



EFFECT UPON ENVIRONMENT OF BRINE CAVITY SUBSIDENCE AT GROSSE ILE, MICHIGAN — 1971

By: Kenneth K. Landes, Thomas B. Piper

April 1972

Sponsored by: Solution Mining Research Institute and BASF Wyandotte Corporation

**Cover:** View of Point Hennepin brine field, Grosse Ile, and downriver section of Detroit River, Detroit, Michigan looking north. Well sites are visible in foreground. Central gallery sinkhole, about three-quarters developed, is the water-filled crater at center. The north gallery sinkhole is partially visible toward upper end of the island. This photo was selected to establish the concept to be developed in the report that while real, the sinkholes represent relatively minor disturbances to the brine field and imperceptible damage to the surrounding community.

Photo courtesy Detroit Edison Company

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Photos, figures 9, 10, 14 courtesy of Detroit Edison Company

## SUMMARY

Artificial brine production began in the Detroit area in 1895. Out of many subsequent operations in Michigan and neighboring Ontario, from which many millions of tons of salt were produced, there have been only two localities where collapse of the cavern roofs has penetrated to the surface. These were at Windsor, Ontario, in 1954 and on Grosse Ile in the Detroit River below Detroit in 1971.

This report is primarily concerned with an investigation into the effect of the Grosse Ile occurrence upon the environment; both surface and subsurface values will be considered. By virtue of its similarity in geologic setting and impact, the Windsor occurrence, now 20 years into history, is available for examination and offers support to the authors' conclusion that the environmental impact of a salt well sinkhole is nominal and that the activity is limited to the immediate area around the wells, and is arrested upon termination of operation of the well gallery involved.

The mechanics of sinkhole formation is not treated in this report. It is currently the subject of a separate Solution Mining Research Institute-sponsored investigation and will be covered in a separate report.

The northern end of Grosse Ile, Point Hennepin, is owned by Wyandotte Chemicals Company, now BASF Wyandotte Corporation, and was originally purchased as a place to pond wastes from the chemical plants on the mainland to the west. The fine-grained light-colored tailings were delivered in slurry form by pipeline to the island where they were ponded and drained. The maximum thickness is 30 feet; beneath is a few feet of organic soil at and below river level. Most of Grosse Ile is a glacial moraine consisting of about 60 feet of clay with scattered boulders. Between the top of the bedrock and the top of the salt measures is 500 feet of nearly flat stratified rock consisting in descending order of impure dolomite, sandstone, and more impure dolomite. The rock section that contains the salt is about 730 feet in thickness; the more massive salt beds brined are toward the base, at depths between 1100 and 1300 feet.

Salt production by the brining method (solution mining) involves pumping fresh water into the salt beds through input wells and removing the brine through production wells. This operation results in cavities, referred to as "galleries," in the salt formation. Solution mining had been in operation on Point Hennepin for nearly 20 years when, in November 1969, cracks first were observed at the surface above the North Gallery. One year later settling became noticeable, resulting in pipeline breaks. On 9 January 1971 cratering started, and several months later the sinkhole reached its present configuration. On 28 April, 1971, collapsing started above the Central Gallery about one-half mile away,

without prior surface cracking or pipeline failures. The result was a second separate sinkhole, this one with a satellite. The Central Gallery cratering also took several months to reach its present size and shape.

A "line of zero cracks" was drawn around each sinkhole, enclosing the area of surface activity. Each lies within the underlying gallery boundaries, and had not changed appreciably at the time this was written, approximately a year later.

Other areas of the brine field are not involved in the activity and operations continue undisturbed. Observations of precise level elevation monuments indicate stability has been restored to the disturbed area; duplicating that achieved at Windsor subsequent to 1954.

Although salt sinkholes are scarce in the Michigan-Ontario district, solution mining of salt has resulted in sinkhole formation in many other parts of the world including New York State, the Gulf Coast, Kansas, Saskatchewan, Virginia, and notably in England, where an entire district is involved. Subsidence of the earth's surface has also resulted from excessive pumping of fluids (water, oil) from Texas, California, and South Africa. The removal of coal and ore in underground mines has brought about surface collapse in many areas of Michigan and elsewhere.

However, these man-made depressions on the surface are insignificant compared with those produced by nature. Sinkholes are abundant the world over, wherever there are soluble rocks (limestone, salt, gypsum) near the surface where percolating waters can dissolve out great caverns. Both the caves and the sink pitted ("Karst") surfaces are popular scenic features.

Michigan law prohibits well drilling and operation that results in either underground or surface waste. "Waste" is defined as "damage or injury" to "potable water, mineralized water, or other subsurface resources" or to "destruction of surface waters, soils, animal, fish and aquatic life or surface property;" by these criteria, there has been little waste.

This investigation yielded no evidence of damage or injury to any animal or plant, soil or mineral resource, or underground or surface water resource. The only effect has been to the topographic surface; this is limited to two partially water-filled steepwalled craters, one single and one double, which interrupt the flat surface of the waste pile. Immediately after collapse, the craters were features of considerable local interest, and guards were employed as a safety precaution. Eventually these sinkholes could become a scenic or recreational feature, as are many abandoned quarries, or used for storage of material to be reclaimed later, or for waste disposal.

It is our opinion that sinkholes do not extend beyond the area of the underlying gallery, and those on Point Hennepin have had no harmful effect on the environment. Both sinkholes and non-collapsed galleries can be of service to the community.