AGGREGATE & READY MIX
ASSOCIATION OF MINNESOTA

Technical Memorandum

To: Environmental and Land Use Committee
From: Groundwater Quality Task Force
Subject: Summary of Findings – Aggregate & Ready Mix Association of Minnesota Groundwater Quality Task Force
Date: July 24, 2026
c: John Cunningham, Executive Director ARM
Producer and Associate Members of ARM

Executive Summary

Recently, the construction aggregate industry has experienced local efforts to limit aggregate mining activity on the basis of groundwater quality concerns. Such efforts have not been supported by any incidents or studies. In short, some communities appear to be pursuing action to limit mining with no real justification for doing so. The consequences for all, including the local community, can be detrimental in an effort to solve a non-existing groundwater contamination problem.

The Aggregate & Ready Mix Association of Minnesota (ARM) Environment and Land Use Committee formed a Groundwater Quality Task Force, hereafter also referred to as the Task Force, to gather accurate information on the relationship between aggregate mining and groundwater; and to address any myths that may be driving unnecessary limitations on aggregate mining.

The Task Force's working hypothesis is that aggregate mines do not contribute to groundwater contamination when following modern Best Management Practices (BMPs). To examine the hypothesis, the Task Force developed a groundwater survey that was completed by ARM producer members. The survey was developed as a scoping tool with a broad set of questions to obtain data that would test the hypothesis.

This Technical Memorandum includes the results of the survey that was administered by the Task Force to ARM producer members. In addition, this document includes the results of research and risk evaluation of aggregate mining effects on groundwater quality conducted by Barr Engineering Co. (Barr) independently of the ARM survey and used by permission from Barr.

The two efforts (the ARM survey and Barr's research) are combined herein to provide relevant context and corroborating lines of evidence that support the general hypothesis that aggregate mines do not contribute to groundwater contamination when following modern BMPs.

1 Introduction

It has become increasingly difficult to permit non-metallic aggregate mines in Minnesota due to the current regulatory climate of local jurisdictions. One of the most commonly cited permitting concerns reported by ARM's producer members is the general perception that mining will negatively impact groundwater quality. As a result, local permitting authorities often consider poorly reasoned restrictions such as limits on mining at or near the water table or depth of mining below the water table. Some of the negative perceptions may be related to opposition to mining in general, and/or the fact that aggregate mines are almost always located in areas mapped as highly sensitive to groundwater contamination due to the permeable nature of the material, and/or concerns conflated with other types of mining (e.g., metal

sulfide mining) that have nothing to do with aggregate mining. The concerns stand in stark contrast to decades of aggregate mining operations which operate below the water table without adverse environmental effects. These operations are located in rural areas served by private water supply wells as well as urban areas where municipal water supply systems operate in close proximity to a mine, without detrimental impacts to groundwater quality.

While there may be valid site- or community-specific reasons for imposing restrictive conditions or standards, one-size-fits-all restrictions, standards or prohibitions, such as *no mining within ten feet of the water table*, have no basis. It is difficult to connect commonly imposed restrictions (e.g., setting a maximum depth above or below water table) to an actual risk posed by an aggregate mine. There is also a lack of clarity on how the proposed restrictions would actually result in protecting groundwater quality. The benefits of aggregate mining are often easy for local jurisdictions to overlook, even when the economic vitality of that jurisdiction stands to gain the most benefit in jobs as well as ready access to and affordable pricing of aggregates for construction of local roads and other infrastructure. These restrictions may, at worst, make mine deposits inaccessible, and at a minimum, add monetary costs to the public in terms of price of materials and infrastructure, and/or environmental costs with respect to additional greenhouse gas emissions due to additional trucking distances by pushing the locations of pits and quarries further from their target markets. The end result is lower availability of products, inflationary pressure of basic materials needed for roads, bridges, affordable housing, and exacerbated climate effects.

1.1 Purpose

The purpose of this document is to provide a comprehensive reference document to address increasing opposition and regulatory concern over the potential for negative effects on groundwater quality related to aggregate mining. The scope of work includes the results of a survey that was administered to ARM producer members regarding groundwater quality effects of aggregate mines in Minnesota. In addition, this document includes the results of research and risk evaluation of aggregate mining effects on groundwater quality conducted independently of the ARM survey by Barr.

The two efforts (the ARM survey and Barr's research) are combined herein to provide relevant context and corroborating lines of evidence that support the general hypothesis that aggregate mines do not contribute to groundwater contamination when following modern Best Management Practices.

For the purpose of this document:

- **Best Management Practices** (BMPs) are defined as, "Practices to prevent or reduce the pollution of waters of the state, including schedules of activities, prohibitions of practices, and other management practices, and also includes treatment requirements, operating procedures, and practices to control plant site runoff, spillage or leaks, sludge, or waste disposal or drainage from raw material storage. (Minn. R. 7001.1020, subp.5.)," under the definitions section provided on page 32 of the *Minnesota Pollution Control Agency* (MPCA) *Wastewater Permit User's Manual – A guide to using National Pollutant Discharge Elimination System/State Disposal System permit*, dated July 2022 (wq-wwtp7-09).

- **Groundwater contamination** is assumed to mean the presence of groundwater constituents above regulatory standards, permit limits, or statistically elevated concentrations above background conditions in groundwater upgradient of the mine location.

1.2 Scope

The content of this Technical Memorandum is divided into three primary sections:

- **Background Information** – This section provides background information including basic information on aggregate mining, groundwater concepts, and the types of potential contaminant risks that are and are not associated with aggregate mining.
- **Data Evaluation** – This section provides a summary of data collected as part of the ARM survey and Barr's research, and offers interpretation where conclusions appear to be supported by the data.
- **Conclusions** – This section provides a concise summary of conclusions that can be used for working with the public and stakeholders.

2 Background Information

Sand, gravel and crushed stone extraction are the most common forms of mining in the state. The geologic composition of the gravel reflects the naturally occurring materials that they are derived from. Extraction is completed via various mechanical excavation methods, dredging, and occasionally blasting for quarried rock. Because these materials are relatively inexpensive to mine but are expensive to transport, most operations are located close to where the resource will be used. Consequently, there are sand and gravel mines and rock quarries located in every county of Minnesota. Aggregate mining in Minnesota involves extracting sand, gravel, and crushed stone which are essential materials for roads, bridges and buildings; the state is a major producer of these construction materials. Aggregate mining operations within Minnesota are carefully regulated through local extraction permits, MPCA stormwater management permits, Minnesota Department of Natural Resources (MN DNR) water appropriation permits, compliance with Stormwater Pollution Prevention Plans (SWPPPs), and compliance with Spill Prevention, Control, and Countermeasure (SPCC) plans to balance economic needs with environmental stewardship.

Fuels and lubricants are mixtures of hydrocarbons with various degrees of mobility and toxicological importance; these are often measured in terms of the parameter "oil and grease" in surface water and as total petroleum hydrocarbons or Total Petroleum Hydrocarbons (TPH) in groundwater. TPH can be expressed as a hydrocarbon chain range commonly including gasoline or diesel fuel. There are no health risk standards for oil and grease or TPH; although, the MPCA may assign permit thresholds or limits for each. From a risk perspective, the components of fuels and lubricants that are of health concern are typically measured by analyzing for benzene, ethylbenzene, toluene, and xylene.

Other organic constituents associated with some mine operations include polycyclic aromatic hydrocarbons (PAHs) that are related to recycled aggregate materials containing asphalt and/or used vehicle and heavy equipment oil. These compounds are relatively immobile in the environment and are regulated by the MPCA on sites that manage these materials.

Other parameters like metals are naturally occurring but are not used or generated at aggregate mine sites. Some concerns about metals often are raised in the context of metal sulfide or precious metal mining, but the concentrations of these metals are very low in aggregate because the gravel has been rounded and weathered by glacial meltwater, and the shallow groundwater has been diluted over long periods of time.

Nitrates are often raised as a contaminant of concern at aggregate mines, but their presence is not due to any mining process. They are found at rural areas where feedlots, manure application, septic systems and fertilizer use are used. Other contaminants associated with agricultural contamination include coliform bacteria and pesticides, which are also unrelated to aggregate mining processes.

2.1 Aggregate Mine Operations and Sources of Potential Contamination

The majority of construction aggregate mines are sited in locations that are comprised of natural occurrences of coarse sand and gravel materials. These geologic materials are known to have a high permeability; in essence, they have the ability to easily transmit the flow of a fluid. The time it takes groundwater to flow through various types and thicknesses of soils and geologic materials is a defining factor when considering the sensitivity of a groundwater resource to pollution.

There is an obvious correlation with aggregate resources and areas that are potentially sensitive to contamination. This is a function of the fact that aggregate deposits tend to be permeable geologic materials, and therefore they can rapidly transmit fluids to the water table. However, it is important to note that a possible vulnerability for contamination to migrate through permeable materials does not mean that contamination inherently exists, or that aggregate mining activities would inherently generate contaminants that could migrate within the permeable material.

Therefore, the first step to understanding the potential for groundwater contamination due to aggregate mining is to understand the risk posed by the mine and its operations by looking at what potential contaminants are used at the mine site, the way they are stored, and what provisions are in place to prevent contamination in the event of a release. Another important factor is to compare this risk to other types of land use to assess whether the risks would require restrictions on operations intended to mitigate those risks.

While there are sources of potential contamination at sand, gravel, and crushed stone operations (including mobile equipment, trucks, fuel storage tanks, etc.), most of these operations do not use chemicals as part of the aggregate production process, and groundwater is used for aggregate washing. This means that the primary focus for aggregate mines is how petroleum is stored, used, and transferred to mobile equipment. The risk of a fuel spill is reduced when operators follow current BMPs that are required to be detailed in a SWPPP and/or SPCC plan; these are common and typically required plans for aggregate mines in Minnesota. SWPPPs detail how the mine will prevent stormwater runoff from carrying sediment and fuel residue off-site or prevent them from migrating on-site. SPCC plans describe the locations of fuel storage and handling areas as well as specific practices and equipment that are on-site for staff to address spills before they soak into the ground or come into contact with groundwater.

BMPs may include good housekeeping, employee training on proper handling of materials, ongoing maintenance of equipment, routine site inspections, proper fuel and oil storage including dedicated fueling areas, secondary containment or double walled tanks, seeding and stabilization of perimeter berms, management of stormwater run-in, management of stormwater discharge, and ongoing reclamation once the aggregate resource has been recovered. BMPs work together to ensure that contaminants do not get released, and if they do get accidentally released, that they are contained and cleaned up prior to reaching the water table or any sensitive receptor.

Relying on natural attenuation of petroleum to degrade in the environment is not a BMP. Therefore, requirements that mandate a soil buffer to create a "filter" for contamination are not a suitable means for preventing release. Natural soil buffers are not effective for petroleum contamination within sand and gravel deposits which lack organic carbon and the typical microbial communities needed to break down petroleum in the environment. The best management practices are those that prevent releases from occurring, and if releases occur, require on-site employee training to rapidly respond to releases.

2.2 Aggregate Mine Operations Relative to Other Land Uses and Non-Point Sources of Potential Contamination

Agricultural operations can create significant nitrate loading, utilize petroleum products, and are not required to have SWPPPs, SPCC plans, or other BMPs that are standard for aggregate sites. The run-off from agricultural fields can carry sediment and farm chemicals (e.g. pesticides) directly into groundwater and water ways (via drain tile or direct runoff). This is an important comparison because aggregate mining operations are often permitted in rural or urban fringe areas that would otherwise be exposed to agricultural contamination. Commercial operations unrelated to aggregate production may have sources of contamination including parking lots with fueled vehicles with leaky components, and some operations may store petroleum and other chemicals without protection. These chemicals can run off a commercial property and soak into the ground and/or enter surface water receptors. By contrast, many aggregate mining operations have perimeter berms in addition to the BMPs listed in the prior section to control both run-on (from adjacent properties) and run-off which is typically managed on-site.

3 Data Evaluation

3.1 Enhanced Literature Search for Evidence of Groundwater Contamination

A commonly stated concern regarding aggregate mining is the potential for groundwater contamination. However, this statement is often puzzling to mining operators and those familiar with the aggregate industry because typical operations do not involve obvious sources of contamination. To test the hypothesis that aggregate mines do not contribute to groundwater contamination when following modern BMPs, Barr conducted a comprehensive literature search in March 2025 to investigate actual examples of groundwater contamination resulting from the operation of an aggregate mine in Minnesota and then expanded the search to all regions in the United States.

3.1.1 AI-Assisted Search Prompts

The search utilized a manual internet search as well as an artificial intelligence (AI) tool to search for published papers, news articles, or other documents that fit one or more of 36 separate query combinations of including the following key words: "Minnesota," "sand and gravel," "aggregates," "non-metallic mining," linked with one or more of the following "contamination," "groundwater contamination," "vulnerability," "pit lakes," "pollution," "protection of aquifers," "diesel fuel," "nitrates," and "pesticides." The AI search was followed by an independent human intelligence search by Barr's Information Services staff as well as a collection of specific articles or publications revealed by the search.

3.1.2 Search Results: No Examples of Groundwater Contamination in Minnesota

The results of the search and AI queries did not return any research, articles, or studies that cited a single example of groundwater contamination in Minnesota related to sand and gravel or quarry operations. In fact, the only example of any contamination associated with sand and gravel in the entire United States involved a Superfund site in New Jersey that was used in the 1970s as an illegal disposal facility after the

mine was closed. Such disposal activities are not directly related to sand and gravel or quarry operations and are illegal in Minnesota.

3.1.3 Groundwater Vulnerability vs. Groundwater Contaminant Source

The most commonly returned finding to the query search was regarding the "vulnerability" of sand and gravel sites to contamination or pollution rather than actual examples of contamination. The observation that sand and gravel sites are vulnerable to contamination is an obvious one; mined materials are typically located within areas that contain sand and gravel deposits relatively near or accessible from the ground surface and often exhibit high permeability that allows for relatively fast infiltration rates on the order of a foot or feet per day. Because lower permeability surface soils are often removed and stockpiled prior to mining, the issue is that a hypothetical release of contamination can rapidly infiltrate to groundwater and migrate toward some (typically undefined) potential receptor.

The primary example of this position is the Minnesota Department of Health (MDH) 2009 guidance for wellhead protection areas and related groundwater vulnerability maps. For clarity, these maps and guidance documents provide no examples of contamination and do not suggest any evidence that sand and gravel operations cause more vulnerability to contamination than other similarly located operations (e.g. agriculture).

The search results returned concerns related to the key words rather than actual instances of contamination. The specific concern is that if a release were postulated to occur, it might be expected to move rapidly to a receptor. If a release occurs in a wellhead protection zone, the water supply could be threatened; however, the premise that a water supply well would be threatened requires a release of contamination in detectable concentrations and that can reach that presumed receptor. The guidance does state that fuel and chemical storage, or use, be managed consistent with BMPs and as required by law, which is a requirement for commercial aggregate mine operations.

3.2 Results of ARM Groundwater Quality Task Force Survey

In order to address the perception that aggregate mines are a potential source of contamination, ARM recognized a need to gather more information on this topic and to specifically seek evidence of groundwater contamination resulting from aggregate mining operations. ARM conducted a survey of its members to gather data on the prevalence of and the potential concerns regarding groundwater quality reflected by permit requirements for aggregate mines located in Minnesota.

Based on an online search, this survey appears to be the first of its kind in Minnesota to attempt to understand quantitative data on the existence of groundwater quality issues related to permitted aggregate mining operations. The survey was distributed to 72 ARM members in direct email messages. It was also announced in ARM member email updates which included 378 members who represent around 100 member companies. In total, 59 responses to the survey were received. Nearly all of the respondents indicated that they are operating at or near the water table.

3.2.1 General Survey Scope

The survey consisted of 18 questions in addition to basic location/identification and contact information and included questions regarding the type of operation, types of monitoring, information on release/spills, and location relative to floodplains and wellhead protection areas. Of the 59 responses received, one did not include responses to most questions, but the remaining 58 responses were deemed generally

complete with less than three questions unanswered. Most of the operations were identified as sand and gravel operations with 8 out of the 58 sites indicating that they operated a bedrock quarry operation.

3.2.2 Groundwater Quality Results

Survey results in regard to groundwater monitoring are summarized on Table 1 below. Of the 58 complete responses received, none indicated that they had ever had any spills or release resulting in groundwater contamination.

Table 1
Summary of Responses for Groundwater Quality Monitoring Survey Questions
(59 total responses, 58 deemed complete)

Operation Type	Number of Operators	Exceedance of Groundwater Quality Threshold	Limit on Mining Below Groundwater	Groundwater Monitoring Network?	Spill Prevention or BMPs	Release History
Sand and Gravel	50[1]	0 (0%)	9 (18%)	12 (24%)	50 (100%)	0 (0%)
Bedrock Quarry	8	0 (0%)[4]	2 (25%)	4 (63%)	8 (100%)	0 (0%)
Other/No Response	1[2]	0	1[2]	5[3]	1	1

1. Total number of sand and gravel operations inferred from other questions as not every operator specifically indicated operation type.
2. 11 out of 58 operations noted no restriction on mining at or below the water table; one did not provide a response to any of the questions.
3. Most responded “no” to this question, but there were five that did not respond.

3.2.3 Sites with Monitoring Networks

Sixteen of the 58 completed responses (28%) indicated they had some type of groundwater monitoring system installed. Nearly all of those sites are required to monitor water levels. Nine of the 16 respondents (56%) reported water quality requirements that include routine monitoring of potential groundwater contaminants. The most common parameters (78%) included either Diesel Range Organic (DRO) or Total Petroleum Hydrocarbons (TPH). These parameters are commonly used as general indicators of dissolved constituents typically found in fuel products. No detections above permit thresholds were reported for any of the groundwater parameters at any operation or any of the 16 operations with groundwater monitoring.

3.2.4 Sites with Restrictions on Mining Below the Water Table

Eleven sites reported some limitations on mining at or below the water table. The restrictions varied from a minimum separation distance to a minimum depth or elevation. Seven of the 11 sites (63%) with these restrictions have a groundwater monitoring network consisting of at least one well installed. It is unclear

from the survey why jurisdictions that are concerned about mining in the water table do not also require monitoring. However, one reason may be that local ordinance may forgo monitoring in exchange for placing restrictions on the operator in regard to mining at or below the water table.

Conversely, 10 of the 16 sites (again 63%) with monitoring well networks indicated a corresponding restriction on mining at or below the water table. This suggests that in some cases, monitoring is required even though it is not accompanied by a specific concern about mining at or below the water table.

3.2.5 No Evidence of Groundwater Contamination at Monitored Sites

None of the 16 sites with groundwater monitoring indicated any evidence of groundwater contamination nor did any of the 58 completed responses indicate that a spill or release had occurred as part of the operation. Every respondent also indicated that they had required state BMPs or federal SPCC plans in place where required. These actions are protective of groundwater because they serve to prevent or contain spills and provide clear response steps before contamination can spread if spills occur.

4 Conclusions

Aggregate mining operations are sometimes identified by the public and regulators as a potential cause or source of groundwater contamination. This has sometimes resulted in blanket restrictions on depth of mining above or near the water table. Even where allowed, some jurisdictions limit the depth of mining below the water table.

However, these restrictions are not justified based on the fact that aggregate mines do not generate store or dispose of contaminants on their property that are significantly different than other land uses in the same geographic area as the mine. The incidental use of fuel or storage of materials is managed under existing regulatory permit authority, and BMPs that may be more protective than other land uses that have no or few regulatory restrictions (e.g., agriculture). In addition, aggregate mining operations are highly regulated by state agencies, utilize a series of BMPs, and leverage SPCC plans to prevent contamination from occurring.

This document provides data and analysis including a literature survey designed to identify evidence of contamination to groundwater resulting from aggregate mining, and a survey of ARM members to determine if groundwater contamination is a problem aggregate mines that requires blanket restrictions described above.

The literature survey returned no results indicating that an aggregate mining operation has resulted in groundwater contamination. There are numerous references to “vulnerability” and potential for contamination, but many of these documents lack context in terms of determining whether aggregate mining is more so a risk than other land uses that are not subject to restrictions based on these concerns.

Direct evidence indicating a lack of contamination related to aggregate mining was provided by an ARM member survey of groundwater monitoring results from active mine operators. Based on the results of the survey consisting of 58 completed responses from aggregate mining industry professionals, none of the 16 operations with groundwater monitoring requirements had a single exceedance of their permit limits for groundwater. The results of the literature search and ARM member survey support the general hypothesis that aggregate mines do not contribute to groundwater contamination.