



*The United Voice of the
Natural Stone Industry*

Best Practices of the Natural Stone Industry

Quarry Site Maintenance and Closure

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The Natural Stone Council (NSC) is a collaboration of businesses and trade associations that have come together to promote the use of Genuine Stone® in commercial and residential applications. By pooling resources, their goal is to increase the understanding of, preference for, and consumption of these natural products. Trade associations affiliated with the NSC include Allied Stone Industries, Building Stone Institute, Elberton Granite Association, Indiana Limestone Institute, Marble Institute of America, National Building Granite Quarries Association, National Slate Association, New York State Bluestone Association, Pennsylvania Bluestone Association, and the Natural Stone Alliance.

The Natural Stone Council is committed to supporting sustainable initiatives and innovations at all levels of the production of Genuine Stone® products. As such, the NSC has established a Sustainability Committee made up of key industry members to elevate the issue of sustainability within the industry and provide a body responsible for planning and implementing relevant initiatives. In 2007, the NSC Sustainability Committee engaged in a partnership with the Center for Clean Products (CCP) at the University of Tennessee to assess current industry operations relating to dimensional stone production. In 2011, the NSC Sub-committee further reviewed and updated this document. The best practices identified and presented in this document are a direct result of the NSC and CCP's efforts to identify and improve the environmental profile of the natural stone industry.

This document is intended to establish guiding principles for the stakeholders as “Best Practices” in our industry and IS NOT intended to serve as a reference standard.

Importance of Site Maintenance & Quarry Closure

In order to address the potential stresses posed on the environment by the extraction of stone, the Natural Stone Council is providing operational suggestions to encourage environmentally responsible quarry practices. The following pages propose guidelines to reduce environmental stresses over the life of the quarry by employing these practices. This document also presents best practices for a return of safety and natural stability to a closed quarry site. Proper site maintenance can reduce costs and increase a manufacturer's good standing in public perception. This report includes:

- Issues that create need for good site maintenance
- Benefits of site maintenance and quarry closure
- Guidelines for best site maintenance
- Guidelines for safe and environmentally conscious quarry closure
- Resources available for further information

The Impact of Quarry Operations

Extracting stone can be an arduous endeavor that affects the local ecosystem and community on a number of levels. Not unlike any development (commercial, residential, government, etc.), quarry operations can greatly modify landscape and topography, can impact wildlife populations, and require supplemental quantities of water and energy. Additionally, potential occupational health and safety risks may exist for quarry employees, and local residents may experience noise and vibrations. Responsible site maintenance, however, can make a remarkable difference in the magnitude of these impacts

The Public

Quarry locations are determined by the location of geologic deposits. This can result in quarry sites that are established close to human habitation, or development may occur after establishment of the quarry site. Blasting, cutting, and truck traffic contribute to noise, vibration, and dust that may impact local residents. Further, the public may protest the unfavorable aesthetics and the safety hazards posed by stone piles and quarry holes. By following best practices, these effects on quarry neighbors and the negative perceptions held by the general public can be better understood and mitigated.

The Employees

A quarry can provide jobs for the local population, and the work can be physically demanding and potentially hazardous. Airborne particulates, the use of heavy machinery and haul trucks, and the size and weight of the cut stone blocks are potential dangers to health and safety. The Mine Safety and Health Administration (MSHA) provides policies and regulations to maintain quarry workers' safety and well-being, but additional site guidelines may be set forth by each quarry operator. The practices advocated in this document provide some of those additional suggestions or options.

The Natural Environment

Stone quarrying, if executed without regard to surrounding ecosystems and geologic conditions, could disrupt the balance of wildlife, plant life, and water bodies in the area. For instance, removal of native vegetation coupled with alteration of topography can generate erosion problems, and site runoff can impact local waterways. The former may impede daily operations, while the latter may lead to regulatory fines. It is essential, therefore, that quarry plans be developed with an emphasis on limiting habitat loss, waterway damage, erosion, pollution, noise, and vibrations. Additionally, quarry closures should be implemented under a reclamation plan that addresses practical ground slope modifications, utilization of vegetation and general site maintenance. In many cases, “abandoned” quarry sites are incorporated into new parks and entertainment venues providing long term benefits to the public.

Benefits of Site Maintenance and Closure

The best practices outlined in this document bring a multitude of advantages to a stone quarry. These include:

- *Reduction in cleanup costs:* Proactive site maintenance over the life of the quarry reduces the time and money spent on site cleanup when the quarry closes; reclaiming a well-maintained site is less laborious than restoring one with a poor preservation plan.
- *Reduction in fuel costs:* Reducing machine idling durations, maintaining infrastructure, and optimizing haul distances reduce fuel consumption and thus expenses.
- *Increase in employee safety & morale:* Employees that feel safe at work are more likely to make a greater personal investment in the company.
- *Generation of revenue:* Site maintenance, interim restoration, and final rehabilitation can increase land value for future leasing and/or sale. Additionally, overburden and sludge may be sold for use in road construction and agricultural applications (see best practice document on Water Consumption, Treatment, and Reuse).
- *Increased efficiency:* A clean and well-organized quarry site can increase production efficiency by ensuring open paths and roadways, reducing debris, and increasing the safety of employees.
- *Enhancement of company reputation:* Adequate maintenance and rehabilitation practices can result in greater community acceptance of the quarry and respect for the company. A company with a reputation for being socially responsible is likely to retain current customers and attract new ones.

Best Practices

As described above, effective site maintenance and quarry closure benefit quarry operations by reducing costs and promoting a healthier and safer work area. MSHA, OSHA, and other state regulating bodies have enacted laws to manage occupational risks, and the practices recommended here are intended to not only build upon those stipulations but also to provide direction for quarries operating in states that have not promulgated more stringent legislation. As such, the NSC recommends that every quarry establish a site maintenance and closure plan that addresses at least the topics identified in this report, as well as applicable government regulations.

Minimizing Dust, Noise and Vibrations

Reducing Noise and Vibrations

Quarry equipment and detonation practices can cause public disturbance through noise pollution and geologic vibration. To maintain positive relations with the neighboring public, it is recommended that a plan to minimize these events be developed. Examples of objectives to include within such a plan consist of the following:

- Replace blasting with the use of wire saws, belt saws, and expanding mortar where possible.
- When blasting is necessary, use the minimum amount of explosive material coupled with micro-sequential detonation to reduce vibrations (Rustan 1998), and follow all Federal, State, and local regulations.
- Detonate explosives only during times of the day designated by the local Department of Commerce or other regulatory body, and sufficiently notify nearby occupants of any routine blasting schedule.

Dust Control

Dust is generated both at point sources (e.g., drilling, sawing) and as fugitive emissions from blasting and excavation operations as well as haul roads. Mitigation of airborne particulates is paramount in sustaining the health of quarry employees. In addition to upholding MSHA and OSHA regulations regarding exposure prevention (e.g., providing workers with dust masks), a management plan may include additional efforts to avoid poor air quality, such as the following:

- Ensure that all saws and drilling machines have adequate dust catchment or air filtration systems, particularly when the machines are situated in a confined or enclosed area where air flow is limited. Water mists may be used conservatively to remove airborne particulates.
- Cover with a tarp trucks hauling loose material.
- Establish a haul road dust control plan. Depending on the local conditions of your site and proximity to public roadways, your Plan may include one or more of the following:
 - Roadway misting
 - Chemical suppressants
 - Asphalt or concrete paving
 - Washout area
 - Aggregate surfaces
- Retain as much native vegetation as possible throughout the quarry's operation. Root structures help maintain soil stability, while tall vegetation—particularly trees—can act as a filter.
- Avoid the use of chemicals whenever possible. However, If chemical suppressants are used, seek chemicals that are biodegradable and non-toxic to minimize any potential effect on local waterways.

Petroleum Product Management

Petroleum product use is a concern from both an economic and an environmental standpoint. Moreover, petroleum products can have deleterious effects on terrestrial and aquatic organisms via a number of pathways; ingestion can be poisonous, while sheens of oil on surface water can reduce gas transmission and suffocate oxygen-dependent aquatic organisms (Leighton 2000). MSHA and the EPA provide regulations for spill prevention and response plans, as well as useful information for heavy equipment management. Website resources are listed below.

Fuel and Emissions

- Minimize idling time for machines to reduce fuel waste and emissions. Systems like an auxiliary power unit (APU) or direct-fired heater (DFH) preserve cab temperature and power electrical accessories while the engine is turned off (Storey et al. 2003). Contact your heavy equipment vendor to learn about technologies offered.
 - Calculate your cost savings when you reduce your idling time: <http://www.transportation.anl.gov/engines/idling.html>
 - Learn more about idling from the EPA and Argonne National Laboratory: <http://www.epa.gov/ne/eco/diesel/idling.html>
<http://www.transportation.anl.gov/engines/idling.html>
- Minimize transport distances by designing the quarry with haul distance economy in mind.
- Consider using an engine-retrofitting system to reduce fuel use and decrease carbon emissions. When purchasing equipment, prioritize the selection of more energy efficient models. Contact your heavy equipment vendor to learn about technologies offered.
- Perform proper maintenance intervals to insure equipment is operating at optimal efficiencies.

Lubricants

- Establish and implement an equipment maintenance plan to avoid petroleum leaks and spills.
- Recycle motor oil and other lubricants used to maintain machinery. Visit your community's web page or <http://earth911.org/> to find a nearby location for motor oil recycling drop-off. Additional disposal and recycling information can be found on the EPA's website at <http://www.epa.gov/epaoswer/hazwaste/usedoil/index.htm>.
- Establish spill prevention and control measures in accordance with federal, state, and local regulations so that proper action may be taken to avoid and manage spill situations. Additional information can be found on the following websites:
 - EPA regulations: <http://www.epa.gov/OEM/content/spcc/index.htm>

Land Maintenance and Ecosystem Conservation

Care should be taken to minimize the operational footprint at the quarry site. It is advised that each quarry establish a maintenance and conservation plan to sustain site integrity. The strategy may include the goals described below, among others, as appropriate for the quarry of interest. It is recommended that each quarry establish a maintenance and conservation plan to sustain site integrity throughout its operational use and eventual closure. The plan should address each of the topics below, as appropriate, for the quarry, and be updated periodically as the quarry and its operations mature over time.

Site Cleanliness and Organization

Maintaining organization and general tidiness at the quarry allows for efficiency in daily task performance, creates a less hazardous work environment, and portrays a sense of corporate responsibility to site visitors, potential customers, and neighbors. Recycling and reusing materials may reduce garbage haul fees or generate income through the sale of scrap metal and old equipment.

- Designate areas for scrap stone storage, and plan for its sale, removal, or later use as fill material (see Operations Waste section below).
- Designate secure areas for trash disposal and recycling bins; ensure that all waste is properly removed from the site.
- Attempt to recycle or reuse any waste including worn machine parts, packaging materials, water, motor oil, and even slurry or sludge; the NSC best practice document on Water Consumption, Treatment, and Reuse further explains potential uses of wastewater sludge.

The NSC best practice document on Waste Management expands on the recommendations provided in this section.

Minimizing Erosion and Runoff

Although erosion and runoff are natural processes, they are not necessarily favorable. Sediment, debris, and impurities can be washed into waterways, potentially damaging water supplies and aquatic life (Relf 2001). Fertile soil can be stripped from the land surface, intensifying the cost and difficulty of revegetation during site closure. In light of these potential challenges, it is suggested that a site maintenance plan include prevention and management of erosion and runoff. Objectives of the plan may include but should not be limited to the following:

- Maintain topsoil in any areas not in use.
- Maintain maximum existing vegetation coverage, and replant any areas not in use, especially to either side of haul roads.
- Slow storm water runoff with contoured, low-gradient drains and channels, as well as retention ponds. A series of ponds may also be used to remove sediment and other contaminants from water before reuse or reintroduction into natural waterways; the NSC best practice document on Water Consumption, Treatment, and Reuse provides further explanation.
- Additional information and assistance can be obtained through the below resources:
 - NSC best practice document on Water Consumption, Treatment, and Reuse

- USDA National Soil Erosion Research Lab:
<http://www.ars.usda.gov/main/docs.htm?docid=2973>
- Government of Ontario - Ministry of Agriculture, Food & Rural Affairs:
<http://www.omafra.gov.on.ca/english/engineer/facts/87-040.htm#Effects>

Respecting and Conserving Ecosystems

Maintaining the area adjacent to the quarry will not only enhance the operation's image as one that is environmentally-considerate, but may in turn prove operationally and fiscally advantageous. Benefits that may be seen are explained below along with suggestions about how to conserve ecosystems.

- Keep disturbed area as small as possible, and ensure vehicles keep to the designated paths.
- Research local wildlife populations to understand any issues with threatened or endangered species in the region. Regulations regarding endangered species and their habitats are located on the US Fish & Wildlife Service's Endangered Species Program webpage: <http://www.fws.gov/angered/>.
- If surface water diversion is necessary, take care to ensure that downstream ecosystems, residential areas, and water supplies are not impaired.
- Minimize removal of native vegetation. As explained previously, plant life aids in soil stability and overall ecosystem health.

Quarry Closure Practices

Responsible closure and rehabilitation of a quarry site is just as important as high-quality site maintenance to public health and safety and the recovery of the natural environment. In fact, some states require a reclamation plan. A 2008 industry survey showed that 68% of the operators who responded to the question already have a quarry closure plan in place at their facility.¹

Planning for closure and restoration from the beginning of an operation makes the process easier. Site rehabilitation can make the land more valuable and attractive for resale. Additionally, establishing a closure strategy (and communicating that activity to the public) can help enhance the company's reputation as a socially-responsible operation.

Operations Waste

Upon closure, the quarry site should be cleared of any materials that would not naturally be found in the area. This should not be difficult if best practices are maintained throughout the life of the quarry. Ensure that all trash and recycling is removed as well as any machine parts and packaging material. Scrap stone can be sold, used as refill or landscaping, crushed for other applications (such as concrete production), or otherwise dealt with responsibly. Additional information can be found in the NSC best practice on waste management.

Site Restoration

There are a number of approaches to restoring a quarry site including:

¹ This (unpublished) data was collected during the benchmarking initiative of the natural stone industry conducted by the University of Tennessee Center for Clean Products in the spring of 2008.

- **Restoring:** This approach returns the site to its natural topography, re-establishing indigenous plant materials, and restoring habitat & wildlife.
- **Re-claiming:** Taking existing conditions of the quarry and implementing measures to re-define the natural setting within the existing context. This may include: some re-grading and/or safing of the quarry, new water features, new bluff features, new habitat for desired indigenous wildlife, re-establishing indigenous plant materials....all in an effort to establish a natural setting, albeit different in topography.
- **Re-purposing (Adaptive Re-use):** Taking existing conditions of the quarry and implementing measures to redefine the natural setting within the existing context to include a human destination for a specific activity or set of activities which may include: water recreation, recreational climbing, concert venue, building development site, etc.

Scrap stone and overburden, materials native to the quarry, should be used to help restore the site. The amount of scrap, however, may be insufficient to completely satisfy the needs. As such, additional options exist to further reclaim the site.

- Overburden, rock, or gravel from other sites can be used to landscape the site.
- Top soil or other soil of sufficient quality can be used to supplement on-site overburden and other reserves to adequately support re-vegetation of the site.
- Water may be used to create a recreational fishing or swimming location. However, safety-related signage is recommended in order to ensure the welfare of patrons. Adequate understanding of local groundwater system and exposed geology is also required to maintain water quality and level.

All restoration activities in the plan should be consistent with sound engineering principles and comply with all local, state and federal laws.

Replanting and Reforesting

In order to effectively repopulate a quarry site, several items must be considered. To ensure effective replanting and reforestation, a quarry closure plan should thoroughly discuss a re-vegetation approach. Of paramount importance is the type of species to be planted. When replanting or reforestation, only plant species native to the local area and region should be used, with a suitable diversity of species selected for restoration or replanting. Species planted on slopes must grow quickly enough to prevent soil erosion.

Final Remarks

Responsible quarry management includes implementation of economic, safe, and environmentally-considerate operations. Preserving and repairing site integrity over the course of the quarry's life generates a smaller need for human resources and land restoration—ultimately implying a lower financial burden—at the time of closure. By employing the best practices explored in this document, stone quarry operators will not only realize these benefits but also improve the overall public perception of quarrying practices.

For questions regarding the content of this brochure or to learn more about the Natural Stone Council's sustainability efforts, please visit the GenuineStone® website at www.genuinestone.com or by email at info@genuinestone.com.

Industry Example

Nestled in the scenic foothills of the Oley Valley located in Berks County, Pennsylvania is one company that knows first-hand the meaning of environmentally-considerate quarry operations: Rolling Rock Building Stone, Inc. Rolling Rock is a family owned business steeped in a long history of mining and producing building stone that extends back over 50 years. Currently operated by second generation members of the Weller family who were born and raised locally, strong ties and a deep appreciation for the natural beauty and environment in which their business has flourished and evolved through the years has made environmental considerations an inherent element of company policy.

As good stewards of the environment, Rolling Rock has built a corporate culture that takes great pride in operating their facility in a manner that is both environmentally responsible as well as sustainable for future generations. Gary Weller, President of Rolling Rock emphasizes the preservation of environmentally sensitive areas located in the lower elevations of their mine property. These areas consist primarily of pastures, wetlands, and streams in addition to potential habitats preferable to an endangered species known as the bog turtle. Due to the delicate nature of this ecosystem, extensive environmental and ecological impact studies over the years have been required to protect the integrity of these sensitive areas.



Quarry roads are laid with gravel to minimize dust, and scrap stone is used to create drainage ditches as well as provide support to the adjacent hillslope.

With these challenges in mind, it has been critical to implement strict maintenance and reclamation programs to minimize and prevent erosion and runoff. Maintenance and reclamation programs are continuous and concurrent with mining, consisting of both temporary and permanent features as the quarry site develops. Rolling Rock's maintenance program includes, but is not limited to, the following items:

- Paved and well graveled haul roads to mitigate dust and runoff.
- Regular street sweeping to collect dust and debris.
- Containment ponds, stone lined traps, and silt fencing for water settling and filtration.
- Terraced slopes and benches to control and direct runoff laterally rather than directly down slope.
- Temporary vegetation to control sediment runoff until the site is completely quarried and ready for final reclamation.
- Final reclamation where the topography is returned as close as possible to the original pre-mining contour.
- Permanent vegetation consisting of special grasses for wildlife management and a re-forestation program which includes a diversified selection of trees.

Industry Example (cont.)

Gary states, “Although concurrent maintenance initiatives can save on overall costs associated to long term reclamation goals, this in itself has never been the driving force behind our maintenance program. A love of the outdoors and a strong commitment to nature are the true motivators.”

Rolling Rock has also found that there are countless indirect benefits of a strong environmental commitment which are many times overlooked but create real value for any company. In Gary’s words, “Just because you can’t attach a dollar sign, doesn’t mean there’s no value in the big picture.” For instance, corporate social responsibility can accomplish the following:

- Strengthen ties and support better relationships with the local community;
- Generate a corporate culture that promotes and instills a good environmental policy among employees; and
- Transcend into a safety-conscious workplace.

When customers and clients visit a clean, orderly, and environmentally-considerate workplace, it says something about you and your products, and this, in turn, will result in more business. People tend to spend money where they feel most comfortable.

As Gary asserts, “Above all, it is our responsibility as an industry to promote both a healthy environment and sustainable operations for the mutual benefit, enjoyment and growth of future generations.”



Quarry reclamation includes restoring natural topography and replanting native vegetation.



Quarry site during reclamation processes.

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