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Best Management Practices for Quarry Operations

Complying with the Edwards Aquifer Rules

Field Operations Support Division

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

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Texas Commission on Environmental Quality

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Hydrologic Design Requirements by Document Section

Management Practice	Hydrologic Design Threshold	Document Section
High water level for purposes of setting quarry bottom elevation	water level in 12-month period with rainfall total at or above 90th percentile	2.1
Perimeter berms	contain 10-year 24 hour, spillway for 100-year 24-hour	2.3
Culverts for stream crossings	2-year event with duration equal to time of concentration	2.5
Sedimentation ponds	10-year 24-hour event plus 1 ft freeboard	5

1 Introduction

Quarry operation is a regulated activity under the Edwards Aquifer rules (Title 30, Texas Administrative Code, Chapter 213, or *30 TAC 213*) and owners must apply to the TCEQ in order to create or expand a quarry located in the recharge or contributing zone. An application for development in the recharge zone is generically referred to as an *Edwards Aquifer Protection Plan* and consists of several plan types including a *Water Pollution Abatement Plan*. An application for development on the contributing zone is referred to as a *Contributing Zone Plan*. This guide uses the term “application” to refer to all of those plans.

The potential impact on groundwater quality and water supplies from quarry operations in the areas subject to the Edwards Aquifer rules is a concern of many citizens and regulators. Quarrying requires substantial heavy equipment, equipment-maintenance areas, and refueling operations, and often includes associated facilities such as concrete or asphalt batch plants. The act of removing rock reduces the separation between these activities and the water table, making the groundwater system much more vulnerable.

Since 1999, quarry operators have developed applications following the guidelines in *Complying with the Edwards Aquifer Rules* (TCEQ publication RG-348). RG-348 was developed primarily to address pollutant-reduction requirements for residential and commercial projects. Consequently, many of the recommended measures are not appropriate for quarry operations. This document is intended as a guide specifically for quarry operations; however, quarry operators can seek variances, exceptions, or revisions based on site-specific facts.

Quarries in the Edwards Aquifer include operations that produce dimension stone, aggregate, and sand and gravel. These quarries also come in a wide range of sizes. Dimension-stone and aggregate operations differ in the type of equipment employed, and in their water use and storage requirements. In addition, some quarry operations are located in pit areas, where no surface discharges occur, while others have a substantial presence in areas where surface discharges do occur. The latter include office areas, material stockpiles, parking lots, and retail-sales locations.

This manual is divided into a chapters and sections. Chapter 2 covers general guidelines that apply to all quarries and address elements such as perimeter berms, sensitive features, dust control, stream crossings, maintenance and fueling facilities, spill response, and the operation of associated industrial facilities, such as batch plants. Chapter 3 recommends measures for implementation in portions of quarries that discharge to surface waters, while Chapter 4 contains guidance for operations within the pit area. The manual concludes with Chapter 5, which addresses the management of process water on-site.

2 General Guidelines

2.1 Separation from Groundwater in the Recharge Zone

To prevent pollution of groundwater in the Edwards Aquifer, the TCEQ recommends a minimum separation of 25 feet between the quarry-pit floor and the groundwater level for quarries in the recharge zone. This distance is based on the maximum propagation of fractures from blasting operation. The water level in the Edwards varies substantially across the area and with changes in rainfall. Consequently, the 25 ft separation should be maintained during even relatively wet years. Analysis of historical rainfall records indicates that 9 out of 10 years have rainfall of less than 45 inches, and this has been selected as the critical rainfall depth.

Determining the allowable quarry depth during the planning stages of development generally requires a preliminary estimate of the high-water level at the site. The best way to estimate this level is to use the water level measured in a water supply well or boring on-site for which historical data are available. The TCEQ will accept the water-table elevation measured in December 2007 either on-site or in the nearest off-site well as the elevation from which the 25 ft separation applies. If an off-site well is used, then the current water level on-site and in the adjacent well should be compared to determine whether to make any adjustments to account for regional variation in the water-surface elevation using the methodology outlined for a county reference well. Abundant data on water surface elevations are available from the Edwards Aquifer Authority and the Barton Springs/Edwards Aquifer Conservation District.

If nearby historical water-level data are not available the applicant may compare water level in an on-site well to certain reference wells located in each county. Easily accessible reference wells and their high-level water measurements are shown in Table 1. Water levels from other wells, closer to the proposed quarry, may also be available from the Edwards Aquifer Authority or Barton Springs/Edwards Aquifer Conservation District.

When using a county reference well, an applicant should select the well located in the county of the proposed project, or the nearest well for locations in Travis or Comal county. The water level in a well within the project boundary should be measured before submitting the application to the

Table 1. Reference-well water levels.

Reference Well	Wet-Weather High-Water Elevation (ft-msl)
Hays [LR-67-02-104 (Kyle No. 2)]	576
Bexar (J-17)	691.4
Medina	762.9
Uvalde	882.5
Williamson (State well no. 5827305)	690

TCEQ for review. This level should be compared to the level in the reference well made at approximately the same date. The difference between the reference-well water level at that date and the high-water level shown in Table 1 should be used to make an estimate of the difference between the on-site water level at the date of measurement and the anticipated water level in a wet year. Daily water levels of the Bexar, Median, and Uvalde wells are available at <www.saws.org/our_water/aquifer/>.

Data from the well in Hays County are available from the U.S. Geological Survey. From the USGS Web page for groundwater data <waterdata.usgs.gov/nwis/gw>, navigate to Daily Data and search for site number 295858097521801. Or access the data directly at <nwis.waterdata.usgs.gov/tx/nwis/gwlevels?site_no=295858097521801&agency_cd=USGS&format=html>.

Data from the well in Williamson County are available from the Texas Water Development Board. From the board's data Web page <www.twdb.state.tx.us/data/data.asp>, navigate to the Groundwater and Well Water section, and then to Williamson County and Water Level Table. Or visit <www.twdb.state.tx.us/publications/reports/GroundWaterReports/GWDatabaseReports/GWdatabaserpt.asp>.

As an example, assume that an exploratory well on a proposed quarry location in Bexar County encounters groundwater at an elevation 580 ft above sea level. On approximately the same date the elevation in the reference well (J-17) is found from the SAWS website to be 670 feet. The difference between the current elevation and the wet weather level is 21.4 feet. Consequently, the estimate for the preliminary high water level at the proposed quarry location would be 21.4 + 580, or 601.4, feet. The quarry floor should be located a minimum of 25 ft above that, which means that the application should indicate a minimum pit-floor elevation of 626.4 ft.

Quarries are typically in operation for many years and it is expected that the critical wet-year rainfall depth will occur at some time during operation. The operator may make a static measurement of the groundwater-surface elevation after 12 consecutive months with a total rainfall of at least 45 inches. This on-site water elevation can then be used to revise the minimum pit-floor elevation in a modification of the application submitted to the TCEQ.

These recommendations regarding separation from groundwater generally do not apply to sand and gravel operations, which may operate under saturated conditions. That is because the groundwater encountered is not located within the Edwards Aquifer, but is usually a perched water table associated with the water level in an adjacent stream or river.

2.2 Sensitive Features

2.2.1 Definition and Related Rules

Sensitive features are defined in the Edwards Aquifer rules (30 TAC 213.3) as permeable geologic or man-made features located on the recharge zone or transition zone where:

- a potential for hydraulic interconnectedness between the surface and the Edwards Aquifer exists, and
- rapid infiltration to the subsurface may occur.

Sensitive features comprise caves, solution cavities, solution-enlarged fractures, sinkholes, and other karst surface expressions that meet those two criteria.

Sensitive features may be identified during the geological assessment or may be encountered during quarrying activities. Site planning must address sensitive features identified in the geological assessment and any sensitive features may need special protection if located near areas with pollutant sources such as where vehicle maintenance or fueling occurs or onsite industrial facilities are located.

The rules require that Best Management Practices (BMPs) be implemented to "prevent pollutants from entering...sensitive features..." and "maintain flow to naturally occurring sensitive features." [TAC 213.5(b)(4)(B) and TAC 213.5(b)(4)(C)]. The recommended practice for protecting sensitive features is the provision of natural buffer areas as described in Subsection 2.2.2. Features identified in the geological assessment and their buffers must be addressed in the application's site plan as described in Subsection 2.2.3. Even with a very thorough assessment, some sensitive features may be discovered while the quarry is operating. These features may be addressed as described in Subsection 2.2.4. Finally, Subsection 2.2.5 describes recommended inspection and maintenance procedures.

2.2.2 Setbacks and Buffers for Sensitive Features

Sensitive features resemble icebergs in that the surface expression often represents only a fraction of the spatial extent of the feature that exists just below the soil profile. Because these features can accept recharge over a substantial area, treating runoff only within the depression may lead to degradation of water quality in the aquifer. Consequently, the best protection for these features is a natural buffer area.

In some cases where several sensitive features occur in close proximity, setbacks may be applied collectively or may overlap, as long as the minimum standard setback for each feature is retained. No stormwater conveyance systems (storm drains, roadside swales, etc.) that would bring runoff from outside the existing drainage area should have outfalls where the runoff would be directed to a sensitive feature by the natural topography.

A buffer in its natural state will typically be a combination of dense native grasses and forbs in a mosaic of shrubs and trees. Native vegetation, particularly live oak trees, should be preserved within the catchment area of caves or sinkholes. Stemflow occurring along the branches and trunks of large trees may enhance infiltration by channeling rainfall to the root zone (Thurow et al., 1987). The existing soil structure and vegetation are compatible with pre-existing recharge conditions and should require little maintenance.

The TCEQ recommends maintaining the buffers around a cave, sensitive feature, or group of features in a natural state to the maximum practical extent. This implies a construction-free zone until the feature will be quarried.

Temporary runoff-protection measures should be installed according to existing recommendations (see TCEQ publication RG-348) during any construction activities within the drainage area of the feature. Temporary erosion-control measures should be placed as near the construction as possible to minimize disturbance within the buffer zones and drainage areas.

2.2.2.1 Caves

For a cave, the buffer is based on the cave footprint, defined as the horizontal or plan-view map of the cave, projected up to the surface to show the area of the site underlain by cave passage. The projected surface, labeled *cave footprint*, should be delineated on the site geologic map and proposed site plan. If caves are identified during the geologic site assessment, maps showing scale or dimensions should be made of their extent, including their openings and subsurface extent and any associated sinkholes.

The natural buffer around the cave should extend at least 50 feet in all directions around the delineated cave footprint as well as any associated openings and sinkholes. Where the boundary of the drainage area to the cave lies more than 50 feet from the footprint, the buffer should extend to the boundary or 200 feet, whichever is less.

2.2.2.2 Other Sensitive Features

For other sensitive features, the buffer is based on the drainage area, which often includes a well-defined bowl-shaped depression of a few feet to many yards across and which represents the local collapse zone over a subterranean cavity. The top of the sharp slope break present at the perimeter of such a collapse zone should constitute the edge of the feature for the purposes of calculating setbacks, since the steep slopes within such a bowl usually filter little or no water and thus cannot improve its quality.

The natural buffer around a feature should extend a minimum of 50 feet in all directions. Where the boundary of the drainage area to the feature lies more than 50 feet from the feature, the buffer should extend to the boundary or 200 feet, whichever is less. Buffers that extend into areas where people or equipment might stray should be fenced or surrounded with large boulders or other measures that allow drainage but deter access.

2.2.3 Sensitive Features Identified in the Geological Assessment

Several outcomes for sensitive features will be specified in the geological assessment, such as:

- Establishment of a natural buffer (as described above) around the feature. Recharge to the aquifer is preserved and its water quality is protected.

- Removal of the feature as part of quarrying.
- Permanent sealing of the feature to protect water quality (appropriate in certain cases).

A key part of quarry planning and permitting is developing the site plan for inclusion in the application. Since the application's site plan must show "areas of soil disturbance" and "existing and finished contours" [30 TAC 213.5(b)(2)(B)], an approved application effectively serves as the approved boundary of the quarry pit.

When possible, avoid sensitive features when locating items outside the quarry pit. Where extenuating circumstances exist and development over a sensitive recharge feature or its catchment is proposed, the project owner can consider demonstrating that no feasible alternatives exist. Feasibility of alternatives should be based primarily on technical, engineering and environmental criteria. Feasibility should not be based predominantly on marketing or economic considerations or special or unique conditions resulting from the method by which the site plan was developed.

Sensitive features not actively being mined should either be protected by a natural buffer or sealed to prevent infiltration. Natural buffers are recommended when proposed developments such as haul roads or other facilities are located outside the buffer areas for such features. Features should be sealed when a significant incursion on the buffer area by a road or other facility is unavoidable.

Where extenuating circumstances are approved by the TCEQ, the owner should provide alternatives to make up for the loss of recharge to the aquifer, taking measures to ensure that the quality of enhanced or induced recharge is adequate to protect groundwater quality, and is consistent with the requirements to protect "improved sinkholes" in 30 TAC 331.

2.2.4 Sensitive Features Discovered During Quarrying

Some sensitive features are discovered during quarrying. The discovery of a new sensitive feature must be reported to the TCEQ and work stops after protection for the feature is installed. The feature can be protected by removing the sediment from the adjacent area without disturbing the feature, and installing a rock berm or other appropriate BMP around it to control and filter any potential flows into it. The work stoppage applies only to activities within the vicinity of the discovered feature, and work is allowed to continue in other areas inside and outside the pit. Wall voids with no surface expression and no drainage area are not considered sensitive. Thus, discovering a wall void during quarrying should not increase the risk of contamination and does not require notifying the TCEQ or stopping work.

2.2.5 Inspection and Maintenance of Sensitive Features

Sensitive features with buffer areas that extend into areas where people or equipment may be present should be inspected at least twice yearly. The inspection should verify that fencing or other barriers to deter access are in place and functional. The buffer itself should be inspected to verify that no disturbance of the natural vegetation or soil has occurred as a result of human or vehicle activity.

If the area has been disturbed, the perimeter fencing should be repaired and the area stabilized and revegetated as soon as feasible. Use of fertilizers and pesticides should be minimized during buffer repair and only native vegetation used for stabilization.

2.3 Quarry Berms

One way to meet pollution prevention goals is to use berms to prevent run-on of surface drainage into a quarry pit by routing flow around it. Berms are also useful for creating a visual and physical buffer between the quarry pit and adjacent property. Quarry operators should be aware that capturing surface drainage in the quarry pit may violate of state water rights. In most situations, persons wishing to divert state water must receive prior authorization. *State water* is defined as the water of the ordinary flow, underflow, and tides of every flowing river, natural stream, and lake, and of every bay or arm of the Gulf of Mexico, and the stormwater, floodwater, and rainwater of every river, natural stream, and watercourse in the state. Appropriate measures, including perimeter berms, should be used to prevent any unauthorized diversion of state water.

Consistent with TCEQ guidance for online facilities (RG-348), berm sizes should be based on the 10-year, 24-hour storm and berms should be vegetated. An upgradient berm that captures and detains upgradient flows should be designed with spillways to safely pass the volume associated with the 100-year, 24-hour duration into a quarry pit. Upgradient berms that simply direct runoff around the pit do not require design and installation of a spillway. In sizing the berms, the contributing drainage area and land cover should be considered. Detailed design of the berms including required height, side slope, construction material, and compaction requirements should be performed by a licensed engineer. Some surface drainage into the pit may be allowed in restricted areas where the applicant can demonstrate that a berm would not be feasible.

Earthen berms should be at least 2 feet wide at the top. The minimum height for earth berms should be 2 feet, with side slopes no steeper than 2:1. If vehicle crossings of the berm are necessary, the crossings should have a slope of 3:1 or flatter and be armored with gravel. This design makes the berm last longer and strengthens the point of vehicle crossing.

If a channel is excavated along the berm, it can be parabolic, trapezoidal, or V-shaped. The maximum design flow velocity should range from 1.5 to 5.0 feet per second, depending on the vegetative cover and soil texture.

Inspect earthen diversion berms quarterly to ensure continued effectiveness for the active life of the quarry. Inspections may be discontinued once all mining activity has ceased and equipment removed from the site, or once vegetation is established. Berms should be maintained to their original height with any decrease in height due to settling or erosion repaired in a timely manner.

2.4 Haul Roads, Parking Lots, and Tire Washes

BMPs should be implemented to prevent tracking of sediment onto adjacent highways and to reduce the generation of dust. Roads and parking areas for vehicles that will leave the site should be paved. Additionally, roads leaving the site should be designed to force drivers to remain on the pavement by the use of large boulders, railings, or other obstructions along the shoulder. Roads outside of the quarry pit should make use of BMPs as described in Chapter 3. Areas used for material stockpiles do not need to be paved, but should contain a system to remove mud and dirt from wheels of vehicles that have traveled on unpaved sections of the quarry except vehicles traveling more than 1,000 ft on paved portions of the site before leaving the property.

A rumble grate may be used to dislodge sediment from the wheels and undercarriage. This should be placed at least 100 feet from a public road. A tire-wash system may be installed. It should be (1) located in front of some type of traffic restriction such as the quarry scale or a *stop* sign to encourage its proper use and (2) set back at least 300 feet from the public road. The system should recycle water to minimize its use and prevent its discharge. Note that tire-wash water cannot be discharged to surface water or infiltrated through the quarry floor. Automatic tire-wash systems are available from a variety of manufacturers.

2.5 Stream Crossings and Buffers

Natural buffer areas adjacent to streams and natural drainage ways play an important role in maintaining predevelopment water quality. Riparian vegetation stabilizes stream channels and floodplain areas, reducing erosion. In addition, buffers filter overland flow from adjacent development. Consequently, all streams and drainage ways with drainage areas exceeding 40 acres should have an undisturbed native-vegetation buffer on each side where feasible. The buffer should extend 25 feet on either side from the 100-year floodplain, or the drainage centerline if it is not in a floodplain.

Buffer zones should generally remain free of construction, development, or other alterations. Haul-road crossings through the buffer zones should be constructed only when necessary, such as when a significant portion of the site can only be reached by crossing a buffer zone. Utility crossings should also be minimized. Roadways and utility crossings should be approximately perpendicular to the buffer zone.

Roadway crossings of streams and drainage ways larger than 40 acres should be paved and include a bridge or culvert that can convey the 2-year storm without overtopping the road. The Rational Method (e.g., Maidment 1993, and many other sources) can be used to compute the peak discharge of the 2-year storm using the rainfall intensities in Table 2. The applicant should seek approval from the floodplain administrator prior to any modification of the floodplain.

All roads within the stream buffer should be paved to reduce the generation of dust that can be directly deposited in the stream or drainage channel. Stream crossings whether by bridge or culvert are considered impervious cover and require 80 percent TSS removal. Vegetated filter strips are an obvious choice for treating roads located outside of the pit area. Additional BMPs that are approved for stormwater treatment are described in RG-348. Where feasible, the runoff from a bridge over the stream should be conveyed to the bank for treatment, rather than discharging directly into the stream.

2.6 Dust Control

Dust from quarrying activities—including excavation, product processing, storage, and vehicle traffic—should be controlled by reasonable means such as watering, paving, or other suitable management practices. Proper management practices for dust control reduce or prevent wind erosion by protecting and roughening the soil surface and reducing the surface wind velocity. Facilities with air quality permits should operate according to their own permit-specific requirements, but may implement additional measures as described below. Other facilities should implement dust-control measures as listed below.

To maximize water conservation, the TCEQ recommends that water-intensive dust-control practices (listed last) should be a last resort. Specific BMPs for dust control include the following list adapted from U.S. EPA (2006) and TCEQ publication RG-348:

- *Vegetative Cover.* In areas that are outside the active quarry and not expected to handle vehicle traffic, vegetative stabilization of disturbed soil is often desirable. Vegetative cover over surface soils slows wind velocity at the ground surface, reducing the potential for dust to become airborne. Vegetation for this use should be native or adapted and need no irrigation, fertilizer, or excessive mowing. Refer to RG-348, Subsection 1.3.8, for more on establishing vegetation.

- *Mulch.* Mulching can be a quick and effective means of dust control for a recently disturbed area. Mobile mulching may be performed on the quarry site for short periods of time so that mulch can be made from cleared overburden materials.

Table 2. Precipitation intensity (in/hr) for various times of concentration for the 2-year storm.

	Time of Concentration									
County	15 min	30 min	1 hr	2 hr	3 hr	6 hr	12 hr	1 day	2 day	3 day
Bexar	4.20	2.90	1.80	1.10	0.800	0.467	0.267	0.150	0.0833	0.0590
Comal	4.00	2.70	1.80	1.10	0.800	0.467	0.258	0.150	0.0833	0.0625
Hays	4.00	2.60	1.75	1.10	0.800	0.450	0.258	0.142	0.0833	0.0625
Kinney	4.00	2.70	1.70	1.03	0.700	0.417	0.233	0.133	0.0729	0.0521
Medina	4.20	2.90	1.80	1.10	0.800	0.467	0.267	0.150	0.0833	0.0590
Travis	3.80	2.60	1.70	1.05	0.767	0.450	0.250	0.142	0.0833	0.0556
Uvalde	4.20	2.80	1.80	1.05	0.767	0.450	0.250	0.142	0.0833	0.0556
Williamson	3.60	2.60	1.70	1.05	0.733	0.433	0.250	0.142	0.0781	0.0556

Source: Compiled from data in Asquith and Roussel 2004.

- *Wind Breaks*. Wind breaks are barriers (either natural or constructed) that reduce wind velocity through a site and, therefore, reduce the possibility of suspended particles. Wind breaks can be trees or shrubs left in place during site clearing or artificial barriers such as wind fences, tarp curtains, hay bales, crate walls, or sediment walls (U.S. EPA, 1992). Barriers placed at right angles to prevailing currents at intervals of about 15 times their height are effective in controlling soil blowing.

- *Stone*. Stone can be an effective dust deterrent for unpaved haul roads or a mulch in areas where vegetation cannot be established.

- *Tarping*. Trucks exiting the site should be tarped to minimize dust.

- *Speed Limit*. Posted speeds of 10–15 mph for unpaved haul roads to minimize dust.

- Commercially available *dust suppressors* if applied in accordance with the manufacturer’s recommendations. Examples of chemical adhesives include anionic asphalt emulsion, latex emulsion, resin-water emulsions, calcium chloride, and polyacrylimide. Polyacrylimide should conform to ANSI-NSF Standard 60 or the criteria in RG-348, Subsection 1.3.4. Cationic chemicals should not be used. Chemical palliatives should be used only on mineral soils. When considering applying a chemical to suppress dust, determine whether it is biodegradable or water-soluble and what effect its application could have on the surrounding environment, including water bodies and wildlife.

- *Sprinkling (Irrigation)*. Sprinkling the ground surface with water until it is moist is an effective dust-control method for unpaved haul roads and other traffic routes.

2.7 Mineral-Exploration Test Holes and Water Wells

Drilling of test holes during quarrying or while exploring sites for new quarries may be necessary to determine the size of the deposit. These test holes or borings are regulated by the TCEQ. Borings can provide a path for pollutants to enter the groundwater, so it is important that they be properly sited, drilled, and plugged.

Note that 16 TAC 76.1000(a)(4) requires all wells to be located at least 150 feet from concentrated sources of potential contamination, such as vehicle maintenance or storage areas. Exceptions will be granted for the location of monitoring wells that may be located where necessity dictates.

In accordance with 30 TAC 213.7, all borings 20 ft deep or deeper must be plugged with a non-shrink grout from the bottom of the hole to within 3 ft of the surface. The remainder of the hole must be backfilled with cuttings from the boring or gravel. All borings less than 20 ft deep must be backfilled with cuttings from the boring or gravel. All borings must be backfilled or plugged within four days of completion of drilling. Voids may be filled with gravel.

2.8 Vehicle and Equipment Maintenance

Vehicle and equipment washing and maintenance activities with the potential for releasing pollutants such as fuel, lubricants, or hydraulic fluids should only be performed in designated areas designed for the purpose and located outside the natural buffer area of any sensitive feature and outside the quarry pit, unless it is infeasible to move a piece of equipment to the designated area. When maintenance or fueling must be performed in the quarry pit, a disposable base pad approximately 1.0 ft thick should be placed beneath the equipment as secondary containment.

Vehicles and equipment that are scheduled for maintenance or that have potential fluid leaks should be confined to the repair area described above. Areas for vehicle repair should be covered and paved. Curbs or berms should be used to prevent runoff from entering or leaving the repair area. Pavement should be sloped to a contained drainage point. These repair areas are considered permanent developments outside of the quarry pit and should therefore have permanent BMPs as outlined in Chapter 3.

Vehicle-washing areas should also be paved so that the bottom is sealed because the wash water cannot be discharged to surface or ground water. Direct wash water to sanitary sewer systems or ensure that washing areas are impervious and are bermed. If the quarry has no access to wastewater disposal, the wash water should be collected and disposed of properly or washing should be performed off-site at an appropriate facility. Because water alone can remove most dirt adequately, use high-pressure water spray without detergents at or, if you must use detergents, avoid phosphate- or organic-based cleansers to reduce nutrient enrichment and biological oxygen demand in wastewater. Use only biodegradable products that are free of halogenated solvents. Use signs to clearly mark all washing areas and inform workers that all washing must occur in those areas. Do not perform other activities, such as vehicle repairs, in washing areas.

Inspect mining vehicles that are used and stored at the site daily, and repair any leaks immediately. Check incoming vehicles and equipment (including delivery trucks, and employee and subcontractor vehicles) for leaking oil and fluids to the extent practicable. Do not allow leaking vehicles or equipment on-site. A leaking vehicle detected on-site should be moved to an area with BMPs that eliminate the potential for discharges to surface water or groundwater.

Dispose of all used oil, antifreeze, solvents, and other automotive-related chemicals according to manufacturer instructions. These wastes require special handling and disposal. Used oil, antifreeze, and some solvents can be recycled at designated facilities, but other chemicals must be disposed of at a hazardous-waste disposal site.

Operational BMPs:

- Inspect for leaks all incoming vehicles, parts, and equipment stored temporarily outside to the extent feasible.

- Use drip pans or containers under parts or vehicles that drip or that are likely to drip liquids, such as during dismantling of liquid-containing parts or removal or transfer of liquids.
- Remove batteries and liquids from vehicles and equipment in designated areas designed to prevent stormwater contamination. Store cracked batteries in a covered non-leaking secondary containment system.
- Empty oil and fuel filters before disposal. Provide for proper disposal of waste oil and fuel.
- Do not pour or otherwise convey washwater, liquid waste, or any other pollutant into storm drains or into surface water.
- Do not connect maintenance or repair shop floor drains to storm drains or to surface water.
- To the extent feasible, conduct all maintenance and repair of vehicles and equipment in a building or other covered impervious containment area that is sloped or bermed to prevent run-on of uncontaminated stormwater and runoff of contaminated stormwater. Emergency repairs conducted in the pit should use BMPs such as drip pans, absorbent mats, and berms as necessary to control spills and leaks.
- Park large mobile equipment, such as front-end loaders, in an area protected from run-on of stormwater and sealed with a clay liner or impermeable pavement to prevent infiltration. Clay liners should conform to the specifications in Table 3.
- Post signs reminding operators to chock wheels, secure connections, check drain outlets, and report spills to the office.

2.9 Storage and Movement of Petroleum and Other Fuel

Fuel storage poses a risk to water quality and is specially regulated by the TCEQ. In addition, federal law requires a *spill-prevention control and countermeasure*, or SPCC, plan if a storage tank for oil (including used oil or petroleum) is located where a spill from the tank could contaminate water—for example on or near a stream, lake, or river. An SPCC plan is needed if

Table 3. Clay-liner specifications. Liners should be at least 12 inches thick.

Property	Test Method	Unit	Specification
Permeability	ASTM D-2434	cm/sec	1×10^{-6}
Plasticity Index of Clay	ASTM D-423, D-424	%	Not less than 15
Liquid Limit of Clay	ASTM D-2216	%	Not less than 30
Clay Particles Passing	ASTM D-422	%	Not less than 30
Clay Compaction	ASTM D-2216	%	95 of Standard Proctor Density

either (1) total aboveground storage capacity (of containers 55 gallons or greater) exceeds 1,320 gallons or (2) total underground storage capacity exceeds 42,000 gallons and none of the tanks are regulated under UST standards. Underground storage is not recommended for quarries.

2.9.1 AST Facility Plan

An aboveground-storage-tank facility plan is required for the installation of permanent ASTs at a facility that will have a total capacity of 500 gallons or more in either the recharge, transition, or contributing zones of the Edwards Aquifer [30 TAC 213.5(a)(4)]. In particular, ASTs that will store static hydrocarbons or hazardous substances are regulated.

The forms for a complete AST facility plan specify additional information that must be attached, such as maps, site plans, drawings for the containment area, and a description of spill controls and response actions. A containment area is a required element of the plan. Containment areas should be covered to prevent the accumulation of rainwater. Double-walled tanks are acceptable in place of tank containment. An AST facility plan must be submitted for review and approved before installation.

Further information about an AST facility plan is available at the TCEQ website: <www.tceq.texas.gov/goto/eapp_ast>.

2.9.2 Fueling Outside the Pit

Fueling of vehicles and equipment, whether at a central location or within the quarry pit, should occur in designated areas equipped with spill kits. Designated fueling areas should be designed to prevent stormwater runoff and spills. Fuel-dispensing areas should be paved with concrete, or an equivalent impervious surface but not asphalt, and have a 2 to 4 percent slope to prevent ponding. The fueling area should be separated from the rest of the site by a grade break or curb that prevents run-on of stormwater.

Fuel dispensing areas should be covered, and the cover's minimum dimensions should be at least as great as those of the area within the grade break or the fuel-dispensing area. The cover should not drain onto the fuel-dispensing area. Use a perimeter drain or slope the pavement inward so that runoff drains to a sump sized to hold at least 55 gallons. It might be necessary to install and maintain an oil-control device in catch basins that can receive runoff from the fueling area.

For facilities where equipment is being fueled with a mobile fuel truck, establish a designated fueling area. Discourage topping off fuel tanks. Secondary containment such as a drain pan should be used when transferring fuel from the tank truck to the fuel tank.

2.9.3 Fueling of Equipment in the Pit

Fuel transfers within the quarry pit pose a higher contamination threat because the pit is closer to the water table. Place drip pans, or other appropriate temporary containment device, at locations where leaks or spills may occur such as hose connections, hose reels, and filler nozzles. Drip pans should always be used when making and breaking connections. Check loading and unloading equipment such as valves, pumps, flanges, and connections regularly for leaks and repair them as needed. Equipment and vehicles that can easily be driven out of the quarry pit, such as personnel trucks and front-end loaders, should be fueled outside the pit.

Some equipment within the quarry pit, such as diesel-powered crushers, may have very large fuel tanks. Where larger tanks are used, the TCEQ recommends, at a minimum, an uncovered containment structure sized for 150 percent of the tank volume, impervious to the material being stored.

If permanent containment is not feasible in the pit, the operator may propose temporary containment. In either case, a spill kit should be located near the tank.

2.10 Industrial Facilities on Site

Industrial facilities on the quarry site may include batch plants for concrete and asphalt and other types of operations. A perimeter of the facility should be established and shown on the site plan submitted with the application. Berms and curbs should be used to prevent run-on of drainage from outside of the facility perimeter. Drainage originating within the facility should be handled according to the requirements of an industrial stormwater permit, which may require permanent BMPs. Wastewater from industrial facilities must not be discharged into the quarry pit, permanent BMPs, or surface streams.

2.11 Sanitary Wastewater Disposal

Sanitary wastewater should be discharged to a municipal wastewater system or an approved septic system located outside of the quarry pit. Portable toilets should be used minimally—only when the site is so large that access to permanent facilities is not feasible. Portable toilets are discouraged because of the potential for spills associated with toilet cleaning or overturning. If their use is unavoidable, the following BMPs are recommended.

2.11.1 Portable Toilet BMPs

Transport (industrial activity)

- Empty portable toilets before transporting them.
- Securely fasten the toilets to the transport truck.
- Use hand trucks, dollies, and power tailgates whenever possible.

Placement (site activity—construction)

- Locate portable toilets at least 20 feet from the nearest storm-drain inlet or sensitive-feature buffer area
- Build an earthen berm or sandbag containment around portable toilets for spill containment and protection from leaks.

- Prepare a level ground surface with clear access to the toilets.
- Secure all portable toilets with a stake driven into the ground to prevent tipping by accident, weather, or vandalism.

Maintenance of portable toilets (site activity—industrial and construction)

- Inspect the toilets frequently (daily during the workweek) for leaks and have the units serviced and sanitized at time intervals that will maintain sanitary conditions of each toilet (typically weekly).
- A licensed waste collector should service all the toilets.
- Suppliers should carry bleach for disinfection in the event of a spill or leak.
- Properly store (cover) and handle chemical materials.
- Train employees on these BMPs, prohibitions on discharging stormwater, and wastewater-discharge requirements.

(Adapted from *Portable Toilet Oversight Program* [Orange County Stormwater Program 2002])

2.12 Spill Prevention and Control

Quarry facilities should implement measures to prevent and control spills. Besides the criteria of section 1.4.16 in RG-348, quarry facilities should implement the following measures.

Education

- Post a summary of the spill prevention procedures in appropriate locations (such as meeting rooms, the cafeteria, and areas with a high spill potential). The summary should identify the spill-cleanup coordinators, the locations of cleanup kits, and the phone numbers of regulatory agencies to be contacted in the event of a spill.

General Measures

- Develop an inventory of potentially polluting materials, including their estimated quantities and size and number of storage containers. Use this inventory to determine the size and type of spill kits that should be present at the site. A sample material inventory appears in Table 4.
- Provide spill-cleanup kits at locations where spills are most likely to occur such as fueling and maintenance areas. Kits are available from several manufacturers or may be prepared by the facility owner. Each spill kit should have sufficient adsorbent capacity to handle a spill of the largest movable container at that location.

Table 4. Sample material inventory.

Material	Typical Container (including volume)	Number of containers Kept On-Site	Reportable Quantity for Spills into Water	Reportable Quantity for Spills onto Land
Gasoline				
Diesel				
Motor oil				
Transmission fluid				
Brake fluid				
Hydraulic fluid				
Lubricating greases				
Coolant				
Battery acid				
Reactives, oxidizers, ammonia				
Detergents				
Portable toilet fluid and wastewater				
Materials classified as hazaradous (specify)				
Other possible pollutants that could spill (specify)				

Adsorbents used in spill cleanup kits may be targeted to specific substances such as oil based liquids, water based liquids, corrosive liquids, or may be of the 'universal' type for all or unknown liquids.

In general, a spill cleanup kit should have:

- adsorbent socks or an adsorbent boom to contain the spill
- adsorbent mats or wipes to clean up the spill
- disposal bags for the used adsorbent
- personal protective equipment such as gloves, a face mask, and safety goggles
- an instruction manual for the equipment
- a clearly labeled container

- Summarize the procedures and information for dealing with spills at the quarry facility in a written spill plan. Facilities that are required to produce spill plans that cover all of items 1–8 below for compliance with other rules and regulations are not required to produce a separate document to illustrate compliance. At a minimum the plan should include:

    1. a description of the facility
    2. an inventory of materials
    3. material safety datasheets (MSDS)
    4. a site plan including drainage features, BMPs, maintenance and fueling areas, and spill kits
    5. spill-prevention measures to be used on-site, such as:
        - using containers suitable for the material stored—for example, a container designed for flammable liquids to store gasoline
        - overfill prevention for storage tanks such as a high-level alarm or audible vent
        - sized secondary containment for bulk storage tanks such as a berm or double-walled tank—a berm should hold 150 percent of the tank capacity plus possible rainfall in accordance with 30 TAC 213.5(e)
        - general secondary containment to catch the most likely spill: where fuel and oil transfers take place
        - periodically inspecting and testing tanks and pipes (both of which should be aboveground to enable visual inspections)—inspections should conform to industry standards such as API SP001, though applicable industry standards are at the discretion of the plan's engineer
    6. reporting requirements
    7. cleanup procedures
    8. the position of the person responsible for coordinating a spill response

    The written spill plan should be prepared by a licensed engineer (PE) in accordance with good engineering practice. Facility management should approve the plan. The plan should be reviewed (and resealed by a PE) at least every five years. It should be maintained on-site for the use and benefit of the operator, but not submitted to the TCEQ for review or approval.

3 BMPs for Areas Discharging to Surface Waters

3.1 Introduction

Quarry facilities and operations may be divided into those in areas where stormwater runoff discharges to surface waters, and those within the quarry pit that do not. Areas of the operation that discharge to surface waters typically include office buildings, vehicle-storage and -maintenance areas, parking lots, roads, and material-stockpile areas, none of which should discharge to the quarry pit. Even though quarry-pit operations are treated in this manual as an ongoing construction activity, improvements outside of the pit are not, because facilities outside the pit are typically used for decades and represent potential sources of pollutants over long periods of time. Consequently, improvements outside of the pit are considered permanent post-construction activities, and an 80 percent reduction of the increase in loads of total suspended solids (TSS) emitted from the facilities is required.

3.2 BMPs for Temporary Erosion and Sediment Control

BMPs for temporary erosion and sediment control are appropriate during the construction and expansion of facilities that discharge to surface waters. Chapter 1 of RG-348 describes a variety of strategies for minimizing the discharge of sediment during construction. This document is available online at <www.tceq.texas.gov/goto/rg-348>.

Measures that will be implemented within a project should be described in the Water Pollution Abatement Plan or Contributing Zone Plan, and installed and maintained in accordance with the plan.

3.3 Permanent Structural BMPs

3.3.1 General Requirements

Once construction of areas outside of the quarry pit has ceased, permanent structural BMPs should be implemented and operational. Under 30 TAC Chapter 213, 80 percent of the increase in TSS load resulting from activity (over background) must be removed. The increase is assumed to occur only on the new impervious areas, with the landscaped portions of the tract contributing the same TSS load as undeveloped areas.

The sizing calculations assume that the TSS concentration in runoff increases from a background concentration of 80 mg/L to 170 mg/L when an area is paved. That is generally a good approximation for conventional urban development, but it underestimates the potential TSS increase on busy roadways and unpaved parking areas, especially during wet weather. Consequently, haul roads and parking lots for vehicles that travel on public roads should be paved to reduce the generation of TSS and tracking of material onto public roadways near the facility entrance. Equipment-storage and material-stockpile areas may be surfaced with compacted native soils or road-base material but are still counted as impervious cover.

The water quality volume (or equivalent rainfall intensity for flow through practices) is a function of the effectiveness of the BMP and the amount of impervious cover. Impervious cover includes but is not limited to:

- pavement including roadways, driveways, parking lots, etc.
- roofs, if not part of a rainwater-harvesting system
- compacted road base, such as that used for parking areas
- material stockpile areas
- other surfaces that prevent the infiltration of water into the soil.

Roof areas connected to a rainfall harvesting system do not need to be included, but the volume of the rainfall collection system should be sufficient to retain the runoff from a 1.5 inch rainfall and the system should be managed so that it is emptied at least weekly to provide storage for subsequent storms.

3.3.2 Required Calculations

Required calculations for determining the amount of TSS that should be removed and the type and sizing of BMPs are included in RG-348. The TCEQ has posted a spreadsheet to facilitate these calculations at <www.tceq.texas.gov/goto/eapp_spreadsheet>.

The document describes a number of approved BMPs to achieve the required TSS reduction. Filtration BMPs (sand filters, bioretention, Aqualogic) may have very high maintenance requirements because of the large amount of sediment and dust generated by quarry operations. Vegetated filter strips often are an attractive choice where enough land is available and the contributing area is not too wide, such as roads, rail lines, and small parking lots.

4 BMP Requirements for Areas within Quarry Pits

4.1 Introduction

During the operational life of the quarry, the area within the pit that does not drain to surface waters is considered to effectively be a construction site. Consequently, the primary BMPs are those associated with preventing the tracking of sediment off-site. This should be facilitated by the use of paved roads outside of the pit area and the implementation of systems to remove sediment from vehicles that have traveled on unpaved areas at the quarry site.

4.2 Permanent Structural BMPs

Permanent structural BMPs must be installed to treat an area within the quarry pit only if the area will generate more TSS than it did in its original condition. A variety of final stabilization measures can be used to achieve TSS generation comparable to conditions before development and the preferred plan should be described in the permit application.

Rather than installing conventional stormwater BMPs in the pit, where no surface discharges occur, the most practical solution is to return the site to its pre-construction natural condition to the extent that is feasible. As portions of the quarry are permanently abandoned, final stabilization should occur in that portion, rather than waiting until the entire quarry is abandoned. Final stabilization is considered to have occurred when any of the following conditions are met:

1. All soil-disturbing activities in that portion of the pit have been completed and a uniform (i.e., evenly distributed, without large bare areas) perennial vegetative cover with a density of at least 70 percent of the native background vegetative cover for the area has been established on all unpaved areas having slopes less than 20 percent (the RG-348 limit for vegetative filter strips) and areas not covered by permanent structures, or equivalent permanent stabilization measures (such as the use of riprap, gabions, or geotextiles) have been employed.
2. For construction on land used previously for agriculture. final stabilization may be accomplished by returning the disturbed land to its pre-construction agricultural use. Areas disturbed that were not previously agricultural—such as buffer strips immediately adjacent to surface water—and areas that are not being returned to their pre-construction agricultural use must meet the final stabilization conditions of condition 1.
3. In drought-stricken areas only, all soil disturbing activities in that portion of the pit have been completed and both of the following criteria have been met:
    a. Temporary erosion control measures (e.g., degradable rolled erosion control product) are selected, designed, and installed along with an appropriate seed base to provide erosion control for at least three years without active maintenance by the operator, and
    b. The temporary erosion control measures are selected, designed, and installed to achieve 70 percent vegetative coverage within three years.

The quarry operator is responsible for the maintenance of these stabilization measures until the applicant informs the TCEQ in writing that another organization or individual has assumed control or ownership of the property.

5 Management of Process Water

One of the most significant issues in quarrying is the management of water used for a variety of processes including aggregate washing and saw lubrication. This water can transport sediment generated at the site to the water table, potentially increasing sediment and turbidity in the aquifer, nearby wells, and surface water.

Sedimentation basins are typically constructed at quarries to remove the fine particles and allow reuse of the water. To prevent contamination of the underlying aquifer an impermeable liner should be provided. The TCEQ sets a minimum standard for clay (see Table 3, above) or geotextile liners (Table 5); however, other materials such as shotcrete or concrete may perform equally well. In addition, freeboard should be sufficient to retain the water from the 10-year, 24-hour storm and a stabilized spillway should be provided for larger storms. Process-water management differs for the two quarry types distinguished by their substantial difference in water use.

5.1.1 Dimension-Stone Facilities (and Other Sites with Minor Water Use)

Dimension-stone quarries use dry-cutting Vermeer saws to rough cut the stone before it is plucked from the formation and processed. The rough-cut stone is transported to a wet saw, where it is sliced into different thicknesses. As the name implies, wet saws require water for cooling and lubricating the stone. The volume of water required is relatively small.

The most cost-effective way to manage process water at this type of site is to construct concrete-lined multi-chamber sedimentation basins, like the one shown in Figure 1. In this example, water is discharged to the basin on the far left, then overflows sequentially into the other basins. Water is withdrawn from the last basin for reuse. The multiple chambers reduce short-circuiting and improve removal of fines, as compared to a single basin of equivalent volume. The concrete construction, including basin walls, facilitates the removal of accumulated sediment without damaging a clay or geomembrane liner.

The basins are constructed with side slopes of not more than 3:1 to allow access by front-end loaders to remove accumulated sediment. Basins should be constructed with approximately 1 ft of freeboard to prevent displacement of process water during sediment removal. The volume of the basins is a function of the amount of water use during manufacturing and of the contributing drainage area. The basin needs to be large enough to provide sufficient sedimentation for the water to be recycled and contain the 10-year, 24-hour event with 1 ft of freeboard. Thus, controlling the drainage area to the basin will help minimize the necessary size. Accumulated sediment should be removed when the recycled water sediment content increases to an unacceptable level. The sediment may then be dried and used as fill material on-site.

Table 5. Geotextile-fabric specifications. Fabric must be at least 30 mils thick and resist ultraviolet.

Property	Test Method	Unit	Specification (min)
Unit Weight		oz/yd^2	8
Filtration Rate		in/sec	0.08
Puncture Strength	ASTM D-751*	lb	125
Mullen Burst Strength	ASTM D-751	psi	400
Tensile Strength	ASTM D-1682	lb	200
Equiv. Opening Size	US Standard Sieve	no.	80

*modified

Figure 1. Concrete-lined sedimentation basins.

5.1.2 Innovative Technology for Aggregate-Production Facilities

Aggregate-production facilities generally have much higher water demands, related to aggregate washing. Consequently, the sedimentation basins are typically many times larger than those used on dimension-stone operations, which makes basin lining more difficult (Figure 2). In particular, lining the vertical faces of the abandoned portions of quarries, which are commonly converted to sedimentation basins, is exceptionally difficult. Consequently, an alternative is available, which is easier to implement, but requires monitoring for at least six months after the beginning of operation or the creation of a new lift to demonstrate that water is not lost from the basin to groundwater at a rate greater than would occur had a conventional liner been implemented. The alternative pond system described below is innovative technology and is reviewable in accordance with Chapter 4 of RG-348.

There is limited data that indicates that the permeability of dense limestone within the Edwards Formation can exceed 10^{-10} cm/s, which is low enough to prevent impact to groundwater. However, these dense beds may be interrupted by voids, fractures, or other features that would allow process water to affect groundwater quality. These features should be identified and plugged with appropriate impermeable material.

In layered formations, such as the Edwards, the horizontal permeability is often many times larger than the vertical. Consequently, identifying and sealing permeable layers in the quarry

Figure 2. Large-scale sedimentation basin at aggregate quarry.

wall is critical to reducing water loss. Voids, fractures, and permeable beds ("cave rock") should be permanently sealed with flowable fill or other impermeable material.

Once this sedimentation basin is operational, a water balance should be performed to demonstrate its integrity. The operator of the quarry should keep detailed records of the volume of makeup water used daily over six months. Makeup water also includes the volume of rainfall that falls on the sedimentation basin; rainfall measurements should be made at the basin or at the facility office. Water losses may include:

- evaporation [measured with the standard "class A" evaporation pan and applied to the basin using a pan coefficient of 0.70 (Maidment 1993)]
- product loss (estimated as a percentage of the bulk volume of material washed, at 6 percent for coarse material and 12 percent for sand)
- other uses on-site (dust control, tire washing, etc.)

The difference between the makeup volume and the sum of the losses is the amount of water that has infiltrated into the aquifer. The applicant (or holder of the approved plan) should supply a calculation demonstrating that this volume is less than or equal to what would have occurred if a conventional liner had been installed. If the calculated infiltration exceeds the expected infiltration from a conventionally lined pond, the quarry operator may try application of a pond sealer, such as sodium bentonite, to reduce infiltration from the sedimentation basin. Otherwise, the TCEQ recommends a more conventional pond liner.

A sample calculation for a basin water balance appears in Table 6. Note that, to perform a water balance, the basin volume and surface area must be known. The leakage from a conventionally lined pond is estimated for comparative purposes. Since these settling basins often have low water levels (< 6 in), the example considers only seepage through the floor of a conventionally lined pond, and not the walls. Quarry operators seeking to demonstrate the acceptability of their pond may supply a more detailed analysis for review.

Table 6. Example water balance for unlined sedimentation basins.

	Information					Volume of Water In			Volume of Water Used				Estim. Vol & Infiltration		
Date	Pan Evap. [in]	Rainfall Depth [in]	Bulk volume of washed . [ft^3]	Basin Area [ft^2]	Acutal Basin Volume [ft^3]	Rainfall into Basin [ft^3]	Make-up Water [ft^3]	**Total Water In** [ft^3]	Product Loss [a] [ft^3]	Evap (using pan coef of 0.7) [ft^3]	Other uses [ft^3]	**Total Accounted for Uses** [ft^3]	Estim. Basin Volume [ft^3]	Estimated Infiltration [ft^3]	Infiltration through RG-348 liner [ft^3]
12/31/2010					10000										
1/1/2011	0.03	0.3	27000	10000	9900	250	0	**250**	1620	18	0	**1637.5**	8612.5	1287.5	28.3465
1/2/2011															
1/3/2011															
. . .															
. . .															
6/28/2011															
6/29/2011															
6/30/2011															
Total Estimated Infiltration should be less than infiltration for RG-348 Liner--->															

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