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REGULATION OF THE SPREADING OF
OIL FIELD BRINE ON MICHIGAN ROADWAYS

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REGULATION OF THE SPREADING OF OIL FIELD BRINE ON MICHIGAN ROADWAYS

By

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ABSTRACT

REGULATION OF THE SPREADING OF
OIL FIELD BRINE ON MICHIGAN ROADWAYS

By

Jeffrey E. Herrold

Waste brine from oil and gas operations has been applied on Michigan roadways as a dust palliative and de-icing agent since the 1930s. In 1981 the Supervisor of Wells established a program to regulate the spreading of oil field brine through the use of brine management plans. To examine the effectiveness of this program, the author interviewed seventy-one individuals from government and industry who were familiar with road brining practices and problems. This study concluded that, despite several flaws, the management plan program adequately addressed known road brining problems. Recorded incidents involving improper brine spreading have steadily declined since program inception. The mere fact that the State established a new regulatory program, rather than actual enforcement of approved management plans, has produced a degree of self-regulation by those parties spreading brine. Overly frequent brine applications on some roads was found to be the major problem yet to be resolved.

INTRODUCTION

Saltwater known as oil field brine is produced as a consequence of the exploration for and extraction of oil and natural gas. Brine is naturally occurring nonpotable water laden principally with dissolved chloride, sodium, calcium, and magnesium. Found in the pore space within sedimentary formations, brine will normally be fossil water that was entrapped at the time of the rocks' deposition. Oil and gas operations provide a pathway for this water to move out of the rock and up to the surface.

As shown in Table 1, oil field brine is many times more saline than seawater. Consequently, its disposal necessitates responsible planning to assure that it does not enter and pollute drinking water resources. In Michigan oil field brine is typically disposed of either through injection to subsurface formations or through application upon roadways for dust control or ice removal. In the past little concern existed as to the manner in which oil and gas producers disposed of their brine. In the 1970s, with the rise in public concern over environmental degradation, attention became focussed upon the dumping of brine on Michigan lands. Allegations began to surface that widespread abuses by the transporters of oil field brine were occurring that might adversely impact the waters of the state. Reports indicated that brine haulers were dumping oil field brine into streams, in woodlots, and onto roadways.

TABLE 1

A COMPARISON OF SEAWATER TO MICHIGAN OIL FIELD BRINE

SEAWATER*

Ion	Average Value
Sodium (Na^+)	10,760 mg/l
Calcium (Ca^{++})	413 mg/l
Magnesium (Mg^{++})	1,294 mg/l
Chloride (Cl^-)	19,375 mg/l

MICHIGAN OIL FIELD BRINE+

Ion	Average Value	Approximate Maximum Value
Sodium (Na^+)	50,000 mg/l	90,000 mg/l
Calcium (Ca^{++})	28,000 mg/l	75,000 mg/l
Magnesium (Mg^{++})	6,000 mg/l	16,000 mg/l
Chloride (Cl^-)	160,000 mg/l	250,000 mg/l

* A. Gene Collins, 1975, Geochemistry of Oilfield Waters, Developments in Petroleum Science Series, Volume 1, Elsevier Scientific Publishing Co., Amsterdam, The Netherlands, page 194.

\+ Michigan Geological Survey Division, United States Bureau of Mines, and Cory Laboratory, Inc., 1976, Oil Field Brine Collection and Analysis Program, unpublished analyses of 319 samples.

The Geological Survey Division of the Michigan Department of Natural Resources responded to these growing concerns by developing a set of instructions to regulate the spreading of oil field brine. Ultimately the Supervisor of Wells issued Special Order Number 1-81 to specify approved brine disposal methods and to more tightly regulate the use of oil field brine in road maintenance practices. Issued in March of 1981, this Order was the first attempt to regulate the disposal of oil field brine on a statewide basis.

Special Order 1-81 established a program centered upon the use of brine management plans (hereafter the brine management plan program) administered by the Department of Natural Resources. The purpose of this program was to eliminate environmentally unsound road brining practices. The author has sought to examine the veracity of a supposition widely accepted within the Department, a belief that the brine management plan program has failed to curb brine spreading abuses.

This study will test the following hypothesis: the brine management plan program initiated under Special Order 1-81 has failed to adequately regulate the use of oil field brine on Michigan roadways. The fundamentals of road brining will be introduced along with the rationale underlying the use of oil field brine in road maintenance practices. Federal and state statutes pertinent to the handling and disposal of oil field brine will be reviewed. The past history of the regulation of oil field brine disposal in Michigan will be summarized

with an emphasis upon the origin and implementation of the Supervisor of Wells' order. Current administrative responsibilities in regulating brine disposal practices will be reviewed with particular attention paid to the legal and procedural bases behind existing arrangements. The status of public and private sector compliance with Special Order 1-81 will then be examined in an attempt to define problem areas. Finally, recommendations will be made concerning changes that could be made in the current regulatory framework to improve its effectiveness.

SOURCES OF OIL FIELD BRINE

Oil and gas exploration is one of the two sources of the fluids collectively referred to as oil field brine. During the drilling of an oil or gas well, brine may flow into the borehole from strata beneath the zone of potable groundwater. In part to prevent this influx of brine, most oil and gas drilling operations in Michigan utilize hydraulic rotary equipment. Such equipment requires the circulation of drilling muds down the borehole to provide the hydrostatic pressure necessary to counterbalance the inflow of formation waters or natural gas. These muds normally contain brine to prevent the solutioning of the massive salt beds that overlie many Michigan oil pools. Michigan's salt beds are the thickest encountered by oil and gas drilling operations in the United States.[1] Many drilling operations encounter 1,200 to 1,600 feet of salt and consequently use large volumes of saline drilling muds.[2] The brine in the drilling mud will eventually empty into a lined pit or other surface containment along with rock cuttings that result from the drilling. The resulting supernatant must be disposed of upon completion or abandonment of the well. Thus, exploration may produce brine both from the formations being drilled through and from the muds being utilized in the drilling operation.

Oil and gas extraction, commonly called production, is the second source of oil field brine. Brine exists in the interstices of each of

the nineteen formations from which oil and/or natural gas are produced in Michigan. This brine mixes with the oil or gas being produced and must be separated from the fluid mixture brought to the surface. Separation by gravity, heat, or a combination of methods will result in crude oil or natural gas and oil field brine. The volume of brine present after separation will vary according to two factors: the formation of origin and the productive age of the oil pool. Older oil pools -- those in production since the 1930s and 1940s -- generally produce more brine than oil.

Whether generated by drilling activities or separated from produced oil or natural gas, oil field brine has traditionally been viewed as a waste product requiring disposal. Michigan oil and gas operations annually generate more than 3 billion gallons of brine. From this total, an estimated 50 to 100 million gallons will be spread upon land surfaces to suppress dust, melt ice, or stabilize roadbed materials.

ROAD BRINING FUNDAMENTALS

During the summer months oil field brine is applied on unpaved roads and parking lots to suppress the formation of dust. Summertime heat often evaporates the moisture that bonds together the soil particles of an unpaved road or parking lot. In addition, traffic tends to reduce both the clay and the moisture content of the road surface, leaving it drier and more friable.[3] The action of tires can then erode the dried road, producing dust which may adversely impact people in several ways. Dust produced by a passing vehicle can reduce visibility, creating a hazard for following and oncoming traffic. Road dust can settle on and damage crops or dirty laundry hung outside to dry. The airborne particles can also make breathing more difficult for nearby people and livestock. In general, residents living along unpaved roads find road dust to be a continual nuisance. In a larger sense, most Michiganians are affected by dusty roads. Traffic causes the loss of fine soil particles from the surfaces of unpaved roadways, material which must eventually be replaced. The costs of required road maintenance -- grading, stabilization, or paving -- will be borne by Michigan taxpayers.

Application of oil field brine reduces road dust in two ways. First, brine wets the road surface, binding fine soil particles to one another. Until the water in the brine evaporates, dust cannot form. Second, brine acts as a dust palliative due to the nature of its

constituents. Oil field brine contains sodium, calcium, and chloride ions. As brine evaporates the ions bond to form sodium chloride and calcium chloride. These compounds are hygroscopic: they attract, absorb, and retain moisture from the air surrounding the road surface. Simply put, an application of brine improves the ability of the road surface to attract and retain moisture. Not only does this action delay the formation of dust but it also aids in the retention of roadbed materials, especially in the case of a gravel road.

Oil field brine may also be used in the maintenance practice known as road stabilization. When an unpaved road is graded or resurfaced, brine can be incorporated into the top layer of road materials to improve soil retention. The hygroscopic nature of sodium and calcium chlorides helps the road surface retain moisture, reducing erosion and lowering future maintenance costs. An application of brine for stabilization purposes is normally made at volumes double that which would be applied for dust control.[4]

During the winter months, oil field brine is used to remove ice and snow from roadways. Sodium and calcium ions in the brine lower the freezing point of water, thereby allowing ambient heat to melt ice and prevent its reformation.[5] The sodium and calcium compliment one another. Sodium ions will melt ice and snow when the air temperature is between ten and thirty-two degrees Fahrenheit; calcium ions work at temperatures down to minus thirty degrees Fahrenheit.[6] A mixture of the two can provide ice and snow removal from freezing down to zero

degrees.[7] However, brine is not the most efficient choice for ice or snow removal. Brine has a tendency to refreeze, leaving a highly slippery coating on the pavement. Also, solid granules of sodium chloride (halite or rock salt) will penetrate through ice or snow to break the bond of ice with the pavement; brine does not accomplish this. In general, for snowfalls greater than two or three inches mechanical removal becomes necessary. "Aqueous solutions are not suitable for treatment of thick layers of pure ice or hardened or packed snow."[8]

Approximately 80% of the oil field brine applied to Michigan roads is spread to control dust. The utility of oil field brine as a dust palliative therefore bears closer examination. Calcium concentration will be the most important parameter in assessing the effectiveness of a given volume of oil field brine as a dust palliative. Calcium and sodium chlorides are both hygroscopic. However, calcium chloride attracts and retains water much more readily than does sodium chloride. Whenever the relative humidity exceeds 29%, calcium chloride will pull moisture from the atmosphere.[9] The relative humidity must exceed 80% for sodium chloride to be hygroscopic.[10] Thus, superior dust suppression will be provided by an oil field brine with a relatively high calcium concentration. The effectiveness of oil field brine as a dust palliative will generally be less than a commercially produced brine. As shown in Table 1 above, Michigan oil field brine may contain up to 75,000 milligrams per liter (mg/l) of calcium ions. On the other hand, LIQUIDOW, a calcium chloride brine

sold throughout Michigan as a dust palliative, contains approximately 190,000 mg/l of calcium.[11] A field study by the Dow Chemical Company in Midland County found that LIQUIDOW may provide three times better dust suppression than will a typical oil field brine.[12]

Aside from the Dow study, few studies have been undertaken to document the effectiveness of natural brine as a dust palliative. University of Arkansas researchers conducted field tests using waste brine from a bromide extraction operation.[13] This brine contained 66,800 mg/l of sodium and 32,000 mg/l of calcium, values quite similar to a typical Michigan oil field brine.[14] The Arkansas researchers found that, when applied at a rate of 1,800 gallons per mile per road lane, the waste brine provided dust control for thirty or more days.[15] The experience of county road commissions also suggests that thirty days is the upper limit of effective dust suppression provided by the typical Michigan oil field brine. Consequently, oil field brine may be applied four to six times during the May through September dust control season. This rate may be compared to the suggested one or two applications of commercial calcium chloride brine that would be made in the same period.[16]

Cost is the principal factor underlying the disposal of oil field brine on the public roads. Commercial calcium chloride brine sells for about 27¢ per gallon delivered in most areas of the Southern Peninsula.[17] For an additional 3¢ per gallon, the supplier will apply the brine on his customer's property.[18] Conversely, county

road commissions can obtain oil field brine at little or no cost. In 1981 the Manistee County Road Commission paid 25¢ for each barrel of brine loaded into county vehicles at a well site.[19] This cost is equivalent to 0.6¢ per gallon, considerably less than would be paid for a commercially produced brine. In 1983 the average price of brine had increased slightly to 30¢ per barrel.[20] Southwestern Michigan Dust Control, a company which spreads oil field brine in several counties, charges road commissions 7¢ for each gallon applied.[21] Nonetheless, in many counties oil field brine can be obtained for free at well sites; a road commission need only incur the costs of transporting and spreading the brine.

In all cases examined by the author, oil field brine from drilling pits has been spread upon the public roads at no charge to county road commissions. Brine removed from a drilling pit contains suspended solids from the spent drilling mud and cuttings held in the pit. These particulates tend to clog the pores of subsurface formations when drilling pit brine is placed down a brine disposal well. Consequently, disposal well owners are often reluctant to accept fluids from drilling pits. Flocculation and settling or mechanical filtration can remove the suspended solids but these operations increase disposal costs. Both transportation and disposal costs can be minimized by spreading drilling pit brine on roadways near well sites. In this manner a producer can empty a drilling pit at a minimal cost while a road commission can gain a degree of dust control on some county roads without spending any tax dollars.

Since oil field brine has a very low dollar value, the cost of transporting the brine to a disposal site normally outweighs the profit that can be gained through its sale. This fact underscores the brine transporter's desire to haul oil field brine a minimal distance from a well site. That desire in turn may lead to illegal disposal of brine through outright dumping into streams, in woodlots, or onto roadways. Since the mid-1970s reports of road brining abuses have centered upon the actions of licensed industrial waste haulers. Anyone seeking to haul liquid industrial wastes, which include oil field brine, from the premises of another must be licensed under the provisions of Michigan's Liquid Industrial Wastes Act. Licensed waste haulers transport much of the oil field brine taken for disposal.

The most important consequence of brine dumping by these waste haulers is the potential contamination of drinking water supplies. Several incidents of water well contamination in Michigan have been linked to road brining activities. Table 2 lists sites where water supply wells are believed to have been contaminated by road brining activities. In each case oil field brine has been repeatedly spread on nearby roads. Well water contaminated as a result of road brining will normally contain less than 600 mg/l of chloride. This contaminated water may be characterized by a salty taste but will not necessarily pose a hazard to the health of its users. The United States Environmental Protection Agency has recommended that 250 mg/l be the maximum concentration of chloride in water for domestic use.[22] This standard was based upon palatability and not upon adverse health

TABLE 2

SITES OF WATER WELL CONTAMINATION POSSIBLY ATTRIBUTABLE TO THE USE OF OIL FIELD BRINE UPON MICHIGAN ROADWAYS

(1) Peterson and other residences
Mill and Fouch Roads
Section 28, Blair Township
Grand Traverse County

(2) Harper, Peterson, and Wolfinger residences
Chula Vista Drive
Section 22, Big Rapids Township
Mecosta County

(3) Potter and Quinn residences
U.S. Route 131
City of Big Rapids
Mecosta County

(4) Adams and Jewett residences
72nd Avenue
Section 6, Weare Township
Oceana County

(5) Martell residence
Arrowhead Trail
Section 27, Bagley Township
Otsego County

(6) Depew residence
Colfax Street
City of Cadillac
Wexford County

(7) Forsgren residence
41½ Road
Section 4, Cedar Creek Township
Wexford County

(8) seven wells
Plett Road area
Section 34, Haring Township
Wexford County

effects. Given time for the body to adjust, a healthy person can consume water with up to 2,000 mg/l of chloride with no ill effect.[23] However, a high concentration of chloride in a well's water may indicate the presence of sodium and excessive sodium can be harmful to individuals suffering from cardiovascular or kidney diseases. In the eight cases listed in Table 2, no well sampled contained more than 550 mg/l of chloride and no health effects have been reported to state officials.

In brief, oil field brine may be spread to control dust on unpaved roads, incorporated into the surfaces of unpaved roads to provide soil stabilization, or applied to roadways to remove ice and snow. Much of the oil field brine annually spread on Michigan roads is applied to control dust. Although commercial brine can provide superior dust suppression, individuals often opt to use oil field brine because it can be obtained at little or no cost. Continual applications of oil field brine on particular roads have probably been responsible for a number of cases of known water well contamination. To date, however, no adverse health effects have been observed as a result of these incidents.

FEDERAL AND STATE STATUTES

Federal statutes of interest to this study focus upon the protection of the environment and the public health from harm. The federal government can play a major role in protecting the health, safety, and welfare of its citizens. Brine spreading activities may be seen as falling under the purview of three principal federal acts. However, no federal statute, rule, or regulation appears to directly impact the spreading of oil field brine on Michigan roadways.

Oil field brine is a liquid waste product which may pollute water supplies if not properly handled during disposal. The Resource Conservation and Recovery Act of 1976 (RCRA) contains provisions which govern solid waste management practices.[24] Under RCRA solid waste includes solid, liquid, and semisolid wastes from industrial, commercial, mining, and agricultural activities.[25] One objective of RCRA is the prohibition of open dumping.[26] An examination of the Act's legislative history indicates that "open dumping" refers to the use of nonregulated disposal sites such as the proverbial town dump.[27] Nevertheless, "open dumping" could encompass uncontrolled spreading of waste brines on road surfaces. The United States Environmental Protection Agency (EPA) was charged with defining those solid waste management practices which constitute open dumping but did not mention waste brine spreading in its State Waste Management Plan Guidelines.[28]

RCRA also provides for the establishment of regulations to govern the disposal of hazardous wastes. Oil field brines have been specifically exempted from the promulgated regulations:

> Solid wastes which are not hazardous wastes....(5) Drilling fluids, produced waters, and other wastes associated with the exploration, development, or production of crude oil, natural gas, or geothermal energy.[29]

In summary, neither RCRA nor its promulgated regulations currently govern land surface applications of oil field brine.

The Federal Water Pollution Control Act protects water resources in part by establishing a National Pollutant Discharge Elimination System (NPDES).[30] The NPDES rules establish a permit system to govern discharges into navigable waters from point sources which, by definition, would appear to include a vehicle applying oil field brine. However, since brine is spread upon land surfaces rather than discharged into water, NPDES permit requirements do not govern brine spreading activities.

The brining of unpaved roads can pose a potential threat to public drinking water supplies. Brine can percolate through the roadbed and into freshwater aquifers, introducing compounds such as chloride into potable water resources. The Federal Safe Drinking Water Act sets national drinking water standards for public water supplies.[31] Under this Act, the EPA has established primary and secondary maximum

allowable levels of particular contaminants for public drinking water supplies. A primary maximum contaminant level or PMCL serves as the upper limit for the quantity of a particular contaminant allowable in drinking water. A secondary maximum contaminant level or SMCL sets a limit necessary for the protection of the public welfare in the judgement of the EPA. In other words, a SCML serves as a recommended limit rather than a legal limit. The EPA has established a SCML for chloride at 250 milligrams per liter, a recommendation based upon taste rather than health effects.[32] If the spreading of oil field brine were to adversely impact public water resources, this SCML could serve as a basis for determining contamination.

The three federal statutes discussed above are parallelled by several Michigan statutes. For example, provisions found in RCRA are embodied in two acts. Act 641, the Michigan Solid Waste Management Act, governs the management of solid wastes but, unlike RCRA, does not include liquids or semisolids in its definition of "solid waste."[33] Act 64, the Michigan Hazardous Waste Management Act, parallels those sections of RCRA which provide for the establishment of hazardous waste management regulations.[34] However, like the RCRA rules, Michigan's Hazardous Waste Management Rules exempt oil field brine from regulation as a hazardous waste.[35]

State permit requirements for discharges to ground and surface waters have been established under Act 245, the Water Resources Commission Act.[36] The use of oil field brine on roadways could be construed as

a potential discharge to groundwater. However, the Water Resources Commission General Rules exempt brine spreading activities from permit requirements. Under Rule 2209(1):

> The following activities do not require a permit from the commission or a hydrogeological report or groundwater monitoring, except as may be required by the commission on a case-by-case basis, where such activities are or may become injurious to the protected uses of a usable aquifer:...(b) Controlled application of dust-suppressant chemicals used with normally accepted or regulated practices [and] (c) Controlled application of de-icing chemicals used with normally accepted or regulated practices...

As noted above, the EPA has set a SCML for chloride in public water supplies that potentially has an indirect bearing upon road brining operations. From a state enforcement perspective, however, the impact of this SCML is nil. Act 399, the Michigan Safe Drinking Water Act, does not adopt any SCML proposed by the EPA.[37] Thus, road brining activities stand largely exempt from state water protection statutes.

The authority to regulate the use of oil field brine on Michigan roadways lies in Act 61, the Supervisor of Wells Act.[38] Under Section 6(c) of this Act, the Supervisor of Wells holds the authority to regulate the disposal of oil field brine:

> (T)he supervisor...is specifically empowered...to require the disposal of salt water and brines and oily wastes produced incidental to oil and gas operations, in such manner and by such methods and means that no unnecessary damage or danger to or destruction of surface or underground resources, to neighboring properties or rights, or to life, shall result.

Rule 601 promulgated under Act 61 states: "Brine or salt water resulting from oil and gas drilling and producing operations shall be stored, transported and disposed of in such manner as may be approved by the supervisor." Rule 602 further states that such brine "shall be returned to an approved underground formation or otherwise disposed of as approved by the supervisor..."

On March 3, 1981 the Supervisor of Wells issued Special Order Number 1-81 to govern the disposition of oil field brine. The author has compiled the provisions of this order and its subsequent amendments in Appendix A.[39] Special Order 1-81 establishes the approved methods of oil field brine disposal. The five principal methods are as follows:

1. injection to an approved subsurface formation by means an approved brine disposal well;
2. injection to a subsurface formation pursuant to an approved secondary recovery plan;[40]
3. use as a constituent in hydraulic drilling muds;
4. use on oil and gas production facility access roads for dust control, ice removal, or road stabilization upon annual written authorization from a District Supervisor of the Geological Survey Division; and
5. use on public roads and private properties for dust control, ice removal, or road stabilization in accordance with a brine management plan approved pursuant to procedures adopted by the Water Resources Commission.

One final Michigan statute does establish authority to regulate oil field brine disposal practices independent of Special Order 1-81.

Act 136, the Liquid Industrial Wastes Act, contains an obscure provision that governs the disposal of liquid industrial wastes such as oil field brine.[41] Section 8(4) states that licensed waste transporters shall not dispose of wastes onto or into the ground except at locations specifically approved by the Water Resources Commission. To date the Commission has not utilized this provision to regulate land surface applications of oil field brine.

PAST REGULATORY ACTIONS

Michigan's petroleum industry has enjoyed a relatively long and prosperous history. Exploration began in the 1860s soon after the initial North American oil discoveries in Pennsylvania and Ontario. Twenty years passed before a driller, while searching for natural gas, struck oil near Port Huron in 1886. Sporadic exploration continued until the first commercially successful oil operation began in the City of Saginaw in 1925, marking the emergence of a new industry in the state. By the late 1930s Michigan had become one of the nation's leading oil producers.[42]

During the years that followed the opening of the Saginaw Field, oil field brine was often held in large surface lagoons or smaller earthen pits prior to disposal. While some of these storage sites were lined with clayey soils, many provided no barrier to impede the seepage of brine into the waters of the state. The use of brine lagoons faded by the late 1940s. Earthen pits declined in number, replaced by tanks of wood or steel. By the beginning of the 1980s open pits could only be used to temporarily hold brines produced during drilling operations. Also, impervious plastic liners were now required for nearly all of these drilling pits.

While brine storage facilities evolved towards improved containment, the ultimate destinations of waste brine also changed. In 1937, the

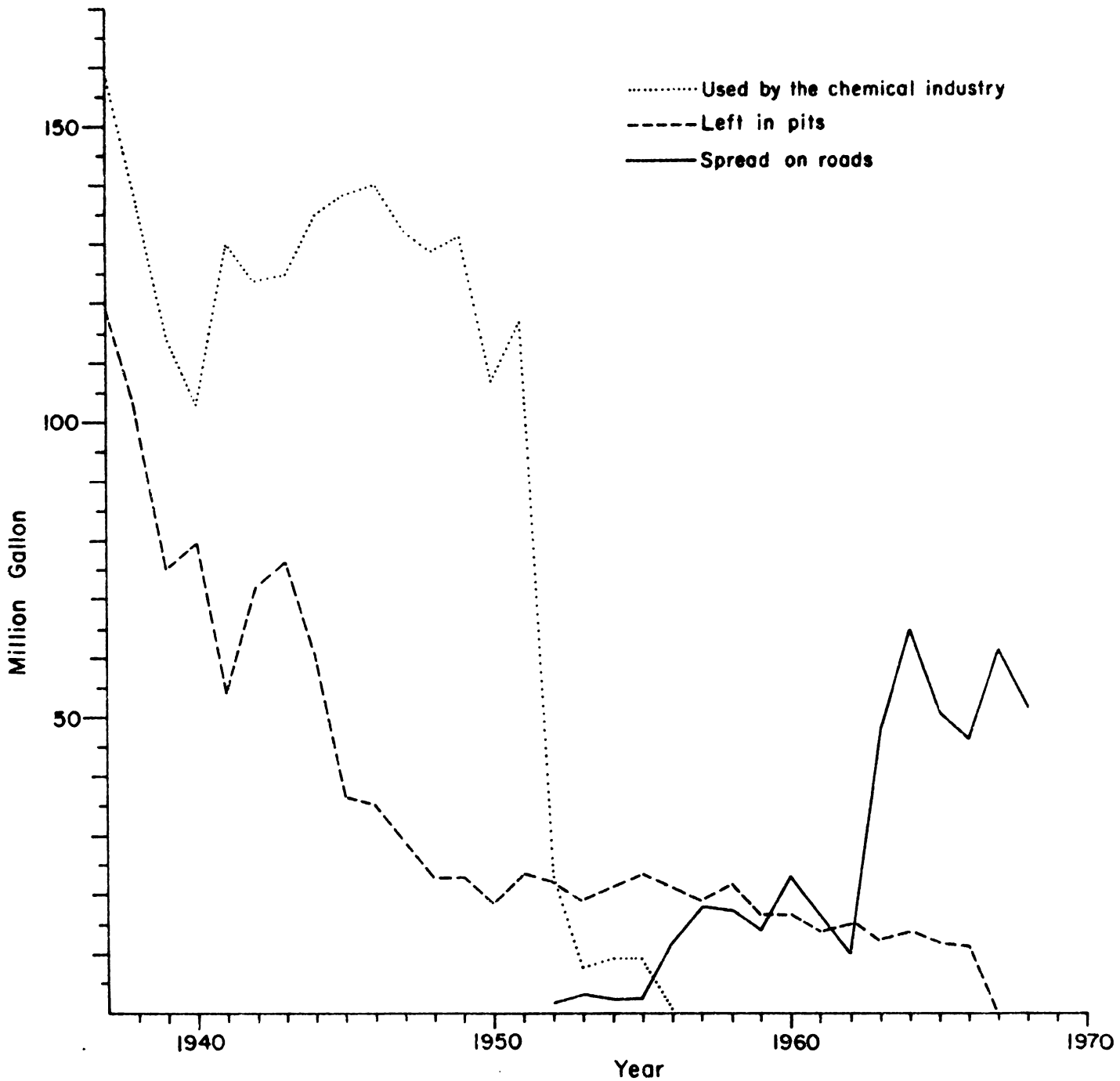
first year in which records were kept, one-half of the brine generated by oil and gas operations was returned to subsurface formations.[43] Approximately one-quarter of the brine produced was used by the chemical industry, usually as a source of sodium or calcium chloride. The rest was left in pits to evaporate or seep away. Figure 1 illustrates the trends in brine disposal throughout the years of recordkeeping. The year 1952 marked a sharp decrease in the use of oil field brine by chemical companies and a corresponding initiation of its recorded use on roadways. Furthermore, as the use of earthen pits declined in the early 1960s, the amount of brine used on roads increased.

In 1983 more than 3.8 billion gallons of brine were generated by Michigan oil and gas operations.[44] Approximately 98% of this total was returned to subsurface formations.[45] Nonetheless, based upon the most accurate data presently available, 79 million gallons of oil field brine were spread on roadways in fifty-eight counties.[46] This figure is likely to be conservative due to the imprecision of the Michigan Geological Survey Division's data collection procedures. The estimated quantity of brine separated from oil or gas at each well is supplied to the Division by the well operator. Division personnel then attempt to record the manner in which that brine was disposed. The estimated quantity of brine drawn from each drilling pit is derived through simple volumetric calculation. Data for 1983, the most recent reporting year, show that 57 million gallons of production facility brine and 22 million gallons of drilling pit brine were used

Figure 1

OIL FIELD BRINE DISPOSAL (1937-1968)

Excluding brine returned to subsurface formations



for road maintenance purposes. In reality the amount of oil field brine used on Michigan roadways annually may well be greater than the 79 million gallons on record.

Geological Survey statistics first record the disposal of oil field brine on roads in 1952. Waste brine has in fact been spread on Michigan roads since the infancy of the oil industry. The first allegations of adverse impacts resulting from brining also date from this period. Reports surfaced as early as 1936 of injury to roadside trees caused by the use of oil field brine as a dust palliative.[47] Forrest C. Strong of the Michigan State College (now University) examined these reports and found evidence of foliage damage attributable to the spreading of oil field brine.[48] He discovered that when a road surface dries after brining, a fresh layer of dust containing salts could be lifted by the wind to coat nearby foliage. The salt, in turn, caused leaf browning (necrosis) detrimental to the trees' vigor.

Although forty years have since passed, one factor governing the disposal of oil field brine has remained constant. In 1944 Strong wrote: "As the brines represent waste products and are consequently cheap, they have sometimes been applied too heavily so that there was a considerable run-off [sic] which killed vegetation."[49] In recent years the runoff of applied brine to low-lying areas is believed to have killed roadside maple trees in Kent County and a stand of poplars in Gladwin County. A more serious concern to arise recently was

speculation that brine runoff or seepage was contaminating drinking water supplies. Beginning in 1976 several Michigan Department of Natural Resources employees expressed the belief that road brining adversely impacted the groundwater in many areas of the state. Particular attention was drawn to the actions of brine haulers who were believed to be dumping loads of oil field brine on roads adjacent to well sites. Interest was sparked within the Geological Survey Division to more carefully examine road brining practices.[50]

In early 1978 Douglas L. Daniels, a field geologist in the Geological Survey's Plainwell District, became concerned about the misuse of oil field brine on roads in Allegan County. Industrial waste haulers were rumored to be dumping large quantities of oil field brine on the county's roads. Allegan County lies in one of the state's older oil producing areas. Older wells often produce brine in volumes much greater than the oil they produce; for each barrel of oil, operators in the Allegan fields may have several barrels of brine requiring disposal. After discovering that no one knew how much brine was being spread on the county roads, Daniels discussed the situation with an Allegan County Road Commissioner and a representative from the Department's Water Quality Division. He then developed and circulated a set of guidelines to govern the use of oil field brine on roads within the Plainwell District.[51] These guidelines were later incorporated in a formal "Notice to All Oil and Gas Producers" issued on June 19, 1978 by the Assistant Supervisor of Wells Arthur E. Slaughter (Appendix B).

The Assistant Supervisor's Notice contained many of the stipulations embodied in subsequent attempts to regulate brine disposal. The Notice prohibited brine applications during or immediately after rainfall and required spreading vehicles to be in motion while applying brine. Producers were asked to keep records of the amount of brine taken from their facilities for use on roads. Most important, the Notice stipulated that brine spreading must be done in a manner which prevented runoff to ditches or watercourses and also guarded against the contamination of groundwater resources. Through these and other provisions, the intent of the Notice was made very clear -- oil field brine was not to be disposed of through dumping disguised as road maintenance work.

Despite some excellent provisions, the Notice failed to curb road brining abuses due primarily to a lack of enforcement by Geological Survey personnel.[52] As noted previously, haulers of oil field brine were deemed to be responsible for most brine disposal problems. At the time when the Notice was issued, the Department's Water Quality Division regulated the activities of these waste haulers. Geological Survey field staff believed that Water Quality personnel, rather than themselves, should be responsible for overseeing road brining. In addition, Geological Survey Division administrators did not issue any instructions concerning the implementation of the Notice. In the absence of a firm commitment to monitor brine spreading activities, the Geological Survey Division did not effectively regulate the disposal of oil field brine. A new, more forceful approach was needed.

In the later part of 1980, faced with growing concern about brine dumping abuses, the Supervisor of Wells contemplated the issuance of an order to control the disposition of oil field brine. A public hearing was held on December 22 to receive testimony concerning the need for such an order. Oral or written statements were presented by the Michigan Oil and Gas Association, the Dow Chemical Company, the Michigan Environmental Council, numerous industry representatives, and several county road commission officials. A position statement was read by the Engineer-Director of the County Road Association of Michigan, the organization which represents the state's eighty-three county road commissions. Personnel from the Geological Survey and Water Quality Divisions also testified. From the evidence presented, the Supervisor reached two conclusions.[53] First, oil field brine had utility when properly used for drilling or road maintenance purposes. Second, the misuse of brine posed a potential threat to freshwater resources which required that its disposal be carefully controlled. Based upon these conclusions, the Supervisor issued Special Order Number 1-81 on March 3, 1981 (Appendix A, Paragraphs 1 through 5). The intent of the Special Order was two-fold: to designate acceptable methods of oil field brine disposal and to more tightly regulate the use of that brine on the public roads.

Shortly after the issuance of Special Order 1-81, the Geological Survey Division began to receive inquiries from oil and gas producers. They were confused by the Order's provision permitting the brining of their facility access roads and asked that the language of

this provision be clarified.[54] Comments were also received during this time from industrial waste haulers and other parties. These individuals complained that the Supervisor's Order precluded the use of oil field brine on private property. These concerns were addressed in a public hearing on October 13, 1981. After the hearing, the Supervisor concluded that the use of oil field brine on facility access roads and private properties was appropriate for dust and ice control. Paragraphs 7 and 8 were added to the original Order on November 3, 1981 (see Appendix A).

Through Special Order 1-81 and its amendments the Supervisor of Wells has defined the approved methods of disposal for oil field brine. These methods include the use of oil field brine for dust control, ice removal, and road stabilization on public roads and on private properties. The Supervisor's Order necessitated the creation of an administrative process through which these uses could be properly regulated. At the heart of that process lies a document known as a brine management plan.

Under Paragraph 1 of Special Order 1-81, the use of oil field brine on the public roads must be "in accord with a plan approved pursuant to procedures adopted by the Water Resources Commission." In the months following the issuance of Special Order 1-81, personnel in the Water Quality Division drafted a set of procedures for the Commission's consideration. In the minutes of the June 18, 1981 meeting of the Water Resources Commission appears the following statement:

The Executive Secretary presented the following draft procedures for obtaining approval of road brining management plans for use of oil field brines:

> "The March 3, 1981 Special Order No. 1-81 of the Supervisor of Wells allows the use of oil field brines by governmental units for ice and dust control if done in accordance with a plan approved pursuant to procedures adopted by the Water Resources Commission.
>
> Approval of management plans is contingent on compliance with Act No. 136, Public Acts of 1969, the Liquid Industrial Waste Haulers Act [sic] and the following Rules of the Water Resources Commission to prevent pollution of the waters of the state in the transporting, storage, handling and use of such brines:
>
> Part 4 Rules, Water Quality Standards
> Part 5 Rules, Spillage of Oil and Polluting Materials
> Part 22 Rules, Ground Water Quality Standards
>
> A management plan should detail the manner in which brines will be transported; equipment or contract services to be used; ownership of vehicles; the storage facilities to be used including a Pollution Incident Prevention Plan (PIPP); the manner in which road brining will be carried out to prevent runoff into surface drains and watercourses; application rates and equipment to be used; and the manner and facilities to be used to prepare salt/sand mixtures to prevent contamination of groundwaters.
>
> Failure to operate in accordance with the approved management plan may result in loss of approval to accept oil field brines."[55]

By an unanimously approved motion, the Water Resources Commission chose to "concur" with these draft procedures.[56] This action may have constituted a formal adoption of procedures as required by Special Order 1-81.

From these procedures personnel in the Water Quality Division developed "Guidelines for Preparation of an Interim Brine Management

Plan under Supervisor of Wells Order 1-81" (Appendix C). Commission meeting minutes contain no reference to an adoption of these "Guidelines;" their acceptability may be inferred based upon their development from the above procedures. The "Guidelines" set forth the required contents of a brine management plan. Five topics must be fully addressed by an applicant in order for a submitted management plan to be approved. An applicant must:

1. describe the location and owner of each well from which brine will be taken for use by the applicant;
2. describe the location, construction, and operation of the applicant's brine storage facilities;
3. provide a Pollution Incident Prevention Plan (PIPP) for each brine storage facility owned by the applicant;
4. describe the vehicles which transport and spread brine for the applicant; and
5. describe the method, quantity, and frequency of brine applications for dust control and for ice removal.

The "Guidelines" also contain several caveats. Brine must be applied "in a manner to prevent direct runoff to any watercourse or from the road surface."[57] Brine applications may be made only when the spreading vehicle is in motion and all spills must be promptly reported to the Department of Natural Resources. Furthermore, brine may not be used for snow removal when effective removal can be attained by plowing. Most important, management plan recipients are required to maintain up-to-date records of their activities. These records must show the date, volume, and specific location of each

brine application as well as a listing of the brine source and transporter. Records must be kept for a three-year period and be available to Department personnel for inspection upon demand.

The brine management plan serves as the keystone of the Department's administration of the Supervisor's Order. Under Special Order 1-81 as amended, management plan approval must be obtained prior to any use of oil field brine on public roads or private properties. Only a governmental body or agency, such as a county road commission, may hold a management plan permitting the spreading of brine on the public roads. Conversely, any party with a legitimate need for dust control or ice removal on private property may submit a brine management plan for approval. The first brine management plans, for the City of Standish and the Kalkaska County Road Commission, were approved on December 15, 1981.[58] To date ninety-eight management plans have been approved under the "Guidelines;" the majority of these plans were approved from May through August in 1982.[59]

One further administrative action was taken subsequent to the issuance of Special Order 1-81. To examine and improve brine handling practices under the new brine management program, the Department initiated a Brine Task Force in May of 1982. Its charge was to develop a "brine handling/disposal management system including Water Quality Division policies and procedures... [that is] consistent with existing Department statutes and regulations."[60] With members drawn from the Environmental Enforcement, Geological Survey, and Water

Quality Divisions, the Brine Task Force met from June 24 through November 1, 1982. Although the Task Force was not formally dissolved, no report was issued and no new brine management system was proposed or implemented. Task Force members did, however, reach a consensus on several issues.

Task Force members concluded that the use of oil field brine on roads was "adequately regulated by the terms of Special Order 1-81" but that current staffing was insufficient for proper monitoring and enforcement of the Order's provisions.[61] They recommended increased staffing to counter the Department's inability to adequately monitor brine management plan compliance, particularly in areas of accelerated drilling activity. Members also recommended that information concerning brine spreaders operating under another party's management plan should be entered into the Law Enforcement Information Network (LEIN) maintained by the Michigan State Police. The LEIN system contained data, such as motor vehicle registrations, which could be transmitted to peace officers by shortwave radio. Once in the LEIN system brine management plan information could be speedily accessed by enforcement personnel statewide.

THE DEPARTMENT OF NATURAL RESOURCES

The Department of Natural Resources (DNR) has been designated by executive order as the state entity responsible for the "coordination of all environmental functions and programs of the state of Michigan."[62] Its duties include the protection of persons and property from environmental harm to land resources, water quality, and land-water interfaces. Furthermore, the DNR holds the responsibility to protect the health of Michigan citizens through the prevention of health hazards associated with liquid and solid wastes.

At present, the DNR holds the only statutory authority to directly regulate the spreading of oil field brine in Michigan. That authority chiefly resides with the Supervisor of Wells, a cabinet level position held by the DNR Director. Current regulation of oil field brine disposal involves four DNR Divisions: Geological Survey, Groundwater Quality, Hazardous Waste, and Law Enforcement. Of these four divisions, Geological Survey and Groundwater Quality play the leading roles in the current brine management program.

The Geological Survey Division monitors all aspects of oil field brine disposal under Special Order 1-81 except the use of brine on public roads and private properties. Geological Survey personnel issue permits for brine disposal wells and periodically inspect these facilities. The Division approves secondary recovery plans under

which a producer may inject oil field brine into an oil-bearing formation to increase production. Also, a District Supervisor of the Geological Survey Division may authorize the use of oil field brine in hydraulic drilling muds. Of greatest interest to this study, this Division regulates road brining on oil and gas lease sites.

Under Paragraph 7 of Special Order 1-81, the Geological Survey Division oversees the use of oil field brine on oil and gas production facility access roads. A District Supervisor, acting as the representative of the Supervisor of Wells, may grant annual written authorization to an operator allowing the brining of his production facility access roads. Applications for this authorization must follow provisions set forth in a November 9, 1981 memorandum from the Chief of the Geological Survey Division. To date no such applications have been submitted to any District Supervisor and, therefore, no access road brining has been authorized in the state.

Groundwater Quality is currently the lead Division in administering the Department's program governing land surface applications of oil field brine. In order to spread oil field brine on public property, a governmental body must obtain approval of a brine management plan. Private property brining can begin after the Division has approved a management plan submitted by an individual, company, or cooperative association. From June 1, 1981 through June 30, 1983 the circulation and review of management plan applications was accomplished by one centrally located contact person within the Water Quality Division.

On August 1, 1983 this person's application review responsibilities were transferred to the District Supervisors within the newly formed Groundwater Quality Division. All brine management plans on file in Lansing were disseminated to the eight District Headquarters that serve the Southern Peninsula. The Division does not maintain a comprehensive central file of approved management plans.

As the third Division involved in oil field brine management, the Hazardous Waste Division is responsible for the licensing of brine transporters and their vehicles. Once a function of the defunct Water Quality Division, the administration of Act 136 under which these liquid industrial waste haulers are licensed is now handled by Hazardous Waste personnel. Licensed waste haulers must maintain trip records for each load of brine transported, with a two-month record to be carried on the transporting vehicle. Trip records from all of the licensee's vehicles must be preserved for two years. Hazardous Waste personnel do not yet inspect vehicle-carried records. Licensee facilities are to be inspected annually; vehicles that transport brine will not be inspected unless they are present during this inspection visit. Under Section 8 of Act 136, the outside of the hauling vehicle and its accessory equipment must be kept clean but the Division has not yet issued any additional vehicle maintenance requirements.

Law Enforcement is the fourth Division involved in the current oil field brine management program. Law Enforcement personnel assist the other three Divisions in implementing and enforcing orders, rules, and

laws relevant to brine management. The Division's field personnel, known as conservation officiers, carry the same authority as is vested in the Michigan State Police. Conservation officers can aid in the collection of evidence against and observation of suspected brine management plan violators. Conservation officers play a vital role in field enforcement because the stopping of a suspected violator on a public road must by law be done by a uniformed officer in a vehicle equipped with a light and a siren.[63] Thus, of the Department personnel involved in brine management, only a conservation officer may stop a brine spreader who the officer has probable cause to believe is improperly applying oil field brine on a county road.

Under the current regulatory framework, the field staffs of the Geological Survey and Groundwater Quality Divisions carry the bulk of responsibility for monitoring road brining activities. Both brine management plan applications and access road brining proposals must be submitted to field offices for review and approval. Field personnel interviewed by the author stated that they have been acting under the following supposition: the Geological Survey Division will be responsible for overseeing the handling of brine on oil and gas lease sites while the Groundwater Quality Division will assume this responsibility after the brine has been removed from a lease site. As will be demonstrated, this is a false supposition.

Under Department Policy Number 2305, the Supervisor of Wells "shall be responsible for...all handling and disposal of oil-field brines."[64]

By this policy the Geological Survey Division, which acts as the Supervisor's representative, would appear to have been designated as the Division responsible for regulating oil field brine. Furthermore, under Department Procedure Number 4505.5:

> The Geology Division is responsible for all investigations, clean-up, and enforcement action for losses resulting from oil and gas well operations. This includes...the handling, storage and disposal of produced brines.[65]

These policy and procedure statements indicate an intent by the Department of Natural Resources to delegate oil field brine management responsibilities to the Geological Survey Division. Furthermore, contrary to the interviewee supposition cited above, the Groundwater Quality Division has <u>not</u> been assigned the task of regulating the handling of oil field brine after its removal from a lease site. The Supervisor of Wells' Order does not assign brine management plan administration responsibilities to a specific Division.

A review of past events leads to the conclusion that Groundwater Quality personnel administer the Department's management plan program for two reasons. The Water Quality Division, predecessor of today's Groundwater Quality Division, acted as the representative of the Water Resources Commission, which had been asked by the Supervisor to adopt procedures to govern road brining activities. Water Quality personnel drafted the procedures adopted by the Commission; one would logically expect the same personnel to assist in the development of the

management plan program which was to be based upon those procedures. Also, at the time of the Order's issuance, the Water Quality Division was responsible for regulating the activities of liquid industrial waste haulers. These waste haulers not only transported much of the oil field brine taken for disposal but were also held to be responsible for most instances of improper road brining. Water Quality personnel could naturally be expected to participate in any new program designed to more tightly monitor the disposal of oil field brine by licensed waste haulers.

The brine management plan approach has received little active support from either Geological Survey or Groundwater Quality personnel. Due to the supposition cited previously, Geological Survey field personnel have largely avoided direct involvement in monitoring road brining activities. In only one of six districts have Survey personnel assumed a more active role in regulating brine spreading practices. Coincidentally, in only one district have Groundwater Quality personnel actively monitored compliance with plans approved by their own Division. In fairness to field personnel in both Divisions, no effort had been made until August of 1983 to distribute copies of approved management plans to field offices even though the program had been in operation for more than two years. Furthermore, only Groundwater Quality District personnel received the management plans distributed to the field. Geological Survey and Law Enforcement field staffs do not yet have ready access to approved plan files. Without access to management plan particulars, Department field personnel are

unable to determine whether illegal brine spreading is occurring in a given situation.

OTHER STATE DEPARTMENTS AND AGENCIES

The Michigan Department of Public Health (DPH) is responsible for the protection of human health "through the management, control, and prevention of environmental factors which may adversely affect the health of individuals. This activity is concerned with the existence of substances, conditions, or facilities in quantities, of characteristics, and under conditions, circumstances, or duration which are or can be injurious to human health."[66] Given this broad mandate, the environmental risks inherent to land surface applications of oil field brine could fall within the domain of the DPH. As the environmental health agency for the state, the Department must:

- Advise the governor, boards, commissions, and state agencies on matters of the environment as those matters affect the health of the people of this state.[67]
- Develop and maintain the capability to monitor and evaluate conditions which represent potential and actual environmental health hazards, reporting its findings to appropriate state departments and local jurisdictions, and to the public as necessary.[68]
- Serve as the central repository and clearinghouse for the collection, evaluation, and dissemination of data and information on environmental health hazards, programs, and practices.[69]

Clearly, the DPH could play an advisory role in the regulation of brine disposal practices. The Department could gather information on the environmental fate of brine applied to road surfaces and then evaluate the seriousness of attendant health risks. However, DPH

statutory authority does not include the power to directly regulate brine spreading practices.

The Michigan Department of Transportation (DOT) would seem at first glance to be a natural candidate to regulate brining operations on Michigan roadways. Instead, DOT holds no direct responsibility for supervising brine spreading activities on county roadways. County road commissions have jurisdiction over primary and local roads listed under a duly adopted county road system.[70] These county road systems included all public roads save for federal routes, state trunkline highways, and city streets. Furthermore, road commissions hold authority to maintain roads under their control by methods of their own choosing.[71] Thus, as long as oil field brine is spread upon a road under county jurisdiction, the DOT lacks the statutory authority to regulate spreading operations.

Nearly all public road applications of oil field brine for the purpose of dust control occur on roads under the jurisdiction of city or county governments. The only exceptions discovered by the author were the use of brine by the DOT for road shoulder stabilization in Kalkaska and Montmorency Counties. On the other hand, oil field brine is applied to state trunkline highways to melt ice. The DOT distributes tax monies to county road commissions to provide ice control on both county and state roadways. Some counties receiving these monies use oil field brine exclusively in their winter maintenance operations. The DOT could choose to attach a rider to

each contract made for county de-icing operations. The rider could set conditions upon the use of oil field brine for snow and ice removal. Failure to comply with the terms of the revised contract would provide grounds for a denial of or reduction in future releases of tax dollars to the offending road commission. This approach to brine spreading regulation is both untested and only applicable to cases involving winter maintenance use of oil field brine.

The Michigan Environmental Review Board (MERB) is the final state agency with a potential role to play in the regulation of oil field brine disposal. The Board includes 15 members, nine from the general public as well as the Directors of the following Departments: Administration, Agriculture, Commerce, Natural Resources, Public Health, and Transportation.[72] Duties and responsibilities of MERB include:

- Providing advice to the Governor and the Department of Natural Resources on environmental issues that are of concern to more than one department or agency of state government; and
- Making recommendations to the Governor, the Director of the Department of Natural Resources, or other state agencies on environmental policy issues as may be requested.

Functioning strictly as an advisory body, MERB cannot actively pursue the regulation of brine spreading operations. The Board could make recommendations to the Governor or the DNR Director concerning necessary improvements in state brine disposal regulations.

By statute and executive order, the Department of Natural Resources holds the authority necessary to administer brine disposal regulations. Both MERB and the DPH could aid the DNR through environmental risk assessment and advisory statements. A lesser role could be played by the DOT through new stipulations in winter maintenance contracts. But, in the final analysis, only the DNR can directly regulate the use of oil field brine on Michigan roadways.

EXISTING PROBLEMS

To investigate the status of public and private sector compliance with Special Order 1-81, the author conducted a series of interviews with individuals familiar with road brining practices. A questionnaire was developed to elicit detailed responses from these individuals on a wide range of brine management topics (Appendix D). Through use of the questionnaire, the author attempted to determine the scope of existing problems throughout the Southern Peninsula.[73] Of special importance, the questionnaire also provided an opportunity for the interviewees to make useful recommendations concerning current and future regulation of brine spreading activities.

The author interviewed forty-seven Michigan Department of Natural Resources (DNR) employees from six Divisions: Environmental Enforcement, Geological Survey, Groundwater Quality, Hazardous Waste, Law Enforcement, and Surface Water Quality. All of these individuals took part in either the development or administration of the Department's brine management plan program. In addition, the author interviewed twenty-four other individuals to attain a comprehensive view of current road brining practices and problems:

- four employees of the Michigan Department of Transportation;
- six members of the Michigan Oil and Gas Association; and
- fourteen county road commission officials.[74]

Michigan Oil and Gas Association interviewees included representatives from three major companies, two small independent operators, and an Association spokesman. The road commission officials interviewed included representatives from eleven counties which spread large quantities of oil field brine and a spokesman from the County Road Association of Michigan. Interviews were conducted in Cadillac, Gaylord, Imlay City, Lansing, Mt. Pleasant, Plainwell, and Roscommon during the period of July 14 to November 8, 1983.

The interview process was intended strictly to serve as a qualitative assessment of the effectiveness of Michigan's brine management program. Quantification of questionnaire responses proved elusive due primarily to necessary variations in the questions posed to particular individuals. The questionnaire was originally designed to be given solely to Department of Natural Resources employees, administrators of the brine management plan program. Questions concerning management plan compliance and administration were not asked during interviews with representatives from the oil industry and the other governmental agencies.

Several problem areas were delineated by the interview process. Improper road brining practices were found to occur throughout the Southern Peninsula and most especially in areas where new oil and gas wells were being drilled. The most frequently cited problem involved excessive brining by licensed industrial waste haulers and by oil and gas producers who hauled and spread their own brine. Waste haulers

and producers spread oil field brine on public roads under the auspices of city or county governmental bodies. Some of these agents have applied oil field brine at a frequency many times greater than cited in the management plans under which they operate. In areas where drilling operations were active, haulers and producers have applied brine from drilling pits to adjacent roadways in quantities believed to greatly exceed permitted application rates. In sum, a number of waste haulers and producers appear to be dumping oil field brine rather than applying it in accordance with an approved brine management plan.

Two factors lie at the root of excessive brining by agents of city and county governments. First, inclusion of these parties in a brine management plan affords them an avenue for disposing of oil field brine at a minimum cost. As noted previously, oil field brine as a commodity has a very low dollar value. The transportation of waste brine to a disposal site costs more money than can be gained through its sale. Consequently, waste haulers and producers can maximize their profits by disposing of brine as close as possible to its place of origin. Authorization to spread brine for a city or county provides them with this opportunity. Second, to compound the problem, city and county officials have frequently failed to adequately supervise the activities of their agents. Nearly all county road commissions have failed to designate roads to be brined by producers and waste haulers; this failure in turn allows the less scrupulous to repeatedly dump brine on roads close to well sites.

A related problem surfaced during the interview process. When the frequency of brine applications was closely scrutinized, the author learned that some waste haulers have claimed that multiple brine spreadings by their vehicles constitute one "application." In two separate instances investigated by DNR personnel, a hauler spread brine on the same section of road on three different days in one week. In both cases the hauler recorded those three passes as one "application." In another case, a hauler used two trucks spreading in tandem to make "one" application; in reality double the prescribed volume of brine had been spread. In the absence of proper supervision or recordkeeping by local governmental officials, several contracted brine spreaders have violated the provisions of the management plans under which they operate.

Applications of excessive amounts of oil field brine by some waste haulers and producers was the only problem found to occur throughout the Southern Peninsula. However, more localized problems also exist. Road commissions in several counties, most notably Montcalm and Roscommon, have been spreading large quantities of oil field brine without having obtained approval of a brine management plan from the Department. In the cities of Clare, Mt. Pleasant, and Roscommon oil field brine has been used for snow and ice removal. In each of these cities, DNR personnel have observed brine-laden meltwaters entering storm sewers or running directly into local streams. In particular, the City of Mt. Pleasant appears to use oil field brine as a substitute for mechanical snow removal rather than as an adjunct to

plowing. As a crowning irony, none of these cities operates under an approved brine management plan. Finally, in some northern and southwestern counties, road commissions and their agents have been spreading brine during or immediately after rainfall throughout the dust control season. Such spreading is superfluous since the rain itself acts as a dust palliative. Furthermore, applying brine during or just after a rainfall increases the possibility that the brine will run off of the roadway and enter local watercourses.

Brining during rainfall is symptomatic of a philosophy that prevails in many areas of the state. Numerous county road commissions operate under what may be termed a "no dust" policy. They believe that their duty lies in assuring that secondary roads remain relatively dust-free during the dry months of summer. This philosophy is analogous to the "bare pavement" policy practiced every winter by state highway agencies nationwide. Similar to the use of large quantities of solid salt to maintain ice-free roads, the county road commissions use frequent doses of oil field brine in order to attain what they feel is adequate dust control. In practice, this policy increases the possibility of excessive road brining and the related opportunity for oil field brine to enter the waters of the state.

The "no dust" philosophy finds its genesis and strength in the desire expressed by some county residents for increased dust control. County road commission officials attest to the fact that many rural residents <u>demand</u> dust-free roads. Department of Natural Resources personnel

questioned by the author concurred. Department field offices received more citizen complaints concerning a perceived restriction of road brining by the State than complaints of excessive brining or other abusive practices. Six of every ten citizens calling about road brining complained that not enough brine was being spread near their residences. DNR interviewees did add that county officials were apt to urge citizens to complain to the Department about insufficient brining and to suppress complaints about abuses by the road commission or its agents. Nevertheless, given a vocal citizenry and diminishing budgets, county road commissions are likely to pursue their "no dust" policy in the most cost effective manner: frequent applications of low-cost oil field brine.

The brining of public roads was not the only topic discussed during the interviews. Questions were also posed concerning brine spreading on private properties and production facility access roads. Few problems appear to have arisen from either practice. Interviewees did cite two instances of illegal dumping of oil field brine in gravel pits but, in each case, the violator was successfully prosecuted. In general, the use of oil field brine on private property is very limited in terms of the quantity of brine spread and the acreage brined. Several individuals did express the belief that the demand for private property brine applications will increase in the immediate future and cautioned that monitoring such applications will be difficult.

When questioned about production facility access road brining, Department personnel stated that some violations of Special Order 1-81 have occurred. Under the Supervisor's Order, an oil or gas production facility operator must have written authorization from the Geological Survey Division prior to the use of oil field brine on his access roads. To date no permits have been applied for or issued anywhere in the state. Operators claim that the permit requirements established by the Division are too burdensome and some have chosen not to comply with the Supervisor's Order. Field personnel have been able to stop several instances of illegal access road brining but some operators continue the practice.

To summarize, through an extensive interview process, the author sought to examine the status of public and private sector compliance with Special Order 1-81. The key problem uncovered was overly frequent brine spreading by licensed industrial waste haulers and oil and gas producers operating as agents of city and county governmental bodies. In other words, the problem centers upon abuses by private sector parties allowed to spread oil field brine under a public sector brine management plan. Both waste haulers and producers have sought to dispose of oil field brine at the lowest cost possible. County road commissions have sought to provide their citizens with dust-free secondary roads at the lowest cost possible. These goals have combined to produce an uneven distribution of brine spread upon Michigan roadways. Overly frequent applications of oil field brine are made to roads near well sites while little is spread in areas

distant from oil and gas fields. This problem is most acute in areas where drilling operations are active. Haulers and producers empty drilling pits by spreading the collected fluids upon nearby roads. At the crux of the hauler-producer problem is brine disposal in the guise of acceptable road maintenance. Haulers and producers have a monetary incentive to dump their brine on local roads and county road commissions have little incentive to discourage this practice.

RECOMMENDATIONS

The brine management plan approach has been the keystone of the Department of Natural Resources' regulation of the land surface disposal of oil field brine. Has this approach been effective in curbing road brining abuses? Interviewees believed that conditions in the field have improved substantially since the issuance of Special Order 1-81. The number of incidents involving improper brine spreading, both those reported to and those witnessed by DNR personnel, have steadily declined since program inception. Although precise records are unavailable, noteworthy problems appear to have dropped from roughly a dozen per year in the late 1970s to just four during 1984. Finally, no reports of waste haulers dumping brine into streams, in woodlots, or on roadways have been recorded in the past two years.

Effective enforcement of management plan stipulations has <u>not</u> brought about these improvements. State government employees, road commission officials, and well operators all agree that program enforcement has been lax or nonexistent. Instead, the fact that the State has taken an active interest in regulating the spreading of oil field brine has lead to a certain degree of self-regulation by those parties handling brine. Some brine spreaders perceive the mere existence of the brine management plan program as increasing the risks involved in continuing questionable or illegal brining practices. The key factor responsible

for the marked reduction in brine dumping problems in the past several years seems to be a desire to avoid undesirable consequences, such as prosecution or negative publicity, rather than effective enforcement of brine management plans.

The perception that the State has acted to more tightly regulate the brining of roadways has resulted in a decrease in improper activities, at least in the short term. However, problems do exist that have not yet been rectified by the current management plan approach. Should the State replace this approach with a new regulatory format? Most interviewees did not favor such a change. The majority felt that fine-tuning could improve the effectiveness of the current program. One pointed to the fact that brine management plans have existed for only three dust control seasons. Regulatory efforts during the past three years have largely been confined to the circulation of brine management plan applications to all interested parties. Many DNR interviewees believed that, given more time, the brine management plan approach would run smoothly.

How can the State's regulation of road brining activities be made more effective? Interviewed DNR employees offered several suggestions, listed here in the order of their frequency of mention:

1. Prohibit oil and gas producers from spreading oil field brine on public roadways.
2. Prohibit industrial waste haulers from spreading oil field brine on public roadways.

3. Require county road commissions to schedule the brining of specific road sections if brine applications by waste haulers are to continue.

4. Increase the number of personnel responsible for monitoring road brining activities and enforcing brine management plan provisions.

5. Distribute photocopies of approved brine management plans to all appropriate Department field offices.

Roughly two-thirds of the DNR interviewees recommended that Special Order 1-81 be amended to prohibit brine spreading by oil and gas producers. Such an amendment may not be necessary to attain this goal. Special Order 1-81 does not make reference to producers spreading oil field brine under the auspices of a city or county government. Rather, the Order speaks of producers providing brine to "a hauler if the hauler can verify his authorization to receive brines on behalf of a governmental unit."[75] The term "hauler" refers to an industrial waste hauler licensed under Act 136, an act which excludes from regulation oil and gas producers who transport their own brine. Thus, producers need not comply with the regulations that govern the actions of all other transporters of oil field brine. Authorization for producers to spread brine appears to have come about through a failure by Water Quality personnel to differentiate between licensed waste haulers and non-licensed producers. Regardless, oil and gas producers have been responsible for a number of the brining abuses reported in recent years. Their elimination from approved brine management plans would be a sensible step towards correcting existing problems.

The second most-cited recommendation centers upon the elimination of industrial waste haulers from approved brine management plans. Reports spanning the past decade have consistently pointed to these individuals as the cause of many brine disposal abuses. Like the producers who haul their own brine, waste haulers operate under a powerful incentive to get rid of the brine they transport as quickly as possible. Brine haulers garner the highest profits by minimizing the distance travelled to disposal sites and maximizing the number of loads hauled in a given period of time. Faced with such constraints, the less scrupulous have dumped brine on roads adjacent to well sites.

Supervision of waste hauler activities is a crucial element in the successful regulation of oil field brine spreading. A governmental body submitting a management plan for DNR approval must include copies of the written contracts between itself and its agents. In almost every case to date, governmental units have failed to produce copies of the required contracts. Under the terms of their own "Guidelines," Water Quality Division personnel should have denied approval of these management plans. A written contract would set forth the conditions under which a waste hauler could apply brine for a governmental body. A chain of responsibility would thus be established and recognized by all participants.

Although DNR interviewees recommended the elimination of waste haulers from all brine management plans, they recognized that such an action may not be taken. Given the large volumes of brine transported by

waste haulers, the safest course to pursue may be to allow their continued inclusion in public sector management plans. Interviewees speculated that outright prohibition of brining by these haulers could lead to an increase in illegal dumping of oil field brine. Brine transporters operate every day of the week; round-the-clock surveillance of their activities is virtually impossible. By permitting haulers to dispose of their loads on roads, the Department channels hauler activities towards a setting where effective enforcement is more easily achieved. However, if haulers are to continue applying brine for county road commissions, DNR interviewees insist that the Department require those commissions to schedule brining by specific road section. Under the current "Guidelines," public sector holders of approved management plans must maintain records of the date, amount, and specific location of each application of oil field brine. With few exceptions, Groundwater Quality personnel have not insisted upon this recordkeeping. Most road commissions have not bothered to schedule brine applications and thereby better control the activities of their agents. In the absence of pressure from the Department, road commissions have found that they can simply turn their agents loose to brine roads without any supervision.

The failure to supervise the activities of private sector agents was the chief indictment leveled at county road commissions by DNR personnel interviewed by the author. Elimination of these agents from approved management plans or increased enforcement of recordkeeping

requirements should substantially reduce existing road brining problems. However, the Department may still face a related problem in dealing with county road commissions. The authority to issue and enforce Special Order 1-81 resides in Act 61 but governmental units are not defined as "persons" subject to the provisions of the Act.[76] This means that government agencies at all levels may fall outside of the jurisdiction of the Supervisor of Wells, the ultimate administrator of Act 61. The Supervisor has decided to allow county road commissions to spread oil field brine but the DNR holds only three means of controlling their activities. Department personnel can attempt to persuade county road commissioners to act within the terms of a brine management plan. If persuasion fails, the Geological Survey Division does have the authority to demand that producers stop releasing brine to a commission that has violated management plan stipulations. Such an order would not only be politically unpopular with both the road commission and the people served by it but might also be slow to take effect due to the Division's formal non-compliance procedures.[77] Finally, the Department can attempt to prosecute the offending road commission under the general provisions of Act 245 or bring suit under Act 127, the Michigan Environmental Protection Act.[78] In any case, the Department would be relying upon an indirect means of regulating county road commission activities. In order for the Supervisor of Wells to obtain direct control over road commission activities, the Michigan legislature may have to amend Act 61 to define governmental bodies as "persons" subject to the Act's provisions.

Regulating the activities of county road commissions may pose continuing problems for DNR personnel. Nevertheless, the Department can substantially improve its brine management program through an increased emphasis upon the enforcement of management plan provisions. The author's interviews highlighted several abuses warranting more attention: waste haulers and producers who spread brine too frequently, county officials who fail to maintain adequate records of brine applications, and a city government which spreads brine as a substitute for mechanical snow removal. Every one of these problems can be attacked through strict enforcement of existing brine management plans. Difficulties may arise -- observing that a section of road is brined too often is not the same as catching a brine spreader in the act of violating a management plan. Yet no explanation should excuse allowing the continued use of oil field brine by county road commissions which do not have approved management plans. The management plan approach was designed with a central purpose: to govern the manner in which oil field brine is spread upon Michigan roads. To fulfill this purpose, the activities of brine spreaders must be monitored and the provisions of brine management plans must be enforced.

When discussing program enforcement, many field employees recommended that the Department increase the number of personnel responsible for monitoring road brining activities. Given current budgetary constraints, increases in the number of field personnel may prove impractical. Another alternative lies in increasing the <u>emphasis</u> upon

enforcement rather than increasing the size of the Department's field staff. Based upon the responses made during the interviews, many individuals in the responsible Divisions do not want to assume an active role in monitoring road brining activities. Indeed they have shown a marked reluctance to involve themselves in brine management matters in the three years that have passed since the approval of the first brine management plans. Aside from a small number of cases, Department personnel have not pursued management plan violations. In the absence of a firm commitment from their superiors, field personnel are likely to continue this course of inaction. Decision makers within the Department must resolve whether or not the spreading of oil field brine warrants attention. If they conclude that continued regulation is valuable, then they should stress the need for better enforcement of the objectives of the brine management program.

Even with a heightened emphasis upon enforcement, Department personnel cannot effectively monitor road brining activities without ready access to the information contained in approved management plans. Many interviewees, when asked about their roles in the brine management program, excused their nonparticipation by pointing to the absence of access to management plan information. Many stated that photocopies of approved brine management plans need to be distributed to all appropriate field offices. While definitely a step in the right direction, disseminating photocopied files is not the only means available for improving field staff access to brine management plan particulars. Both the 1982 Brine Task Force and Law Enforcement

Division interviewees have recommended entering management plan information into the Law Enforcement Information Network (LEIN) system. If practical, this recommendation would provide Department personnel with speedy access to information while in the field. They could check for possible management plan violations while actually observing a vehicle in the act of spreading brine. Whether distributed as photocopies or entered into the LEIN system, management plan information must be made more accessible if the Department's program is to succeed.

In addition to the recommendations made by DNR personnel, the author suggests several further changes in the current brine management program. A revised set of brine management plan instructions should be introduced. Field experiences indicate that the time has come to reassess the contents of the current "Guidelines." Minor changes can correct a number of the problems delineated by this study. For example, a stipulation should be included in a revised version of the "Guidelines" to prohibit brine spreading during or immediately after rainfall. This activity increases the risk that brine will wash from the road surface into a nearby watercourse. Another caveat should plainly state that all brine spreading not performed by the management plan applicant must be done by a party under written contract to that applicant. A copy of the written contract would then have to be submitted with the proposed management plan. Through this provision, a contracted brine spreader would be required to sign a legal document stating his willingness to adhere to the terms of the applicant's

management plan. Finally, the revised instructions should specify that applications of brine for dust control may only be made by means of a fully operational spreader bar. Current management plan instructions do not forbid brining by means of an open valve or splash plate, methods conducive to brine dumping in the guise of dust control. With this new stipulation in place, individuals who dump oil field brine on a public road can be more easily prosecuted than has proved possible with management plans approved under the present "Guidelines."

Revising the "Guidelines" is a first step towards improving the existing brine management plan approach. However, many management plans that have already been approved contain flaws that need to be corrected. Many plans were approved despite the fact that the information they provided was incomplete. Some do not list the names and addresses of contracted brine spreaders; others do not name the well sites from which brine is taken for use upon the public roads. A number of plans do not state whether oil field brine will be used to control dust, to melt ice, or to do both. In several cases, two different plans submitted by a county road commission have received approval and no one within the Department can say which approved plan takes precedence. Because of such discrepancies, a complete review of existing brine management plans is in order.

To improve the current management plan format, emphasis should be placed upon producing consistent, enforceable brine management plans.

The repetition of some road brining problems under future management plans can be prevented through the introduction of revised instructions as discussed above. To correct deficiencies in existing plans, the recipients of approved management plans should be asked to submit new brine spreading proposals that conform to the revised "Guidelines." This process would entail Department review of all brine spreading proposals prior to granting new approval of management plans. In this manner the Department can correct past mistakes by requiring the submission of information missing from current brine management plans. All current management plans are plainly labeled as "interim" plans. Furthermore, no provision in either Special Order 1-81 or the "Guidelines" states that management plan approval continues in perpetuity. A review and reapproval process can also help to assure more consistency in approved management plans statewide. At present, the brine management program is plagued by a confusing array of differing plans. A myriad of spreading volumes and frequencies proliferate throughout the counties of the Southern Peninsula. Dissimilar applicant needs can not explain these variations. Instead, most management plans were approved in the form in which they were submitted, with little cross-referencing to previously approved plans. In addition, two different application forms have been used for the submission of brine management plan proposals. The earlier version produced management plans that, although few in number, contain less essential information than later plans. Requiring all brine management plans to be written under one set of revised instructions, on one standard form, will produce a

uniformity which will make plans easier to compare and enforce. More consistent plans could also better protect the waters of the state from brine pollution by curbing the wide variations in application volumes and frequencies that now exist.

The foundation of a revised brine management program could rest upon a standard set to govern brine application rates so that the state's water resources are adequately protected. Neither the Water Resources Commission nor the Groundwater Quality Division has proposed or adopted standards to govern the application of oil field brine on roadways. The August 18, 1983 meeting of the Groundwater Quality Division Supervisory Staff did result in informal agreement with the following standard: the maximum permissible rate of application of oil field brine to Michigan roads should be 1,000 gallons per mile per road lane. The suggested maximum frequency of application agreed upon was six applications per dust control season. These standards were deemed to provide a reasonable assurance that the State's groundwater resources would not be adversely impacted by road brining activities.[79] If such standards were formally adopted, the Department would foster a statewide uniformity in brine application rates and frequencies.

Adopting interviewee recommendations and revising management plan instructions alone will not solve road brining problems. For these changes to be truly effective, stronger cooperation among the responsible Department Divisions will be needed. Field staff

confusion over monitoring responsibilities and the failure to properly distribute management plan information highlight the need for program coordination. A number of interviewees stressed the desirability of designating a contact person in Lansing to coordinate the Department's brine management program. This person could coordinate the review of brine management plans submitted under the revised instructions and thereby insure the use of consistent criteria in approving management plans. A central contact position could also serve as a focal point for obtaining or distributing information concerning approved management plans.

Clearly, since several Divisions play a part in the Department's brine management program, cooperation and coordination of effort are essential to effective enforcement. At the least, a memorandum of understanding between the Geological Survey and Groundwater Quality Divisions would be useful in promoting stronger program coordination. These two Divisions play the largest roles in the current brine management program. A formal memorandum could delineate the roles each Division must play in program administration, helping to end the confusion that has prevailed in the past several years.

Forty of the forty-seven DNR employees interviewed by the author (85%) believed that the Department should assign to one Division primary responsibility in administering the brine management program. Several compelling reasons support the designation of the Geological Survey Division as that lead Division. First, the Geological Survey Division

has a larger field staff than do either the Groundwater Quality or Hazardous Waste Divisions. Furthermore, the duties of Geological Survey field personnel include regular visits to oil and gas production facilities throughout the state. Survey personnel are familiar with the facilities which serve as the sources of oil field brine and they know the individuals who are involved in the handling and disposal of that brine.

Second, the Geological Survey and Law Enforcement Divisions recently signed a formal Memorandum of Understanding establishing a cooperative enforcement of Act 61. As discussed in the preceding section of this report, conservation officers are the key to the effective monitoring of road brining activities and enforcement of brine management plan provisions. Under the recent agreement, conservation officers have received special training so that they may assist Survey personnel in enforcing the provisions of Act 61. That assistance includes the enforcement of Special Order 1-81.

Third, and perhaps most important, Geological Survey personnel administer Act 61 and its promulgated regulations. In Act 61 lies the authority under which the program to regulate oil field brine disposal was initiated. The review and approval of brine management plans now relies upon Groundwater Quality personnel acting under the authority of Special Order 1-81 even though the Supervisor of Wells has not designated their Division as his representative in these matters. On the other hand, the Geological Survey Division already administers all

other provisions of Special Order 1-81. And, under current Department policy and procedure statements, the Geological Survey should be the lead Division in regulating the handling and disposal of oil field brine. The authority to enforce management plan provisions resides in Act 61, authority that has not been vested upon the Groundwater Quality Division. Clearly, enforcement of the Supervisor's Order would be on firmer legal grounds if management plan responsibilities were tied to the Geological Survey Division.

SUMMATION

Oil field brine is highly saline water produced as a by-product during oil and gas drilling and production operations. Most of this waste brine will be returned to the subsurface; however, 50 million gallons or more will be spread each year upon roadways and other properties in Michigan. A strong suspicion exists that this road brining will cause long-term, low-level contamination of the state's groundwaters but no proof of this trend currently exists. In recent years the continual use of oil field brine on several roads has probably been the cause of a number of cases of well water contamination. No adverse health effects have been reported as a result of any of these incidences.

The Supervisor of Wells holds the authority to regulate the disposal of oil field brine under Act 61. Through Special Order 1-81 and its amendments, the Supervisor has declared that this brine may be used for dust control, ice removal, and road stabilization on public roads, private properties, and production facility access roads. The Supervisor's Order resulted in the creation of an administrative process through which these uses could be properly regulated. At the heart of this process lies the brine management plan. Approval of a brine management plan must be obtained from the Department of Natural Resources prior to any use of oil field brine on public roads or private properties.

To examine the effectiveness of the DNR brine management plan program, the author interviewed seventy-one individuals familiar with road brining practices. Interviewed individuals included state government personnel, oil producers, and county road commissioners. The interview process focussed upon testing the validity of the following hypothesis: the brine management plan program initiated under Special Order 1-81 has failed to adequately regulate the use of oil field brine on Michigan roadways. Based upon the responses garnered through the use of a questionnaire, the author concludes that this supposition is erroneous. The mere fact that the State has moved to regulate the manner in which oil field brine is spread has lead to a marked decrease in improper practices. The perception that the State has acted, rather than actual enforcement of management plan particulars, has produced a degree of self-regulation by those parties spreading brine. DNR personnel assert that incidents of improper brine spreading have clearly declined since the inception of the brine management plan program. No reports of brine dumping into streams, in woodlots, or on roadways have been recorded in the past two years. Thus, the DNR brine management plan program can be said to have adequately addressed known road brining problems. Nevertheless, the results of this program remain imperfect and improvement should be made to tighten existing regulations.

The key problem uncovered by this study involved excessive brine spreading by licensed industrial waste haulers and by oil and gas producers who hauled and spread their own brine. These individuals,

operating for county, township, or city governments, have in a number of cases applied oil field brine at a frequency many times greater than cited in the management plans under which they operate. In areas where new drilling operations are active, some haulers and producers have been applying brine from drilling pits to adjacent roadways in quantities believed to greatly exceed permitted application rates. In summary, some waste haulers and producers appear to be dumping oil field brine rather than applying it in accordance with an approved brine management plan.

At the crux of this problem is brine disposal in the guise of acceptable road maintenance. Waste haulers and producers want to dispose of oil field brine at the lowest possible cost. County road commissions want to provide their citizens with dust-free secondary roads at the lowest possible cost. In essence, haulers and producers have a monetary incentive to dump their brine on local roads and county road commissions have little incentive to discourage this practice. As a result, overly frequent applications of oil field brine are made to roads near well sites while little is spread in areas distant from oil and gas fields.

In the three years since its inception, the brine management plan approach has received limited support from personnel in the DNR Divisions responsible for administering this program. Regulatory efforts during these three years have largely been confined to the circulation of management plan applications to all interested

parties. Furthermore, DNR field personnel have not adequately monitored road brining activities, in part due to a failure to distribute management plan information to District offices. Department decision makers in turn have not delineated the roles to be played by each Division in the enforcement of brine management plans. In the absence of a coherent Department policy, road commissions and their agents have been able to ignore those management plan restrictions which they have deemed to be inconvenient.

Because of lethargy and indecision within the Department of Natural Resources, the brine management plan approach has not yet been truly tested. Both the author and most interviewees have concluded that the management plan approach can be improved and need not be abandoned. Based upon the findings of this study, the author recommends that the following actions be taken:

1. The Geological Survey Division should be designated as the lead Division in administering the Department of Natural Resources' brine management plan program.

2. A Memorandum of Understanding between the Geological Survey and Groundwater Quality Divisions should be drafted to delineate the roles each Division should play in the brine management program.

3. A revised set of brine management plan instructions should be introduced. Current holders of approved management plans should be required to resubmit their brine spreading proposals for approval under the revised instructions.

4. Oil and gas producers should no longer be permitted to spread their brine on the public roads.

5. Licensed industrial waste haulers should not be permitted to spread oil field brine on the public roads unless the governmental unit for whom they operate specifies exactly where and how that brine will be applied, under a written contract signed by both parties.

6. The Department should increase the emphasis placed upon monitoring road brining activities and enforcing management plan provisions.

7. The information contained in approved brine management plans should be made readily accessible to personnel at all appropriate Department field offices.

8. A centrally located contact person should be assigned the responsibility of coordinating the statewide implementation of the brine management program.

AFTERWORD

Since this study was conducted, a series of events have transpired which will affect future state actions concerning the use of brine on Michigan roadways. New information has been gathered concerning the presence of toxic compounds entrained in oil field brines. A study performed by the staff of the Geological Survey Division has established that benzene, toluene, and xylenes are present in Michigan oil field brines.[80] Of greatest concern, benzene, a known carcinogen, was present in all brine samples collected for analysis. Based upon this finding, Division administrators contemplated additional research to determine the environmental fate of benzene in order to assess the risk of groundwater contamination associated with the brining of roads.

Prior to the commencement of new research, the Chairman of the Michigan Environmental Review Board (MERB) learned of the Division's initial study. Upon review of the study findings, MERB concluded that the potential harm to human health and the environment posed by toxic contaminants in brine necessitated a moratorium on further spreading of oil field brine. On September 24, 1984 MERB recommended that the Governor direct the Supervisor of Wells to prohibit the release of brines from oil and gas production facilities for use in road maintenance practices. MERB also recommended that this moratorium should begin no later than October 31, 1984 and remain in effect until

three conditions had been met:

1. A study is completed by the DNR and other appropriate state agencies to determine acceptable levels of specific organics and other pollutants in brines. MERB recommends that the study be coordinated by the Toxic Substances Control Commission;

2. Currently known sources of such brines are analyzed for levels of organics and other pollutants;

3. A periodic monitoring program is established to ensure that acceptable organic and other pollutant levels in the brines are not exceeded.[81]

Although the Governor never formally acted on these recommendations, the DNR Director chose to pursue the moratorium approach suggested by MERB. Such a moratorium could not legally be imposed prior to a public hearing before the Supervisor of Wells and the subsequent amendment of Special Order Number 1-81.[82] The Geological Survey Division, acting on behalf of the State, petitioned the Supervisor to issue a new Order prohibiting the use of oil field brine on roads after April 15, 1985. This date reflects the approximate commencement of the annual dust control season.

On November 29 and 30 of 1984 a public hearing was held before the Supervisor of Wells and the Oil and Gas Advisory Board to consider the State's petition. Created by Act 61, this Board assists the Supervisor during all hearings to consider the adoption of orders having statewide application.[83] Board members then deliberate and submit a formal opinion to the Supervisor regarding the adoption of

the proposed order. Seventeen hours of testimony were presented during the two-day hearing. Due to the volume of testimony under review, the Advisory Board had not submitted its opinion to the Supervisor at the time of this writing. A decision by the Supervisor is expected by April 1, 1985.[84]

APPENDICES

APPENDIX A

SUPERVISOR OF WELLS SPECIAL ORDER NUMBER 1-81

Paragraph 1. All brines shall be disposed of by injection to approved subsurface formations through approved brine disposal wells, injected pursuant to an approved secondary recovery plan, reused for drilling purposes, or use[d] in accord with a plan approved pursuant to procedures adopted by the Water Resources Commission, except as provided in paragraphs 2 and 7 below.

Paragraph 2. The field representative of the Supervisor of Wells may authorize the disposal of on-site drilling fluids to dry holes under controlled conditions as part of the plugging operations, or in the event that production casing is run on a well, may, under special conditions, authorize annular space disposal of injectable drilling fluids generated during the drilling of that well, provided in both cases that drilling fluids are injected in permeable formations below the fresh water horizons and that disposal pressure gradients do not exceed 0.7 psi per foot at the surface casing seat.

Paragraph 3. Producers shall be responsible for the proper handling of all brines on their lease site, central tank battery, or other proximate loading site [facilities] irrespective of the ownership of storage or loading facilities.

Paragraph 4. Producers shall maintain records for two years of the disposition of all brines. The records shall indicate dates, volumes, recipient, transporter, destination, and proof of delivery.

If an authorized hauler receives brines at an unattended loading site the hauler shall provide the producer a signed record describing the volume, time, date, destination, and proof of delivery.

Paragraph 5. Producers may provide brine to governmental units or a hauler if the hauler can verify his authorization to receive brines on behalf of a governmental unit. After September 15, 1981, all uses of oil field brines by units of government will be in accord with a management plan approved pursuant to procedures adopted by the Water Resources Commission.

Paragraph 6. The governmental unit receiving brine shall be responsible for the safe handling and use of brines from the point of loading, and for separate storage and place of use, regardless of ownership of hauling vehicles.

Paragraph 7. A District Supervisor of the Geological Survey Division, as a representative of the Supervisor of Wells, may grant an annual written authorization to an operator to use oil field brines for dust or ice control and [road] stabilization on oil and gas production facility access roads that are maintained and controlled by the operator. The application shall be made to the District Supervisor providing such data as is required. Failure by the operator to use the brine as required by the Supervisor of Wells may result in the revoking of the Supervisor of Wells' written authorization.

Paragraph 8. Oil field brines may be used on private roads and property (i.e. parking lots, construction projects) for dust or ice control and road stabilization. The application on private property shall be pursuant to a management plan approved by the Water Resources Commission.

Paragraph 9. No brines shall be used as drilling fluid for the drilling and workover of any kind of well or test hole without written approval from the field representative of the Supervisor of Wells. In no case will such approval be granted if brines are derived from oil and/or gas wells containing more than 20 ppm of H_2S in the gas stream unless it can be shown that there is less than 500 ppm concentration present in the brine.

Paragraph 10. Brines used for road purposes:

(a) Brines containing H_2S may be used in accord with an approved plan under Special Order 1-81 for road dust, ice control, or [road] stabilization purposes.

(b) All brines from oil and/or gas wells known to contain H_2S shall be tested for their H_2S concentration by September 30, 1982 and annually thereafter.

(c) Those using brines containing H_2S should implement training programs for their employees in the safe handling of these materials. The Michigan Department of Public Health and Michigan Department of Labor should be consulted in developing programs. It should be noted that existing regulations concerning occupational health and safety are applicable to exposure to H_2S and must be complied with.

Paragraph 11. All testing for H_2S shall be done by methods approved by the Supervisor of Wells. The attached instructions for testing H_2S in brine [not included here] are to be followed and are incorporated in this order by reference. Results of all tests shall be filed with [the] appropriate field representative of the Supervisor.

APPENDIX B

NOTICE TO ALL OIL AND GAS PRODUCERS

Rules 601 and 602 of the Administrative Rules promulgated pursuant to Act 61, P.A. 1939 provide that brine or saltwater produced in the drilling for or production of oil and gas shall be returned to an approved underground formation or otherwise disposed of as approved by the Supervisor of Wells. Most brine is returned to the subsurface but some is in demand for beneficial uses.

Employment of produced brines for the drilling of other wells or for secondary recovery projects are highly regarded and approved practices. Utilization of brines for dust control, road stabilization, or ice removal is acceptable if ground surface spreading is performed in a careful manner and will not cause groundwater contamination.

Authorization by the Supervisor of Wells for surface use of oil field brines is subject to owners, operators, and haulers compliance with the criteria which follow:

1. Brine may be used only for road stabilization, dust control, and ice removal.

2. Permission and authorization for brine application must first be obtained from each owner of the surface on which the brine is to be applied.

3. Devices, such as spreader bar or sprayer, must be used for even distribution of brine. Dump valves are not acceptable. The truck must be in motion during the spreading process.

4. Brine is not to be applied during or immediately after rains or while the road surface is wet.

5. Brine is to be applied only in a manner where runoff to ditches or watercourses will not occur.

6. Brine application shall be performed in a manner that will prevent the contamination of groundwaters. Brine dumping or spreading to the ground surface as a disposal method is not approved.

7. Brine application to [surfaces] other than roadways or parking areas is not approved.

8. Producers are expected to keep records of the quantities of brine employed in ground surface applications.

APPENDIX C

GUIDELINES FOR PREPARATION OF AN INTERIM
BRINE MANAGEMENT PLAN UNDER SUPERVISOR OF WELLS ORDER 1-81

I. Describe Source of Brine

A. Include:

1. Name of company that produces brine.

2. Address and telephone number of producer.

3. The principle or designated authority of said company.

4. County, township, town and range, 1/4, 1/4, and section.

2. Storage Areas

A. Brine Storage

Management plan shall comply with Part 5 of the Water Resources Commission Administrative Rules and as a minimum shall address and adhere to the following:

1. Include in location: county, township, section number, 1/4, 1/4, road name, and address.

2. Container shall be constructed of material resistant to material stored.

3. Compliance with Rule 157, Part 5, by submitting detailed construction plans with management plan for existing storage and loading/unloading areas and thirty (30) days prior to any new construction.

4. Maintenance of all storage containers and associated piping and valving in a liquid tight condition at all times.

5. Prohibit cross-contamination with materials not otherwise allowed for the uses identified in the plan.

6. Provide for locked valves when not in use.

7. Develop and post in a conspicuous location at all transfer sites operating procedures designed to prevent overflows and all other spillage.

8. Develop and practice procedures for the immediate recovery of spills.

9. Report spills as required by Rule 164, Part 5.

B. Salt/Brine/Sand Mixing and Storage Sites

1. Maintain impervious primary surface pad curbed sufficently to prevent the entrance of uncontaminated runoff and to direct contaminated runoff to impervious containment or authorized discharge.

2. Compliance with Rule 157, Part 5, by submitting detailed construction plans with management plan for existing salt/brine/sand mixing and storage sites and thirty (30) days prior to any new construction.

3. Provide sufficent cover to direct rain and snow melt runoff to the outside of the curbed area of the primary impervious pad.

4. Provide for disposal of liquids generated by the operation of the facility in accordance with the provisions of the approved management plan.

III. Pollution Incident Prevention Plan

Management plan shall comply with Part 5 of the Water Resources Commission Administrative Rules. Rule 162 outlines the necessary components of a Pollution Incident Prevention Plan, which are stated in part below:

Owner/operator of such facility shall file with the Commission a Pollution Incident Prevention Plan setting forth:

1. The procedures by which such person proposes to prevent pollution of the waters of this State from storage and use areas.

2. The emergency clean-up procedures to be used in case of a spill, discharge, seepage, runoff, or leakage into the waters of this State.

3. The type of surveillance employed by such a person.

4. The method by which inventories are made from the time the materials are received until such time as they are treated and discharged or shipped out.

IV. Describe Transportation and Spreader Vehicles Used

Approved vehicles

1. be government owned.

2. be privately owned under terms of a written contract (copy to DNR) with governmental unit that as a minimum incorporates and provides for compliance with the provisions of:

   a. the approved management plan.

   b. State of Michigan Motor Vehicle Codes.

   c. license under Act 136, P.A. of 1969.

3. Transport tanks and associated piping and valving must be maintained in a liquid tight condition at all times except during the actual spreading for purposes addressed in the management plan.

4. Prohibit cross-contamination with materials not otherwise allowed for the uses identified in the plan.

5. Provide contingency planning for the immediate containment and recovery of spills.

6. Report spills as required by Rule 164, Part 5.

V. Describe Method of Application

A. For Dust Control/Soil Stabilization

1. Applied at a rate and in a manner to prevent direct runoff to any watercourse or from the road surface.

2. Indicate application rate per lane mile and frequency of application.

3. Indicate application method (i.e. diffusing plate, spreader bar).

4. Application only when vehicle is in motion.

5. Maintain up-to-date records showing dates, specific locations including road lane, volume, brine source, and name of hauler for three (3) years and make available to DNR upon demand.

6. Direct injection of brine to storm or sanitary sewers shall not be allowed by this management plan and such activities may result in removal from the list of those authorized to receive oil and gas brines.

B. For Ice Removal

1. Applied at a rate and in a manner to prevent direct runoff to any watercourse or from the road surface.

2. Indicate application rate. Application rate and frequency not to exceed that necessary for ice removal as dictated by conditions.

3. Indicate application method (i.e. spreader bar, open valve in center of road).

4. Application only when vehicle is in motion.

5. Maintain up-to-date records showing dates, specific locations including road lane, volume, brine source, and name of hauler for three (3) years and make available to DNR upon demand.

6. Brine shall not be used for snow removal when effective removal would be achieved by plow or grader.

APPENDIX D

BRINE INTERVIEW QUESTIONNAIRE

1. Do the following occur in your district?

   a. Too frequent brine applications at some sites? (how often?)

   b. Too much brine per application? (how can you tell?)

   c. Improper spreading techniques? (such as?)

   d. Application when unnecessary? (why unnecessary?)

   e. Application on roads not designated for brining?

   f. Application on roads not suitable for brining? (due to slope, drainage, or other factors?)

   g. Application by unlicensed waste haulers?

2. Is there misuse of brine in applications on private roads? Is this a major problem?

3. Is there misuse of brine in applications on lease sites roads? Is this a major problem?

4. In which areas of this district have road brining problems occurred? Have attempts been made to prosecute individuals or companies for improper or unauthorized brine spreading? To what result?

5. What environmental impacts do you foresee resulting from the use of oil field brine on roadways?

6. Have any of these impacts occurred? Do you have documentation of those occurrences?

7. Do you have records of complaints from residents about too much brining? Do you have records of complaints from residents about not enough brining?

8. Which county road commissions request or receive date, location, and quantity information prior to brine applications by contracted waste haulers? Would such information be useful if submitted to you?

9. If brine is properly applied in accordance to an approved brine management plan, would we still have problems? (if YES, would you recommend any changes in the current BMP program?)

10. Who is responsible for current road brining problems? Why?

    a. The oil & gas producers?

    b. The waste haulers?

    c. The county road commissions?

11. Which Division should be responsible for overseeing brine disposal practices? Why? Should joint enforcement be attempted?

12. How much do county road commissions pay for oil field brine?

13. Do the following pose any problems? (How severe?)

    a. Brine contaminated with oil?

    b. Brine contaminated with hydrogen sulfide?

    c. Brine contaminated with toxic chemicals?

    d. Brine drawn from drilling pits?

FOOTNOTES

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[1] Kenneth S. Johnson and Serge Gonzales, 1978, Salt Deposits in the United States and Regional Characteristics Important for Storage of Radioactive Wastes, prepared for the Union Carbide Corporation and the United States Department of Energy, March 1978, Earth Resource Associates, Inc., Athens, Georgia.

[2] Ibid, pages 21, 24, 25, 26, and 29.

[3] Hassan A. Sultan and Peter Fleming, 1974, Soil Erosion and Dust Control on Arizona Highways: Part I. State of the Art Review, Arizona Transportation and Traffic Institute, The University of Arizona, Research Project HPR-1-10(141), The Arizona Department of Transportation, page 92.

[4] P.J. Moses, 1981, "An Environmental Review of Calcium Chloride in Road Dust Control and Stabilization Applications," The Dow Chemical Company, June 1981.

[5] Franklin S. Adams, 1973, "Highway Salt: Social and Environmental Concerns," Environmental Degradation by De-Icing Chemicals and Effective Countermeasures, Highway Research Record Number 425, Highway Research Board, National Academy of Sciences - National Academy of Engineering, page 5.

[6] J. Hode Keyser, 1973, "De-Icing Chemicals and Abrasives: State of the Art," Environmental Degradation by De-Icing Chemicals and Effective Countermeasures, Highway Research Record Number 425, Highway Research Board, National Academy of Sciences - National Academy of Engineering, page 37 (Table 2).

[7] Keyser, 1973, page 37 (Table 2).

[8] Keyser, 1973, page 40.

[9] Sultan, 1974, page 96.

[10] Sultan, 1974, page 96.

[11] Based upon an assumed LIQUIDOW specific gravity of 1.34 and a calcium chloride content of 38% by weight.

[12] P.J. Moses, 1982, "A Study on Dust Control Effectiveness of Calcium Chloride and Waste Brine," The Dow Chemical Company, April 1982.

[13] James W. Moore and Robert C. Welch, 1977, Environmental Aspects of Brine Usage for Highway Purposes, College of Engineering, University of Arkansas, Highway Research Project 44, Arkansas State Highway and Transportation Department, page 2.

[14] Moore and Welch, 1977, page 31, Table I.

[15] Moore and Welch, 1977, page 118, Figure 61.

[16] P.J. Moses, 1982.

[17] Henry W. Kirchner, December 19, 1983 correspondence with the author.

[18] Ibid.

[19] Testimony given by Micheal K. Dillenbeck, Engineer-Manager of the Manistee County Road Commission, at the October 13, 1983 public hearing before the Supervisor of Wells on Cause (A) 18-10-81.

[20] Information supplied by Douglas L. Daniels, Area Geologist, Plainwell District, Geological Survey Division during an interview conducted by the author on August 30, 1983.

[21] Ibid.

[22] 40 C.F.R. 143.3 (1983). This recommended standard has not been adopted in Michigan and is therefore not enforceable for public or private water supplies (Michigan Environmental Health Association, 1983, Environmental Health Ready Reference, 2nd edition, page 64).

[23] R.E. Hanes, L.W. Zelazny, and R.E. Blaser, 1970, Effects of Deicing Salts on Water Quality and Biota: Literature Review and Recommended Research, National Cooperative Highway Research Program Report 91, Highway Research Board, National Academy of Sciences - National Academy of Engineering, page 5.

[24] 42 U.S.C. 6901 et seq. (1982).

[25] 42 U.S.C. 6903 (27) (1982).

[26] 42 U.S.C. 6902 (3) (1982).

[27] 1976 U.S. Code Cong. and Admin. News, p. 6238.

[28] 40 C.F.R. 256 et seq. (1983).

[29] 40 C.F.R. 261.4 (b) (1983).

[30] 33 U.S.C. 1251 et seq. (1982); 40 C.F.R. 122 et seq. (1983).

[31] 42 U.S.C. 300f et seq. (1982)

[32] 40 C.F.R. 143.3 (1983).

[33] M.C.L. 299.401 et seq. (1979).

[34] M.C.L. 299.501 et seq. (1979).

[35] R 299.6202 (2) (1981).

[36] M.C.L. 323.1 et seq. (1979).

[37] M.C.L. 325.1001 et seq. (1979).

[38] M.C.L. 319.1 et seq. (1979).

[39] Special Order Number 1-81 was amended on June 15, 1981 (a change of date in paragraph 5), on November 3, 1981 (the addition of paragraphs 7 and 8), and again on June 2, 1982 (the addition of paragraphs 9 through 11).

[40] Secondary recovery involves the injection of a fluid such as oil field brine into an oil-bearing formation in order to drive the oil from the rock's pore space so that it may be pumped to the surface.

[41] M.C.L. 323.271 et seq. (1979).

[42] Information in this paragraph was derived from Daniel H. Pollard, 1964, "Michigan: Oil State of the Great Lakes, Origin and Early Development 1860-1935," Doctor of Philosophy Thesis, University of Michigan.

[43] Geological Survey Division, Michigan Department of Natural Resources, 1969, Michigan Oil and Gas Fields, 1968, Annual Statistical Summary 10, Table 17, page 63.

[44] Jeffrey E. Herrold, 1984, "Revised Oil Field Brine Statistics," November 27, 1984 memorandum to Allen F. Crabtree, Assistant Division Chief, Geological Survey Division.

[45] Ibid, page 1.

[46] Ibid, page 4.

[47] Forrest C. Strong, 1944, "A Study of Calcium Chloride Injury to Roadside Trees," Quarterly Bulletin, Volume 27, Number 2, Michigan State College, Agricultural Experiment Station, page 216.

[48] Strong, 1944, pages 216 - 217.

[49] Strong, 1944, page 217.

[50] Information supplied by Douglas L. Daniels, Area Geologist, Plainwell District, Geological Survey Division during an interview conducted by the author on August 30, 1983.

[51] Ibid.

[52] Ibid.

[53] Supervisor of Wells' Findings of Fact, Cause No. (A) 21-12-80, Special Order Number 1-81, March 3, 1981.

[54] Paragraph 2 of Special Order 1-81 originally included the following:

> The field representative may also authorize limited quantity application of brine for ice or dust control to a drilling site access road which is not a part of a governmental road system. Such applications shall be done with the permission of the property owner or his representative and at rates and in a manner to prevent contamination of ground or surface waters.

Compare this language with Paragraph 7 of the amended Special Order (Appendix A).

[55] Minutes of the June 18, 1981 meeting of the Michigan Water Resources Commission.

[56] Ibid.

[57] Water Quality Division, Michigan Department of Natural Resources, 1981, "Guidelines for Preparation of an Interim Brine Management Plan under Supervisor of Wells Order 1-81," section V (A)(1) and (B)(1).

[58] Geological Survey Division, Michigan Department of Natural Resources, Brine Management File.

[59] Ibid (as of November 27, 1984).

[60] David M. Dennis, 1982, undated memorandum entitled "Special Assignments for Ron Shaver, Unit Chief, Emergency Response & Waste Hauler Licensing Section, Water Quality Division."

[61] Water Quality Division, Michigan Department of Natural Resources, Brine Task Force, 1982, Minutes of the September 20, 1982 meeting at Mt. Pleasant, Alice Cantu, recording secretary.

[62] Executive Order 1973-2 issued by Governor William G. Milliken on January 11, 1973.

[63] M.C.L. 257.602a (1980).

[64] Michigan Department of Natural Resources, Policy and Procedure, Department Policy Number 2305, effective January 1, 1977.

[65] Michigan Department of Natural Resources, Policy and Procedure, Department Procedure Number 4505.5, effective July 1, 1977.

[66] M.C.L. 333.12101 (1) (1980).

[67] M.C.L. 333.12103 (a) (1980).

[68] M.C.L. 333.12103 (c) (1980).

[69] M.C.L. 333.12103 (e) (1980).

[70] M.C.L. 224.1 (1982) and M.C.L. 224.18 (1982).

[71] M.C.L. 224.19 (1982).

[72] Executive Order 1973-9 issued by Governor William G. Milliken on July 26, 1973.

[73] Oil or natural gas are not produced in Michigan's Northern Peninsula and no oil field brine is presently spread upon Northern Peninsula roads.

[74] The author also contacted seven licensed waste haulers who transport and spread large volumes of oil field brine. All either declined to be interviewed or expressed the opinion that they operated within the bounds of existing state regulations.

[75] Paragraph 5, Supervisor of Wells' Special Order 1-81 as amended.

[76] M.C.L. 319.2 (a) (1979).

[77] Allen F. Crabtree, Assistant Chief, Geological Survey Division, Michigan Department of Natural Resources, October 12, 1983 conversation with the author.

[78] Legal actions can be brought against a governmental body alleged to be violating the provisions of either Act. Pertinent sections of each Act are as follows:

> Section 6(a) of Act 245: "It shall be unlawful for any [governmental body] directly or indirectly to discharge into the waters of the state any substance which is or may become injurious to the public health, safety, or welfare..."
>
> Section 10(2) of Act 245: A governmental body which "discharges a substance into the waters of the state contrary to the provisions of this act...is guilty of a misdemeanor and shall be fined not less than $2,500.00 nor more than $25,000.00 for each violation."
>
> Section 2(1) of Act 127 [M.C.L. 691.1201 et seq. (1979)]: The State "may maintain an action in the circuit court having jurisdiction where the alleged violation occurred or is likely to occur for declaratory and equitable relief against...any political subdivision [of the state]...for the protection of the air, water and other natural resources and the public trust therein from pollution, impairment or destruction."

[79] Gene L. Hall, Water Quality Specialist, Groundwater Quality Division, Michigan Department of Natural Resources, October 26, 1983 conversation with the author.

[80] J.R. Heinzman, J.E. Herrold, J.A. Daniels, and H.R. Fitch, 1984, Analysis for Aromatic Hydrocarbons in Oil Field Brine - A Preliminary Report, Oil Field Brine Sampling Committee, Geological Survey Division, Michigan Department of Natural Resources, August 24, 1984.

[81] Motion passed at the September 24, 1984 meeting of the Michigan Environmental Review Board as recorded by the author.

[82] M.C.L. 319.16 (1979) and R 299.2004 (1983).

[83] M.C.L. 319.3 (1979) and R 299.2003 (a) (1983).

[84] Allen F. Crabtree, Assistant Chief, Geological Survey Division, Michigan Department of Natural Resources, February 5, 1985 conversation with the author.

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9. Groundwater Quality Division, Michigan Department of Natural Resources, 1984, Michigan Sites of Environmental Contamination Priority List, prepared pursuant to Act 307 (P.A. 1982), the Michigan Environmental Response Act, February 1984.

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