential sites, the nature and amount of hydrocarbon fuels involved in the discharges, subsurface characteristics of the sites and the depth to ground water. In June of 1982, the EID began to inventory all known or suspected cases of hydrocarbon fuel contamination of ground water as a first step in evaluating statewide impacts. The EID Surface Impoundment Assessment (Boyer et al. 1980) provided a baseline for many contamination incidents. Additional information was obtained through EID drinking water files, ground water files, spill reports and telephone surveys. Of the 78 incidents recorded in the 1982 inventory, more than 32 percent were associated with underground leakage of hydrocarbon fuels from commercial retail outlets (table 1). Commercial retail outlets, such as gasoline stations, may be one of the major sources of concern for the following reasons:

1. Sheer numbers--2,750 operating facilities as of November 1982
2. Many storage tanks put into the ground in the lush service station growth days of the 1950s and 1960s are now 20 to 30 years old and pose a high leakage risk
3. Storage tanks are usually below ground so that leakages are not visually apparent
4. Small leaks, on the order of one or two gallons per day, are not detected by current facility operating practices
5. Largest concentrations of facilities occur in population centers located in the river valleys of the Rio Grande and Pecos River areas characterized by permeable, unconsolidated sediments and shallow water tables
6. The installation of used storage tanks which pose even a higher leakage risk

TABLE 1
Summary of Documented Incidents of Known or Suspected Ground Water Contamination by Hydrocarbon Fuels

FACILITY	UNDER-GROUND LEAKAGE	SURFACE SPILLAGE	SURFACE DISPOSAL
AIRPORTS	0	0	1
BULK-FUEL TERMINALS	0	0	1
RAILROAD FACILITIES	0	1	3
RECYCLING FACILITIES	0	0	2
RETAIL OUTLETS	25	1	2
TRANSFORMERS	0	1	3
TRANSMISSION PIPELINES	2	0	0
TRUCK STOPS	1	0	3
TRUCKING COMPANIES	0	5	5
WASTE SITES	0	0	13
TOTAL	28	8	33

UNKNOWN SOURCES	9
TOTAL INCIDENTS	78

7. An unknown number of abandoned facilities, the majority of which have fuel storage tanks left in the ground

The abandoned gasoline stations may prove to be of as much concern as the active gasoline stations. Four weeks ago, while replacing a floor in a television warehouse, three abandoned underground storage tanks were discovered and upon opening the tanks, the building quickly filled with explosive concentrations of gasoline fumes. The building was closed down by fire officials and tank removing experts were called in. A gasoline station had occupied the site 11 years earlier and the tanks had been filled with sand and abandoned, as required by fire codes. One of the three tanks, however, had been left with approximately 20 centimeters of leaded fuel in the bottom. The portion of sand in contact with the fuel contained 574 parts per million (ppm) organic lead, thus legally qualifying it as a hazardous waste. Approximately 20 barrels of the fuel-contaminated sand had to be shipped out of state to a hazardous waste site at great expense. The remainder of the sand, containing less than two ppm organic lead, was disposed of in a landfill and the tanks were subsequently filled with a concrete slurry. In the past, when fuel prices were lower, large quantities of fuel may have been left in abandoned tanks. Eventually, corrosion of the abandoned tank allows hydrocarbon fuels to escape, potentially impacting ground water. It is clear that the potential health and environmental problems do not necessarily cease when a gasoline station is abandoned.

Compounding this problem of leaking underground tanks from active and abandoned gasoline stations is the fact that there is no agency in the state of New Mexico which knows how many tanks are currently in use.

There are no inventories of underground tanks at abandoned stations or even an inventory of where these abandoned stations are located. Furthermore, there is no used tank tracking at this time. Several of the large United States oil companies have implemented tank integrity programs at those stations for which they have ultimate liability. At each of the stations, all tanks and lines are tested. If the testing reveals any leaks in the tank or line systems, say for instance, one leaking tank out of four tested, then all four tanks are removed and replaced. The companies reason that if the tanks are of similar age and material and are in place in similar soil conditions, then it is only a matter of time before the other three tanks fail. Those three tanks, although each has a high failure risk, are available for resale and reuse. Where do those tanks go? Consequently, the EID cannot predict how many tanks may have leaked or are presently leaking.

Hydrocarbon Fuel Contamination of Ground Water--Possible Solutions

For the past few years, the EID's role in hydrocarbon fuel contamination of ground water has primarily been one of response to contamination incidents. For efficiency and effectiveness, this role must become one of mitigation and prevention. Regardless of the source of contamination, whether it be a bulk fuel terminal, a large refinery or a "mom and pop" gasoline station, responsible parties must be made aware of the environmental and financial liabilities they assume when handling hydrocarbon fuels. Property damages and aquifer restoration costs have climbed as high as $10 million from a single leaking underground gasoline tank. Prevention of losses is in the best interest of all parties.

The EID is currently developing some possible solutions to the problems of ground water contamination by hydrocarbon fuels. The following are some preliminary suggestions:

1. Hydrocarbon fuels or hydrocarbon fuel contaminated water from refineries, bulk terminals or other facilities should be discharged to lined evaporation ponds unless depths to ground water are sufficient to ensure no potential impact

2. Prompt reporting of all losses to local or central EID offices and expedient cleanup of any escaped hydrocarbon fuels

3. Accurate daily inventories of all hydrocarbon fuels stored at a facility and possibly the implementation of leak detection systems at these facilities

4. Development of a statewide inventory of all underground tanks, both active and abandoned; including numbers, sizes, locations, age and contents

5. Development of guidelines restricting the resale and installation of used storage tanks

6. Periodic tank testing of all underground fuel storage tanks, the period to be determined by the age of the tank and type of tank material (steel, fiberglass, etc.)

7. Perhaps most importantly, a more active role by the EID and other regulatory agencies in increasing the public awareness of the significance of ground water contamination by hydrocarbon fuels

These suggestions will involve the cooperation of the state and local fire prevention agencies, the New Mexico Department of Agriculture, and most importantly, the petroleum industry. However, only through such a cooperative effort will it be possible to protect ground water from hydrocarbon fuel contamination in New Mexico.

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