**Soil Science Expert Witness Report on the Use of Oil and Gas Well Brine for Dust Control on Unpaved Roads.**

**Prepared by**

**Bryce F. Payne Jr., PhD**

EXECUTIVE SUMMARY

Oil and gas wells typically produce substantially more water than oil or gas. That water, produced along with the oil or gas, is known as produced water and must be separated from the hydrocarbon product stream before the product is transported. Produced water typically has a high salt content, mostly sodium chloride, and is consequently also referred to as oil and gas well (OGW) brine. Once separated the produced water, or OGW brine, is a waste. A number of practices have been used to manage oil and gas well waste water [Veil 2004]. Among such practices, due to its typically elevated salt content, OGW brine is used as a winter paved road de-icer and in summertime applied to unpaved roads as a chemical agent for dust control and road stabilization. This practice is common and locally important in some areas, including [arts of Pennsylvania, where the local authority utilizing the OGW brine must obtain approval from the Pennsylvania Department of Environmental Protection (DEP).

There have been complaints to the DEP that OGW brine spreading for dust control and road stabilization has led to the degradation of roads, increased dust, and health impacts among citizens who reside along those roads. Thorough development and assessment of real-time evidence with respect to such complaints would require a substantial and sustained investigative effort, and is beyond the scope of this effort. Consequently, the present effort has instead focused on identifying and analyzing available information on road-spreading of OGW brine for dust control in order to discern and evaluate the science and engineering knowledge on which the effectiveness and advisability of the practice has been based.

An examination of the literature reveals few clear facts. Though there is no clear documentation on the earliest use of OGW brine for dust control, it seems plausible the practice began as a matter of convenience for dust control on or near oil and gas well sites, which had the additional advantage of disposing of a high volume waste stream. Dust problems were immediate and OGW brine was immediately available as a wetting agent capable of suppressing dust. There may have been observations or perceptions that repeated applications of OGW brine resulted in a reduction of the recurrence of dust on some roads, but, again, there is no direct documentation of that. The earliest, and still among the most thorough considerations of the use of OGW brine to control dust was that of Herrold (1984), who clarified two fundamentally important questions. What basis is there for the belief that OGW brine is effective as a dust control agent on unpaved roads? Does use of OGW brine for dust control pose environmental risks and, if so, how can those risks be managed?

Herrold found that the effectiveness of OGW brine for dust control had been formally evaluated in only two experimental efforts, only one of which could be recovered for the present investigation. Herrold’s discussion of a lost investigation by a Dow Chemical researcher indicated the investigation was short and comparative, finding that OGW brine was about 1/3 as effective as LIQUIDOW, Dow Chemical’s commercial calcium chloride brine dust control product. Without any specifics on that study its merits or shortcomings cannot be evaluated, though its findings seem reasonable given typical concentrations of chlorides in OGW brines compared to commercial products.

A copy of the report for the other relevant investigation, done at the University of Arkansas in 1977, was discovered during this investigation. The Arkansas 1977 study concluded that an industrial brine similar in concentrations and types of chlorides was effective at controlling dust on an unpaved road at an application rate of about 0.3 gallons per square yard. The experiment lasted only 32 days, dust reduction was not dramatic, and the brine used was not actual OGW brine. Specific statements regarding the origin of the maximum application rates approved by DEP, and authorities in some other states, have not been discovered, but it seems unlikely to be a mere coincidence that the DEP maximum (maintenance) application rate is the same as the rate concluded to be effective in the 1977 Arkansas study.

Because of the importance of the report of the Arkansas 1977 study, that document was thoroughly reviewed by the present investigator. The experimental design of the study was found inadequate to the purpose. There was no replication of treatments, no recognition of variations in inherent differences in conditions likely to affect dust emissions over the 1-mile length of experimental road, and the statistical analysis of the data did not account for likely sources of variability. An analysis of the 1977 Arkansas data analysis that could at least in part account for variability likely to arise from the casual experimental design, indicated that if there were any dust control effect for application of OGW brine it apparently lasted about 2, perhaps as long as 4, days following application. That is, the single, never-reproduced, landmark study that has been used for 40 years to support OGW brine application to unpaved roads for dust control, was fundamentally flawed and greatly exaggerated the dust control effectiveness of an industrial brine similar to OGW brine.

Apparently only one other investigation of the dust control effectiveness of OGW brine was ever carried out, that of Russell and Crowe (1982). Herrold (1984) was apparently unaware of the Russell and Crowe report. To the time of completion of this report, an actual copy of the Russell and Crowe report has not been discovered, but their data was graphically reported in an EPA document. That Russell and Crowe data showed that an OGW brine application more than 10 times higher than the DEP recommended maximum application rate did provide sustained dust reduction for about 20 days, and an additional application at twice the DEP maximum rate only restored dust control for another several days. That is, the data from the only known study to have actually investigated the dust control effectiveness of OGW brine on an unpaved road showed that to be effective the OGW would have to be applied at a rate far in excess of what the DEP considers environmentally acceptable.

There is now a fairly substantial related literature on the use of commercial chloride based dust control agents. Those products, their use, and their impacts are reasonably well understood. It is clear from that literature that OGW brine does not meet the known criteria for effectiveness of such products. To summarize succinctly, chloride brine dust control products are regarded as no more effective than plain water when the chloride salt concentration is below 20%. Though OGW brines are very salty, an OGW brine with a total salt concentration of 20% or higher would be truly exceptional.

Given the nearly complete lack of scientific and engineering evidence supporting the actual effectiveness of OGW brine as a dust control agent, it seems almost remarkable that the practice is so widespread with the approval of DEP, and its counterparts in other states. There appears to be no reasonable explanation for this wide acceptance other than “Throughout the history of conventional oil and gas development, brine has been beneficially used in dust suppression and road stabilization activities on dirt roads…” (PaDEP 2016). That is, the sole justification for the use of OGW brine for dust control is effectively the argument “ but we have always done it that way.” The difficulty with such reasoning as justification for a practice in the realm of environmental protection is surely obvious. If that reasoning were legitimate, then we would still be flushing raw sewage into our rivers.

There are some subtleties in consideration of the “regulation” of the use of OGW brine by the DEP. For example, in the late 1990s, it was a DEP recognition, and related investigation, that spreading OGW brine on roads could present a threat to the waters of the commonwealth that resulted in the reduction of approvable application rates to the current 1/2 (initial), followed by 1/3 (maintenance) gallon per square yard per month. This revised DEP application rate, however, ignores that the only available data (Arkansas 1977, Russell and Crowe 1982) indicate such an application will have little or no effectiveness as a dust control agent, but will still pose risks to the environment. The literature is now accumulating regarding the environmental risks posed by road-spreading of OGW brine, but most of the investigative work has been focused water quality impacts, little or none on air quality impacts, dust being of particular concern in this regard.

It would seem that the rationale in effect is, if OGW brine spreading is effective as a dust control agent, then there is no need to consider possible risks associated with the dust that would rise from roads treated with OGW brine for dust control, since presumably there would not be any, or at least much less. That reasoning is fundamentally flawed. Even if there were less dust from OGW brine-treated roads, and recall there is no evidence to that effect, due to the contaminants in OGW brine not present in the native road soil materials or in commercial chloride dust control products, it is reasonable to be presume that the dust from OGW-brine-treated roads could present additional risks. It is well documented that besides potentially problematic levels of sodium and chloride, OGW brine also carries petroleum hydrocarbons, mostly diesel range organics that include benzene and polycyclic aromatic hydrocarbons. Some OGW brines also carry substantial amounts of radium. It is a matter of relatively simple calculations based on rudimentary soil science to show that the concentrations of such contaminants in dust from roads treated with just one OGW brine application can be reasonably expected to exceed DEP action levels, in most cases being several to several tens of times higher than the action levels. Individuals exposed to such dust, such as residents along roads treated with OGW brine, will be regularly, in some situations nearly continuously, exposed to such dust during the several months of the annual road dust season.

Examination of the DEP documents, related documents from similar agencies in other states, the USEPA, legal records, documents from the oil and gas industry, and in some of the science and engineering literature also reveals a disturbingly common conflation of closely related but importantly distinct terms. Such mixing of meanings has serious ramifications in the collective, practical and operational perceptions regarding the use of OGW brine as a purportedly effective, environmentally benign dust control. Among such terms is “stabilization”, as in “aggregate stabilization” compared to “road stabilization”, both of which are central to dust control on unpaved roads but are entirely distinct in their meanings and implications. Another is, especially on the part of DEP, mixing common or casual and formal (per the Solid Waste Management Act) uses of the term “beneficial use” with respect to road applications of OGW brine.

After exploring the literature from numerous sources regarding the use of OGW brine for dust control on unpaved roads, the present author concludes that such use is without scientific or engineering merit and likely poses substantial environmental risks, perhaps foremost among those risks being health impacts to individuals who reside along or frequently travel roads treated with OGW brine.

REFERENCES

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