AGGREGATE PROTECTION GUIDANCE

2022

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INTRODUCTION

The availability of affordable construction materials is one of the most critical elements affecting the sustainability of future development. These valuable construction materials, consisting of sand, aggregate, and crushed rock or stone, are the crucial building materials for every residential, commercial, industrial, and public infrastructure project.

Figure 1: Residential development encroaching on active mining operations frequently sterilizes aggregate resources.

Over the years, population growth in Arizona has significantly expanded the urban boundaries of many communities, including Phoenix, Tucson, Peoria, Marana, Buckeye, and others. This expansion has resulted in the development of residential communities in rural areas, often near existing aggregate operations. Ironically, while the location of these mines assured an abundance of low-cost construction materials, the industrial nature of these operations frequently creates conflict with the residents over concerns about noise, dust, traffic, and other environmental and operational impacts. In other areas of Arizona, shortages of permitted aggregate resources cause producers to transport aggregates from more distant quarries. This results in higher materials prices, increased traffic, safety exposures, higher road maintenance costs, congestion, and greater vehicle emissions.

These conditions can be particularly intense where local zoning regulations, or the absence of such regulations, have allowed the construction of residential communities immediately adjacent to ongoing mining operations or over known aggregate deposits. When mines and communities interact in an unplanned manner, community frustration can quickly escalate and local leaders and regulators are frequently barraged by complaints, with only limited authority and few viable options to retroactively address these conditions.

However, keeping regulators, city staff, and elected officials out of the middle of avoidable disputes between operators and the community is essential. And, where mitigation alternatives are possible, such as modifying traffic patterns or hours of operation, the alternatives are oftentimes difficult and costly to implement because they were not originally contemplated during the initial development of the area.

In many areas, communities have failed to recognize the importance of locally available aggregate resources. Communities have purposefully or inadvertently prohibited quarry development, or have allowed community development to overlay or encroach upon valuable aggregate deposits. This often results in the loss or “sterilization” of valuable aggregate resources as communities or other permanent developments are built over these deposits. Unfortunately, these types of planning decisions do not alter future aggregate demands, and the loss of aggregate reserves will inevitably lead to local material shortages and substantial increases in development costs.

As the population of Arizona continues to grow, it becomes readily apparent that neither of these scenarios achieves a balanced and sustainable development model. However, when community planners fully understand and recognize their need for affordable aggregate resources, these communities can develop adaptive management strategies and achieve financially and environmentally sustainable growth well into the future. As part of this process, it is imperative to encourage responsible land use development and planning within communities to ensure long-term aggregate resource availability and avoid untenable land use conflicts.

BACKGROUND AND INTENT

The passage of the aggregate protection legislation including the Aggregate Protection Act (SB 1598) and its companion bill (HB 2453) created a significant opportunity for counties, municipalities, and special districts to ensure the sustainable growth of our communities. This can be achieved because the Aggregate Protection Act established a collaborative framework and new requirements for planners and community leaders to responsibly address a critical element affecting the sustainability of future development—the availability of affordable construction materials.

Arizona's Aggregate Protection Act simply requires that city and county General Plans (required under Arizona's Growing Smarter legislation) be revised or updated to identify active aggregate operations in their planning areas and that planners develop meaningful policies to protect these aggregates for future use by avoiding incompatible land uses. The excerpted requirements of the law are included below.

> ARS: 9-461.05. General plans; authority; scope
>
> *...Includes sources of aggregates from maps that are available from state agencies, information from the Arizona geological survey on how to locate existing mines, consideration of existing mining operations and suitable geologic resources, policies to preserve currently identified aggregates sufficient for future development and policies to avoid incompatible land uses...*

As part of its proactive public outreach program, the Arizona Rock Products Association (ARPA) developed a practical guidance document that could serve as a valuable resource for planners who are amending General Plans to conform to the requirements of the Aggregate Protection Act. This document updates our original guidance in 2015 and provides information essential for identifying aggregate resources in municipal or county planning areas and offers practical guidance in developing strategies and policies for protecting those resources. This guidance also assists those working for state, county, and municipal governments to understand:

- The nature and availability of aggregate deposits
- Methods for calculating future aggregate needs of communities and planning districts
- The relationship between the aggregate availability and development cost
- Community benefits from proactive planning of future aggregate production
- Tools for avoiding unnecessary conflict between aggregate production and residential land uses
- Strategies for influencing productive reclamation and post-mining land uses to achieve long-term planning goals

Because of the zoning exemptions granted in Arizona Revised Statutes (A.R.S), county planners have less input on the regulation of aggregate mining operations in unincorporated areas of the state. That does not imply that mines in unincorporated areas are unregulated, because there are a myriad of authorizations and permitting requirements that address reclamation and air and water protection. However, county planners can still identify the regional sources of aggregates in their planning jurisdictions and encourage the responsible management of those resources by addressing related transportation, development, mine reclamation, and post-mining land use efforts. General Plans that identify aggregate production areas demonstrate the intrinsic value of these resources, link the availability of aggregate resources with low-cost infrastructure, and development growth for the county.

Figure 2: Most aggregates are mined from unconsolidated alluvial deposits found in and along active river systems.

UNDERSTANDING AGGREGATE RESOURCES

Mineral deposits, by their very nature, are unique and finite resources. The conditions that create economically extractable resources result from complex interactions between geologic and depositional environments. Unfortunately, we cannot influence the location of these resources, nor can we change the unique characteristics of these deposits. As such, communities that are endowed with abundant mineral resources suitable for mining possess a valuable and essential component needed for growth. And, like water or any other valuable community asset, planners should diligently protect and responsibly use these materials for the benefit of existing and future generations.

Although aggregate resources in Arizona tend to be more prevalent than other types of mineral deposits, exacting physical and chemical building specifications significantly impact the suitability of these materials for use in concrete, asphalt, and other durable construction materials. Further, limitations associated with land position and configuration, permitting requirements, and proximity to the market significantly impact the viability of any given aggregate resource. Consequently, while aggregate resources may be more abundant, these other factors inevitably reduce the location, quantity, and availability of economically extractable resources.

Thus, if development is allowed to encroach near or over these deposits, vast volumes of aggregate resources can become permanently and irrevocably inaccessible to extraction. Unfortunately, these resources cannot simply be moved to a more convenient or remote location, nor can replacement deposits be easily developed. Thus, this sterilization process is permanent and can significantly affect future development costs and impacts because alternative supplies will need to be imported from more distant mines. As discussed in later sections, the proximity of aggregate resources to the point of use has the greatest impact on the cost of those aggregates and the resultant construction products that use these materials. There are also dramatic environmental, safety, and infrastructure impacts associated with hauling aggregate resources great distances to their points of use.

In Arizona, the most prevalent type of aggregate resources are found in alluvial deposits. Simply stated, alluvial materials are transported and deposited by streams and rivers that erode bedrock materials from higher elevations and transport these materials downstream. Major alluvial systems in Arizona, like the Gila, Salt, Colorado, San Pedro, and Santa Cruz Rivers, have created vast aggregate deposits within the floodplains and floodways of these systems.

Alluvial materials are highly valued because the transport and depositional forces that create these deposits have conveniently washed, sorted, and broken down the rocks. These processes tend to remove less durable materials that make mining and processing easier. These types of deposits are often unconsolidated (meaning that the materials are not cemented together or lithified) and thus can be easily mined and processed. These factors generally make alluvial deposits more desirable because they generate less waste material and can be more economically mined and processed than other aggregate sources.

In areas lacking alluvial deposits, aggregates must be produced by mining and processing competent bedrock deposits. These types of deposits typically require more expensive mining techniques, such as drilling and blasting, and extensive processing to produce suitable aggregate materials. Although there can be very large rock deposits, the increased mining and processing requirements of crushed stone or "manufactured" aggregates typically make them more expensive and less desirable as compared to alluvial materials. Approximately 15 percent of all aggregates produced in Arizona are from crushed stone deposits, and in some areas bedrock deposits may be the only source of durable construction aggregates. Therefore, suitable bedrock deposits also need to be identified and protected from development or conservation easements.

Figure 3: Aggregates can also be "manufactured" from mined bedrock deposits.

WHAT ARE THE BENEFITS OF LOCALLY PRODUCED AGGREGATES?

The answer may surprise you when you consider the total impacts of importing aggregates into your community. In addition to their lower costs, locally produced aggregates require less fuel for transport; produce less traffic congestion, traffic accidents, and road wear; and have lower air emissions and a smaller carbon footprint compared with imported aggregates.

Local studies in Arizona have not evaluated this, but in California where longer hauls (average greater than 50 miles) are commonplace, the effects of transportation can be significant. The California Department of Transportation (Caltrans) estimated that transporting aggregates from mines to consumers generates over 18.8 million truck trips per year. With an average haul distance of 50 miles, these trips generated close to 1 billion miles of transportation-related impacts to the state.

Further, Caltrans reported in 2020 that the materials and equipment used for Caltrans highway construction and maintenance projects account for roughly 2.5 million metric tons (MMT) of greenhouse gas (GHG) emissions per year, or 0.6 percent of statewide emissions.

If haul distances were reduced by 30 percent (to 35 miles) the effect would reduce transportation impacts by 282 million miles and diesel fuel consumption by approximately 44 million gallons. This in turn reduces truck emissions (CO, NOx, PM10, SOx and VOCs) by approximately 835 tons per year. Additionally, Caltrans estimated that reduced haul distances would generate a statewide transportation cost savings of $705 million, reduce capital project costs by over $108 million, and save between $12 and $18 million in pavement rehabilitation cost. Reduced travel distances would also lower congestion and traffic-related accidents on the roadways.

But what does that mean in Arizona? At historically peak production levels, Arizona produced 94.1 million tons of aggregates plus an additional 15 million tons of crushed stone.

At 25 tons per truck, this generated 8.73 million truck trips (including empty trucks returning to the mines) traveling more than 174 million miles (conservatively assuming a 20-mile haul distance). Using California Air Resources Board emission factors, these trips required more than 26.7 million gallons of diesel fuel and generated more than 506.9 tons of truck emissions.

Clearly, transportation-related factors are important, and developing local sources can significantly reduce both the impacts and costs related to transporting aggregates. This reduces project costs, makes roadways safer and less congested, reduces maintenance costs, and keeps our air cleaner.

In 2006, Arizona produced a record 109 million tons of aggregates and crushed stone. Transportation of these materials generated 8.73 million truck trips traveling more than 174 million miles. This required more than 26.7 million gallons of diesel fuel and generated over 506.9 tons of truck emissions!

DETERMINING AGGREGATE DEMAND IN YOUR PLANNING AREA

The aggregate needs of a community change with the pace of development, maintenance, and gentrification. To realistically quantify the total aggregate needs of your planning area, one should consider both the baseline as well as future aggregate demands of the community.

When considering baseline aggregate needs, the maintenance and upgrade of existing infrastructure, as well as future development, requires substantial amounts of construction aggregates. This demand is created when infrastructure is maintained or replaced and when new commercial, municipal, or residential construction replaces or revitalizes aging development. While this baseline aggregate demand can be significant, it is comparatively lower than the aggregate needs of rapidly expanding communities with "greenfield" construction and infrastructure development. However, it is incorrect to assume that aggregate needs of fully "built-out" communities are zero.

Future aggregate needs for a particular planning area can be simply estimated based on existing populations and future growth projections already established for your planning areas. The existing population is used to determine the baseline aggregate demands, and the growth projections will determine the potential aggregate needs associated with future development.

Production Year	AZ Construction Sand and Gravel (million metric tons)	AZ Crushed Stone (million metric tons)	AZ Population (millions-approximate)	AZ Consumption per Capita (metric tons)
2008	67.8	14.1	6.6	12.4
2009	40.8	9.2	6.7	7.5
2010	35.7	8.0	6.3	6.9
2011	31.7	8.1	6.4	6.2
2012	34.2	6.6	6.5	6.3
2013	35.3	8.0	6.5	6.7
2014	36.2	8.5	6.6	6.8
2015	39.5	10.2	6.6	7.5
2016	40.3	10.1	6.8	7.4
2017	42.1	10.7	6.9	7.6
2018	47.6	12.7	7.0	8.6
Totals	**451.2**	**106.2**	**6.6 (average)**	**7.6 (average)**

Note: Population data from the Arizona Commerce Authority adapted from Arizona Office of Economic Opportunity

The California Department of Conservation-California Geological Survey (CGS) has extensively studied aggregate demand and supply trends for nearly three decades. In their long-term analysis of the various market and production areas of California, the CGS calculated a long-term average per capita aggregate consumption rate of approximately 6.6 tons per person per year (tons/person/year). It is important to note that this value represents a long-term average consumption rate for California. On a short-term basis, this number could be much higher or lower depending on market conditions and the intensity and rates of development.

But Arizona is much different than California, and according to the United States Geologic Survey (USGS) Mineral Industry Surveys, Arizona has produced over 450 million tons of construction sand and gravel and over 105 million tons of crushed stone from 2008 to 2018. During this time, the per capita consumption of these materials averaged approximately 7.6 tons/person/year. However, during times of peak development activity (2004 to 2007, for instance), per capita consumption exceeded 15 tons/person/year and actually peaked at over 17 tons/person/year. Conversely, at the deepest part of the recession, per capita consumption dropped significantly, but never below 6.2 tons/person/year.

Based on the table above, which doesn't reflect elevated production values after 2018, it appears that the average per capita consumptions are underreported. Therefore, when estimating per capita consumption for most of the large metropolitan areas in Arizona (Phoenix, Scottsdale, Mesa, Tucson, etc.) an average per capita consumption rate of approximately 10.0 tons/person/year is recommended.

For suburban areas where significant anticipated growth is planned (Florence, Queen Creek, Marana, Buckeye, etc.), per capita consumption rates exceeding 12.0 tons/person/year should be anticipated. When estimating per capita consumption in rural communities (Globe-Miami, Winslow, Quartzite, Willcox, etc.) an average per capita consumption rate of approximately 15.0 tons/person/year is appropriate. Naturally, a large infrastructure project in these relatively small markets may cause a significant, although temporary, increase in per capita demand.

Interestingly, per capita consumption rates for rural communities are higher than in more developed urbanized areas because of the relative low population density of rural development, higher percentage of single-family homes, and remoteness to other urban centers. In fact, Oregon found that some rural counties used 30 percent more aggregates per capita than larger counties with 20 times the population.

Development Intensity	Approximate per Capita Consumption (tons/person/year)	Impact of Large Infrastructure Projects on per Capita Demands
Metropolitan	10.0	Low
Suburban	12.0	Moderate
Rural	15.0	High

CALCULATING FUTURE AGGREGATE DEMANDS IN YOUR COMMUNITY

Estimating per capita aggregate demand for Arizona, the population-based formula can be expressed as follows:

*Current population (persons) * aggregate use (tons/person/year) = X tons/year*

As an example, if a suburban community had a current population of 550,000 persons and was experiencing significant development growth, the yearly aggregate consumption of the community would be estimated as follows:

*550,000 persons * 12.0 tons/person/year = 6,600,000 tons/year*

However, a metropolitan community with the same population but essentially fully developed, the future aggregate needs of the community would be estimated as follows:

*550,000 persons * 10.0 tons/person/year = 5,500,000 tons/year*

Finally, for a rural community with the same population but spread over a large area, the future aggregate needs of the community would be estimated as follows:

*550,000 persons * 15.0 tons/person/year = 8,250,000 tons/year*

Using the examples above, changes in development intensity or rurality could result in a nearly 50 percent swing in yearly aggregate demand. However, keep in mind that these are average aggregate demands and that year-to-year changes in these values will occur because of variable population growth rates, the construction of large infrastructure or transportation projects, or as a consequence of significant natural events (such as flooding, earthquakes, or fires).

THE CALIFORNIA PROBLEM

For more than 40 years the California Geological Survey has conducted ongoing studies that identify and evaluate aggregate resources throughout the state. The study projects aggregate demand in over 31 market areas (referred to as production-consumption areas) in California and compare those estimates to currently permitted aggregate reserves.

Map Sheet 52 (2018) is an updated summary of supply and demand data from these studies. The map presents a statewide overview of projected future aggregate needs and currently permitted reserves.

The following conclusions can be drawn from Map Sheet 52 (2018) and the accompanying report "Aggregate Sustainability in California":

- In the next 50 years, California will need approximately 11 billion tons of aggregate.
- The study areas shown on Map Sheet 52 currently have about 7.6 billion tons of permitted reserves, which is about 69 percent of the total projected 50-year aggregate demand identified for these study areas.
- One aggregate study area is projected to have 10 or fewer years of permitted aggregate reserves remaining as of January 2017 (San Fernando Valley/Saugus Newhall area).
- Seven aggregate study areas have between 11 and 20 years of aggregate reserves remaining.

California Geological Survey MS 52

The report indicates that only five of the 31 market areas in California had permitted aggregate reserves sufficient to meet projected long-term aggregate demands. These findings are significant because permitting new aggregate resources in California often exceeds 10 years. More importantly, only half of the market areas actually increased permitted resources

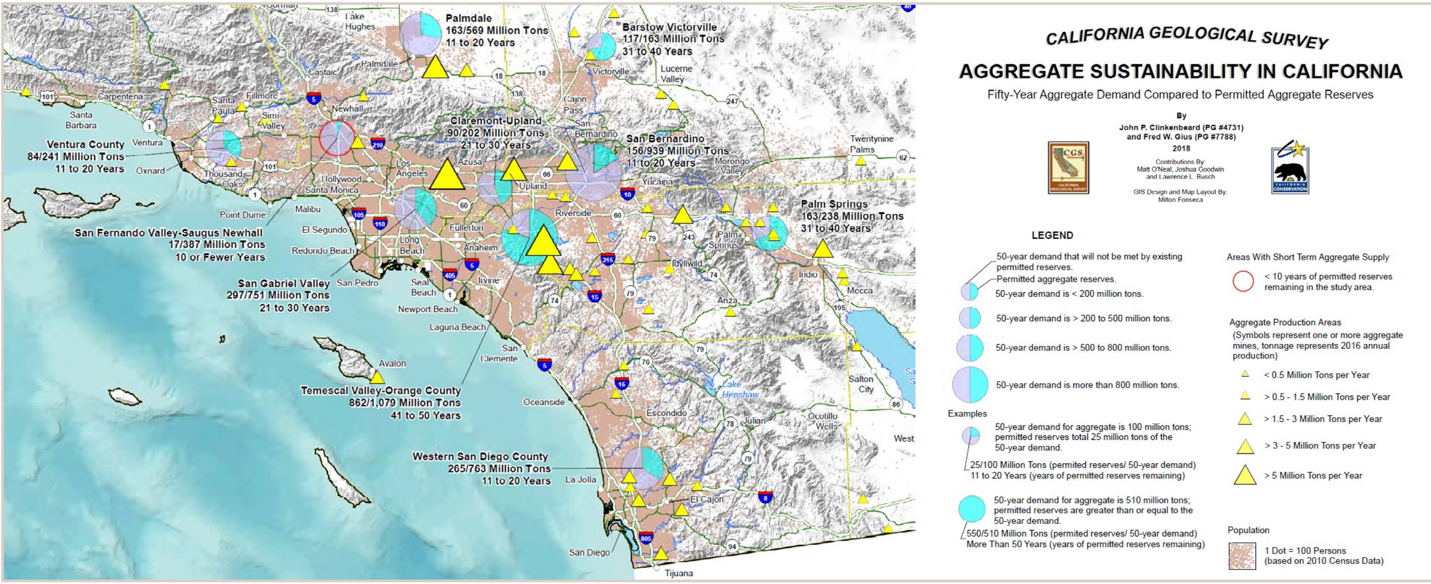

Figure 4: California Department of Conservation Aggregate Study (2018) shows critical aggregate supply issues in many metropolitan areas.

since the last survey (2018), suggesting that large areas of California are still moving toward a costly aggregate supply model based on remote production and the extended transport of raw materials and finished products to the markets.

The impact of aggregate shortages is profound, and California is currently importing sand and aggregate into San Diego, Los Angeles, and San Francisco from mines located in Mexico and Canada. Further, some major markets are forced to import aggregates from production areas located more than 80 miles away—the equivalent of importing aggregates from Tucson to Phoenix. The transportation of these materials into many of the major California markets has significantly increased both the costs of those aggregates as well as unwanted environmental impacts associated with the added transportation (refer to How Green are your Aggregates).

In terms of cost, the CGS reported that the average cost of aggregates imported from Canada or Mexico are over $20/ton, which is significantly greater than the lowest priced aggregates available in other areas of the state with ample local supplies. In these areas, the reported cost of aggregates was approximately $9-$12/ton. The problem has gotten so serious that Caltrans developed an Aggregate Resource Policy that stated: "… Caltrans will continue to work with local and state agencies to help gain approval of new aggregate mining sites throughout the state, acknowledging the need for an increased aggregate supply."

The cost of transportation increases the cost of aggregates by approximately 15 cents/ton/mile. Consequently, transporting aggregates 20 miles will increase the price of aggregate by approximately $3.00/ton, or about 55 to 60 percent more than locally sourced aggregates. When you consider that one mile of six-lane interstate requires approximately 113,505 tons of aggregate, these increased transportation costs would raise highway construction costs by approximately $340,000 per mile. Of course, the added transportation also creates unnecessary air emissions, traffic congestion, and an increased need for road maintenance.

Nearly 50% of all aggregates and crushed stone produced in Arizona are used in public infrastructure development. Annual transportation costs for all aggregates used for roads and infrastructure in Arizona is estimated at $163 million.

Although only briefly addressed in the report, the shortages of aggregate in California are not typically caused by the lack of suitable geologic materials. Rather, the unfortunate combination of intense development pressures, strict environmental laws, unfavorable mining legislation, and strong community opposition to local mining has effectively sterilized vast reserves of high quality, locally derived aggregates.

HOW TO IDENTIFY AGGREGATE RESOURCES IN YOUR COMMUNITY

Unfortunately, the difficulty of locating potential aggregate resources in your community can vary significantly based on the breadth of geologic information known of the area and the amount of existing mining data you can obtain. While detailed geologic mapping may be available for your area, it is extremely unlikely that any map will simply identify "aggregate resources". Rather, geologic maps will identify specific geologic units and the potential value of those units as aggregate resources can be inferred from the location of existing mining operations or from personal communications with subject matter experts. If you feel that inadequate information is available to make a determination, you are encouraged to consult with an Arizona registered geologist to assist you with the data collection and interpretation effort.

What's the difference between aggregate resources and reserves?

Resources are untested and unproven geologic deposits and reserves are aggregate resources that have been thoroughly explored, tested, and permitted for profitable extraction.

Where sufficient information exists, the best way to identify potential aggregate resources in your community is to locate existing aggregate mines in your area and correlate these mines with known geologic conditions. This process can be conducted using readily-accessible public resources and may not require specialized geologic interpretations or mining knowledge. The process does differ slightly based on available lands and the types of geologic materials used to produce aggregates and some common examples are provided below.

Step 1: Identify local aggregate mines

There are several methods to identify current mining operations in your area. First, all aggregate mine sites in Arizona must have a unique mine identification number and be registered with the Arizona State Mine Inspector (ASMI). Second, ARS requires that all aggregate mines located on state or private lands have approved aggregate mined land reclamation plans approved by the ASMI (mines on federal lands also have similar federal requirements). Lastly, the amended Aggregate Protection Act requires the Arizona State Geologic Survey (AZGS) to locate all permitted mines in Arizona by either physical address or latitude and longitude.

The figure below shows an example of the type of data you can get from the ASMI or AZGS and how it can be placed on a map. The map shows aggregate mines located in central Phoenix in proximity to the Salt River.

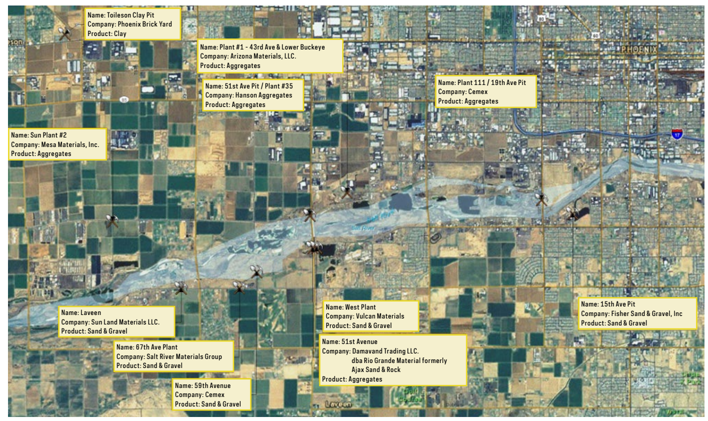

Figure 5: Active mining operations provided by the Arizona State Mine Inspector or Arizona Geologic Survey can easily be located on a topographic or aerial base map.

Step 2: Determine local geology

Once you have located the mines in your planning area and plot them on a working base map, correlating these sites with known geologic conditions becomes your next priority. The best source for geological information in Arizona is from the AZGS. The AZGS has mapped surficial geology across much of Arizona (their mapping priorities have included all significant population centers in Arizona) and accessing this information is accomplished via their interactive website (www.azgs.az.gov) or by contacting them directly.

By starting with a base map such as an aerial photo or topographic map, the surficial geology for the area can be uploaded from the AZGS and draped over the base map. Keep in mind that not all AZGS mapping is available in GIS format, but the mapping exercise can also be accomplished using more basic mapping technologies.

In some areas, the AZGS may have prepared more than one map of local geologic conditions and there may be subtle differences between these maps based on their age, scale, and purpose. Although it is very unlikely that the geologic conditions have changed, the maps may reflect a refined geologic interpretation or show differing colors or symbols when identifying the various rock types. Reference the map legend for the definition of the various symbols and colors shown on a map and use the geologic descriptions as a guide in interpreting the differing rock types.

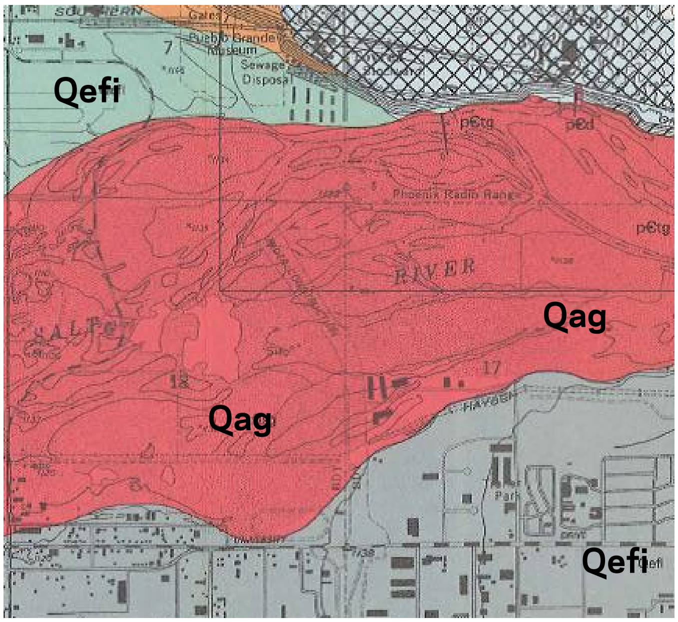

Figure 6: Surficial geology on the Arizona Geologic Survey Tempe Quadrangle is shown using both colors and symbols.

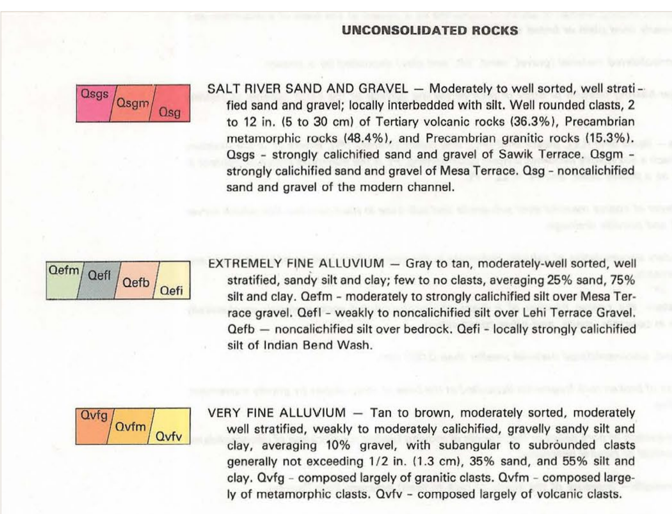

Figure 7: Map legends help to interpret the unique colors and symbols used on geologic maps.

Most maps will contain a legend that identifies the types of rock or unconsolidated materials shown on the map and offers a brief description of the material types. As shown above, geologic units are typically denoted by a unique color or symbol and corresponding letter designation (such as Qsgs or Qefi). As discussed previously, unconsolidated sediments are the predominant source of aggregates in Arizona.

Step 3: Correlate geology with active mining operations

When the surficial geology and permitted mining operations are placed on a single map, a relationship between mine location and geologic materials often becomes apparent. This correlation suggests that the mines in a given area have been purposefully located to extract a desirable geologic resource unique to that area.

Remember that deposits are unique because specific depositional environments have concentrated, processed, and placed these materials in a manner to create an economically extractable resource. As Figure 8 suggests, it would be a reasonable assumption that future mines in the area would target the yellow alluvial materials (identified as Qr on the map) generally located within the Santa Cruz River floodplain.

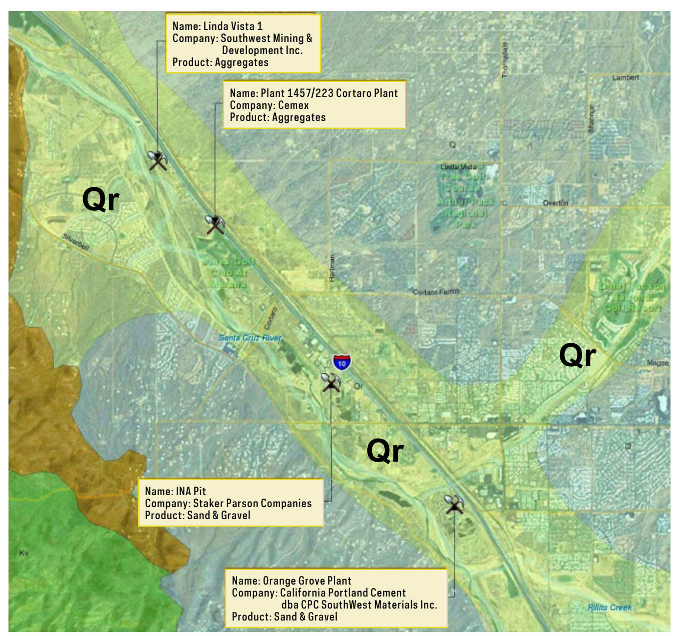

Figure 8: Locating mining sites on geologic mapping in the Tucson area shows strong correlation with Recent Quaternary Alluvium (Qr) in the floodplain of the Santa Cruz River and tributaries. AGZS base map.

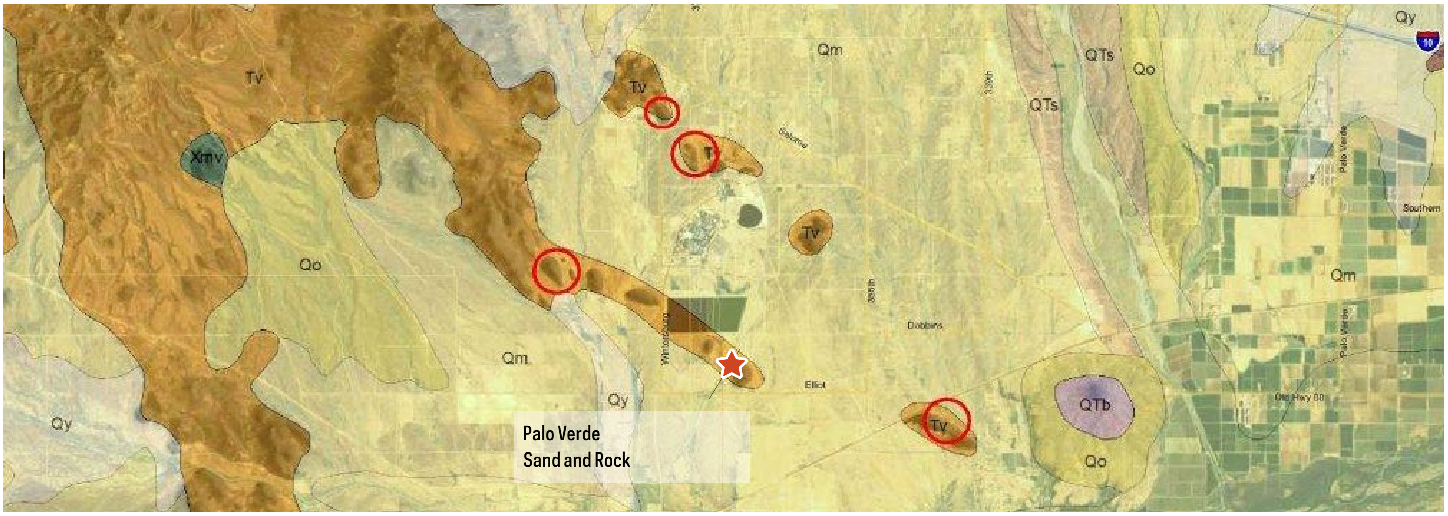

Figure 9: Active mining from a basalt unit (Tv) suggests that other basalt deposits in the area may yield suitable aggregate sources. AGZS base map.

However, it is particularly important to recognize that not all the yellow alluvial (Qr) materials identified on Figure 8 will contain aggregates of sufficient quantity or quality to warrant economic extraction. Further, these construction materials are subject to intense pressure from urbanization and zoning regulations unfavorable to mining. These regulations have essentially prohibited the development of many new mining operations.

More realistically, most of the economically extractible aggregates located in any given area may never be mined because of other factors unrelated to material quality and quantity, such as non-compatible land uses, unsuitable parcel size or shape, and zoning restrictions (sterilization).

Example of rock deposits for manufactured aggregates

In areas where alluvial materials are not present or are of insufficient quality, aggregate production will often target competent bedrock to manufacture aggregates from crushed rock. In these cases, the process for identifying aggregate resources would be very similar to those evaluations performed for alluvial deposits. However, you will often realize that the shape of these deposits is substantially different to those continuous alluvial deposits that occupy active stream systems. Conversely, the shape of these deposits is largely controlled by the rock forming event rather than by their erosion and subsequent deposition.

Using the steps outlined above, Figure 9 shows that an aggregate mining operation (Palo Verde Sand and Rock) is extracting a specific geologic material identified in AZGS mapping as Tv (Tertiary-aged Volcanic Rocks). Assuming that this is the most economical source of aggregates in the area, it is reasonable to assume that additional aggregate production in the area would also be sourced from similar rock types. Consequently, sufficient volumes of these exposed volcanic rocks identified in this planning area should be protected for future aggregate production.

STEPS FOR PREVENTING THE STERILIZATION OF VALUABLE AGGREGATE RESOURCES

As previously discussed, sterilization primarily occurs when development or unfavorable zoning regulations permanently prevent the extraction of valuable mineral resources. This can occur when development is placed directly over mineral resources or when development is placed sufficiently close to mineral resources that the development footprint (including prudent setbacks) interferes with mineral extraction. This is perhaps best illustrated in the report by the British Geological Survey titled "Mineral Safeguarding in England: Good Practice Advice" dated 2011 (see Figure 10).

The best way to prevent sterilization is to implement a process for identifying aggregate resources and developing policies for protecting those resources. The process can be divided into three discrete steps.

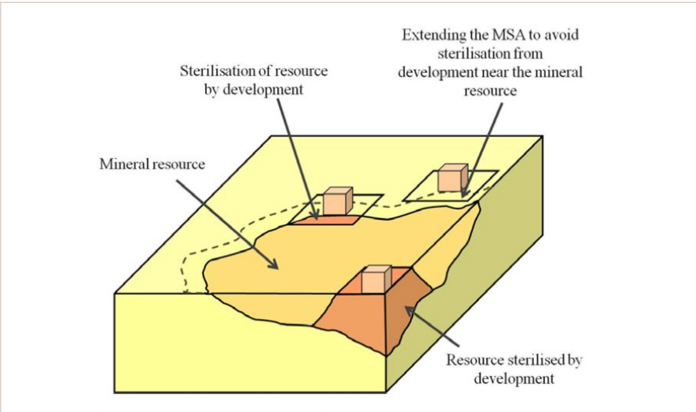

Figure 10: Ways that surface development sterilizes internal resources (adapted from the British Geological Survey). Reproduced from Wrighton et al. 2011. British Geological Survey © UKRI 2011

Step 1: Identify aggregate resources you intend on protecting

This process was discussed above and essentially requires the identification of active mining sites in the planning jurisdictions and correlating these mines to known geologic conditions. Once you have identified a relationship between active mining operations and a specific geologic unit(s), these units should be considered as future potential aggregate resources across the entire planning area. For example, if active mining operations are isolated to recent alluvial deposits, then all mapped recent alluvial deposits in the planning area could potentially have suitable aggregate resources to be economically mined. Other factors, such as proximity to existing neighborhoods, parcel size, or access to transportation could further refine your planning area.

Keep in mind that suitable geology does not mean that all deposits in the planning area will ultimately be mined, but rather it allows for the possibility that some of these areas will be mined if the critical resource, social, and economic factors are all favorable for mining. Further, it is highly likely that these factors will make most of these resources impracticable or uneconomic to extract. Unfortunately, it is impossible to determine which of these resources can be economically mined without detailed resource studies. Therefore, the most reasonable action would be to identify all similar geologic deposits as having the potential to yield extractable aggregate resources and allow the marketplace the opportunity to develop economically viable mines.

Step 2: Communicate and Consult Findings

Once suitable geologic resources have been mapped, it's important to communicate the findings with the stakeholders such as other public agencies, internal departments, developers, and the community. The intent of such communication and consultation process is to demonstrate the intrinsic value of these aggregate resources, the need for communities to have adequate supplies of low-cost aggregates, and the implications of allowing these resources to be inadvertently or purposefully sterilized.

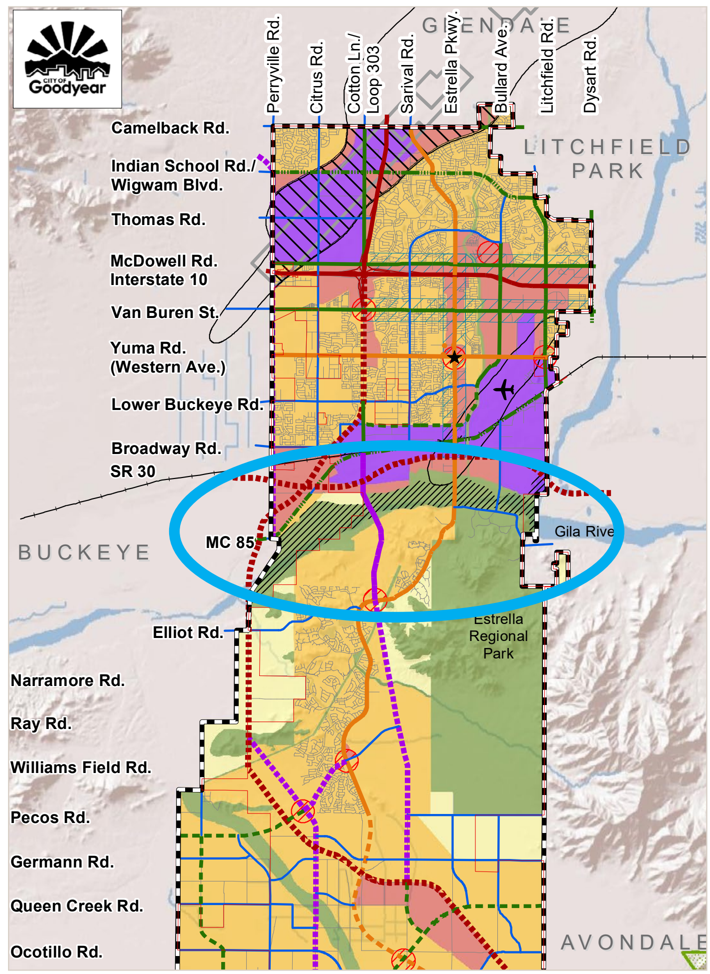

Figure 11: The City of Goodyear, Arizona created an Aggregate Mining Overlay in their General Plan that denotes sources of currently identified aggregates and identifies a general area with the potential for future aggregate development. Blue circle indicates location of aggregate mining overlay.

How much area do I reserve for future mineral extraction?

Assuming the average mine will produce about 125,000 tons of aggregate per acre, a 50-acre mine will likely produce less than a two-year aggregate supply for a community of 500,000 people during its lifetime.

The City of Phoenix consumes approximately 18 million tons of aggregates per year, which would exhaust the entire aggregate supply of a 50-acre mine site in less than four months.

Documenting this process in the General Plan and following the required notification process for amending General Plans substantially addresses this need. However, by taking the extra steps of communicating the process to a broader stakeholder group, it is possible to gain broad support for implementing responsible policies for protecting these valuable resources.

Step 3: Implement policies to prevent sterilization and ensure future aggregate availability

In an ideal world, it would be possible to protect all aggregate resources needed to achieve long-term demand in a particular planning area and prevent conflicting development that would preclude extraction of those resources in those areas. However, in the real world there are always competing interests for developable property, and landowners enjoy significant rights to develop property (in conformance with local zoning regulations) in ways they see fit.

But recognizing a greater public benefit, communities have also enjoyed broad legal authority to condemn, protect, and acquire properties that possess certain environmental, social, or resource significance. This includes areas with unique cultural or biological resources, areas that impact or protect air quality, view sheds, or aquifer quality (water sheds). Arguably, communities evoke such authority when the absence of such resources will permanently and significantly impact public health, property values, or the quality of life.

Under this precedence, communities could exercise reasonable controls over the development of aggregate resources, just as they exercise control over other types of development, because the absence of such controls will have permanent and lasting negative consequences for the community. In the case of aggregate shortages, these consequences would clearly and definitively include higher development and infrastructure costs, increased road congestion, and adverse air quality impacts.

Planning for Aggregate; A guide to planning for aggregate resources in Oregon

"Since aggregate is so vital to the state, it is important to adequately plan for protection and utilization of this natural resource."

BEST PRACTICE

CITY OF PHOENIX **GENERAL PLAN**

Goal:

To provide equal protection for residential development and aggregate mining operations by promoting compatible land uses in areas of close proximity to existing or planned aggregate and mineral mining operations.

Policies

- *Discourage new residential zoning where future residences would be adjacent to an existing or planned aggregate/mineral mining operation.*
- *Discourage new mining operations adjacent to or near existing residential development, schools, or existing or planned city recreation areas.*
- *Promote non-residential development such as business parks and industrial uses adjacent to existing mining operations.*
- *Update the General Plan Land Use Map to recognize existing mining sites and as needed when new potential mining sites are identified.*

MINNESOTA STATE STATUTES 84.94

AGGREGATE PLANNING AND PROTECTION

Minnesota recently established an aggregate protection statute intended to protect aggregate resources; to promote environmentally sound development and introduce aggregate resource protection into local comprehensive planning and land use controls.

The Department of Natural Resources, with the state Geological Survey, shall conduct a program of identification and classification of potentially valuable aggregate lands located outside of urban or developed areas where aggregate mining is restricted, without consideration of their present land use.

The program shall prioritize areas of the state where urbanization or other factors may result in a loss of aggregate resources to development.

The information will be shared with state departments and agencies, to the local planning authorities, and the appropriate county engineer. The county planning authority shall notify owners of land classified under this subdivision by publication in a newspaper of general circulation in the county or by mail.

Each planning authority of a county or municipality shall consider the protection of identified and important aggregate resources in their land use decisions.

Minnesota's aggregate mapping site can be found here.

One way to begin protecting aggregate resources is to examine the role of the local zoning and entitlement process. Here are some recommended actions:

- **Recommendation 1:** Areas that have been identified as having potential aggregate resources should have a unique zoning or land use designation. This designation (such as Aggregate Development Areas) could clearly identify the aggregate development potential of the area.
- **Recommendation 2:** Conflicting development proposals in Aggregate Development Areas could be required to conduct a highest and best land use study. These studies should include aggregate production as a potential alternative and the implications of importing alternative aggregate sources.
- **Recommendation 3:** Proposals for residential development in Aggregate Development Areas could be required to establish buffers (occupied by greenspace or golf courses, for instance) to mitigate potential noise and dust impacts from adjacent (both existing and potential future) mining areas.
- **Recommendation 4:** Conversely, all mining proposals in Aggregate Development Areas could be required to establish buffers along any shared property boundaries with existing or planned residential development to mitigate potential community impacts.
- **Recommendation 5:** Residential homes sold in Aggregate Development Areas (especially those built within 2,000 feet of active or planned mining operations) must have a deed restriction or mandatory pre-sale notification that acknowledges the potential for aggregate mining in the area.
- **Recommendation 6:** Commercial transportation corridors could be planned and established to safely route mine traffic away from residential areas, schools, and other sensitive areas.

> "This set of 11 recommendations is the jewel in this report. I would suggest that NSSGA and others working on implementation of the ROCKS Act read and digest those recommendations."
>
> John C. Cunningham, Executive Director Aggregate and Ready-Mix Association of Minnesota

UNIVERSITY OF MINNESOTA

OUTREACH, RESEARCH, AND EDUCATION PARK

The University of Minnesota Outreach, Research and Education Park (UMore Park) is a 5,000-acre development project located southeast of the Twin Cities. The plan created a unique mixed-use development supporting up to 30,000 residents. The plan envisions "a sustainable community integrating environmental, socio-cultural, and economic opportunities with a specific focus on innovations in renewable energy, education and lifelong learning and wellness, the natural environment and regional economic development."

The plan incorporates a long-term aggregate mining operation on the property that supplies aggregates, ready mix and asphalt to the growing community but also constructs reclaimed areas and urban lakes that form a framework of the stormwater management system and the parks and open space of the new community.

- **Recommendation 7:** Identify preferred post-mining land uses within Aggregate Development Areas to guide preparation of reclamation plans that achieve long-term development goals for the area. For instance, Oregon's statewide Planning Goal 5 (OAR 660-023-0180(4)(f)) requires that post-mining land uses conform with pre-mining comprehensive plan and zoning designations.
- **Recommendation 8:** Encourage mining operational practices that reduce or mitigate noise, dust, view shed, light, and traffic impacts from active and future mining operations. Use vegetative berms and other measures to enhance the visual appeal of active operations.
- **Recommendation 9:** Develop a well-defined process to evaluate proposed residential or commercial development within Aggregate Development Areas. The process would determine if mining were the preferred or highest and best land use.
- **Recommendation 10:** Quantify the financial and environmental impacts associated with the loss of locally- available aggregates in your community.
- **Recommendation 11:** Add mining and mineral processing to the activities allowed under certain commercial zoning designations.

ACHIEVING PRODUCTIVE POST-MINING LAND USES

It is helpful to understand that mine sites possess a finite resource and that depending on resource volume and production rates, all mines will eventually run out of mineable materials. Therefore, mining operations could be considered as temporary or interim property uses.

And, as previously discussed, all mining operations on private land in Arizona are required to prepare an ASMI-approved reclamation plan, and mines on state and federal lands also have similar requirements. These plans must include the identification of a potential post-mining land use and a reclamation strategy that, when implemented, achieves that desired post-mining land use. Approved reclamation plans are required prior to new mine operation, and community planners and other affected parties have an opportunity to review and comment on draft plans prior to ASMI approval.

Consequently, communities have a unique opportunity to achieve their long-term planning goals for an area and still extract the valuable aggregate resources that lie within.

By identifying post-mining land use strategies for Aggregate Development Areas, and collaborating productively with mine operators to guide the reclamation plan development process long-term, development goals can be achieved. In many cases, much of the site preparation, including rough grading and

Figure 12: By focusing on a productive post-mining land use, communities can build attractive public amenities, such as this golf course, following mining.

backfilling, can be accomplished during the mine operation or reclamation process. Examples of long-term development goals that are easily integrated into mining operations include:

- Habitat preservation and conservation easements
- Greenway and public parks
- Golf course development
- Flood control and aquifer storage facilities
- Inert backfilling with subsequent commercial or residential development

THE ROCKS ACT

The National Stone Sand and Gravel Association (NSSGA) noted that the historic Infrastructure Investment and Jobs Act (IIJA) creates a tremendous opportunity for the aggregate industry to build a vast array of important infrastructure projects across the country. Funding for federal highways alone increased 30 percent, and the legislation also included a new source of federal dollars to build water projects, bridges, ports, airports, transit, rail, energy, and other infrastructure, supporting thousands of new construction projects across the United States.

Within the thousand-page IIJA is little-known legislation known as the ROCKS Act (Rebuilding Our Communities by Keeping Aggregates Sustainable). This bill was championed by Rep. Greg Stanton and Sen. Mark Kelly of Arizona, and many others. This legislation is an important first step to delivering critical infrastructure by ensuring that project planners, from the federal government to local entities, are working to protect aggregates and allow for smoother permitting.

According to Austin Bone, NSSGA Director of Government Affairs, "Now our attention turns to implementing the ROCKS Act and completing the work laid out under the IIJA. NSSGA is engaged with the U.S. Department of Transportation and key members of Congress to plan and establish the ROCKS Act working group. A critical component of our efforts will be utilizing the great work that has been done at the state level by Arizona and Minnesota, specifically, to promote aggregates development and protection…."

IN CONCLUSION

Satisfying the competing interests and diverse opinions of your community makes land use planning especially challenging, and we recognize that adding a requirement to address aggregate resources does not make planning any easier. But consider for a moment the political and financial implication of not protecting these valuable resources.

Fortunately, we don't have to look very far to find an excellent example of bad planning. Even though they are blessed with abundant natural resources, California is forced to import construction materials from Mexico and Canada and their average haul distances exceed 50 miles. This increases the base cost of aggregates and more than doubles their transportation costs. The result is that California aggregates are 200 to 300 percent more expensive than equivalent Arizona aggregates. Plus, Arizona has lower transportation impacts such as pavement wear, congestion, and vehicle emissions.

Price does matter, and the availability of low-cost aggregates makes residential, commercial, and infrastructure development (including maintenance and replacement) more affordable. Consider that 50 percent of all aggregates produced in Arizona are used for public roads and infrastructure projects. This means that municipalities, and ultimately taxpayers, bear the greatest burden of increased transportation and aggregate costs. Remember that for every 20 miles aggregates are transported the cost of those aggregates essentially doubles and the cost of a single mile of freeway increases over $340,000.

Mining should be considered an interim property use, and every mine needs a detailed reclamation plan. Municipalities have input into the reclamation planning process and can ask for post-mining land uses that conform to their General Plans. This means that you can enjoy the benefits of locally sourced aggregates and still achieve the long-term planning goals of your area. In the short term, you can also collaborate proactively with mine operators to reduce the potential for dust, noise, visibility, and traffic impacts before they become problematic for the community.

Every acre of a mining property can generate up to 125,000 tons of finished aggregates. This equates to a significant source of royalties, taxes, and family-wage jobs that are simply lost if those resources become sterilized. Keep in mind that a city the size of Phoenix consumes approximately 18 to 20 million tons of aggregates per year. Smaller communities with greater development potential and rural communities will consume much more aggregates on a per capita basis than those communities that are essentially built out.

Lastly, remember that effective planning can mitigate many of the land use conflicts associated with co-locating residential development and active mining operations. By working proactively with public agencies, developers, and mining companies, planners can ensure that both uses can reasonably and peacefully coexist.

Figure 13: Balancing the competing interests and diverse opinions of your community makes land use planning especially difficult.

BIBLIOGRAPHY:

1. Arizona Geological Survey. Geologic maps (website http://www.azgs.az.gov/).
2. Arizona Department of Administration, Office of Employment and Population Statistics. Population Estimates (website http:// www.workforce.az.gov/).
3. British Geological Survey, 2011. Mineral Safeguarding in England: Good Practice Advice. Minerals and Waste Programme, Open Report OF/11/046. Wrighton, C E, McEvoy, F M and Bust, R. 2011. Mineral safeguarding in England: good practice advice. British Geological Survey Open Report, OR/11/046. 53pp
4. California Construction and Industrial Materials Association (CalCIMA). (Website http://calcima.org/)
5. California Department of Transportation (Caltrans), 2007. Construction Aggregate Supply Limitations, Estimates of Economic Impact.
6. California Department of Transportation, 2020. Greenhouse Gas Emissions and Mitigation Report Final Report.
7. Caltrans, 2011. Aggregate Resource Policy Statement and Tools. Memorandum.
8. California Geological Survey (Department of Conservation), 2018. Aggregate Availability in California, Map Sheet 52.
9. Design Workshop, Inc., 2008. Concept Master Plan Summary; For the University of Minnesota's New Sustainable Community at UMore Park.
10. National Stone, Sand & Gravel Association. Guiding Principles for Sustainability.
11. National Stone, Sand & Gravel Association. Sand & Gravel Review March/April 2022 Digital Edition.
12. Oregon Department of Land Conservation and Development and Oregon Department of Transportation, 2001. Planning for Aggregate, A guide to planning for aggregate resources in Oregon.
13. The United States Census Bureau, 2013. 2010 Population Estimate for the City of Phoenix. (Website http://quickfacts.census.gov).
14. United States Geologic Survey. Mineral Yearbooks, 2000-2018.
15. Minnesota State Statutes 84.94 – Aggregate Planning and Protection.
16. Aggregate Resources Task Force, Final Report to the Minnesota Legislature, January 15, 2018.

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Eric Mears is a passionate advocate for the mining industry and is a connected leader at Haley & Aldrich. With more than 30 years of experience in the mining industry, he has acquired extensive regulatory and technical knowledge while managing and coordinating complex mining development, permitting, and closure projects located in the United States, Canada, and Mexico. He specializes in resource and asset evaluation, litigation support, strategy development, community relations, and regulatory negotiations.

Eric actively participates in numerous state and national mining associations and is a member of the Arizona Mining Association (AMA), the Arizona Rock Products Association (ARPA), the American Exploration and Mining Association (AEMA), and the National Sand Stone and Gravel Association (NSSGA). He has served on the AEMA, ARPA, and AMA Board of Directors and is a Life Director with ARPA. Eric routinely participates in state and federal rulemaking on matters affecting the mining industry, land use issues, community relations, mining and reclamation practices, and sustainable development.

In 2019, Eric received the Mining Achievement Award from the Arizona Rock Products Association for his significant contributions to safety and sustainability in the rock products industry. He has also authored and co-authored numerous presentations and publications on political, regulatory, and environmental issues affecting the mining industry and is a prolific speaker and writer on issues affecting aggregate resource protection.

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