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DEPARTMENT OF ENVIRONMENTAL PROTECTION
Bureau of Mining Programs

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TITLE: Alkaline Addition for Surface Coal Mines

EFFECTIVE DATE: Upon publication of notice as final in the *Pennsylvania Bulletin*

AUTHORITY: Section 4 (a)(2)(G) of the Surface Mining Conservation and Reclamation Act (52 P.S. § 1936.4(a)(2)(G)); Section 315 of the Clean Streams Law (35 P.S. § 691.315).

POLICY: The Department of Environmental Protection (DEP) may authorize the use of alkaline addition on mine sites under certain limited conditions, including some sites where a permit would not be issuable without alkaline addition.

PURPOSE: This policy explains the situations in which alkaline addition is appropriate and describes the options and procedures for mine operators to maintain and achieve compliance with environmental protection standards including calculation of application rates and placement of alkaline material.

APPLICABILITY: This policy applies to mine operators who wish to utilize alkaline addition as a mine drainage pollution prevention method and to DEP staff reviewing proposals submitted by mine operators.

DISCLAIMER: The policies and procedures outlined in this guidance are intended to supplement existing requirements. Nothing in the policies or procedures shall affect regulatory requirements.

The policies and procedures herein are not an adjudication or a regulation. DEP does not intend to give this guidance that weight or deference. This document establishes the framework, within which DEP will exercise its administrative discretion in the future. DEP reserves the discretion to deviate from this policy statement if circumstances warrant.

PAGE LENGTH: 8 pages

DEFINITIONS

Alkaline Addition - For the purposes of this document, “alkaline addition” means the importation of offsite material that will produce alkalinity and prevent the formation of acid mine drainage. It does not include alkaline redistribution (the redistribution of naturally occurring alkaline material within a mine site) and use of alkaline materials as a best management practice. Best management practices include routine pit floor liming, liming for revegetation purposes, alkaline addition as a “safety factor”, and addition of alkaline materials on sites where overburden has been weathered, but could produce water with a pH below 6.0 without the addition of alkaline materials.

BACKGROUND

This guidance provides applicants considering alkaline addition with instruction regarding the acceptable procedures for approval and with technical details based on DEP’s experience and the best available science. DEP developed this guidance based on published research and field experience, including retrospective evaluations of mining and reclamation projects, and has updated this document to include current information and methodologies.

The procedure and details outlined in this guidance also help DEP determine whether using alkaline addition on a particular mining permit will prevent potential pollution to surface water and groundwater.

For DEP to make this determination, the applicant provides overburden analysis and subsequent calculations, information regarding the postmining water quality on nearby previously mined areas, and discusses the selective placement of overburden materials in conjunction with the mining plan, geology, surface and groundwater hydrology, and premining groundwater quality. In addition, DEP will consider the sensitivity of protected environmental resources.

Historically, DEP has restricted alkaline addition to remining sites, abandoned mine lands, and other areas where the receiving stream was degraded by previous mining. Alkaline addition was previously prohibited from use in areas that had not been previously mined (“virgin sites”). This guidance includes consideration of the use of alkaline addition on virgin sites and provides flexibility in determining rates for remining sites authorized under Subchapter F of 25 Pa. Code Chapter 87. Alkaline addition utilization is not the sole determinant as to whether the permit should be issued or denied. DEP will consider all relevant factors in making a permit decision, including the demonstration by the applicant that there is no presumptive evidence of potential pollution of the waters of the Commonwealth. See 25 Pa. Code § 86.37.

2019 Alkaline Addition Study

A retrospective alkaline addition study titled “Assessment of Alkaline Addition on Reclaimed Surface Mines in Pennsylvania” was conducted in 2019 to determine the rates of success and ways to improve the alkaline addition program. Sites were selected based on alkaline addition rates greater than 200 tons/acre,¹ adequacy of the monitoring point(s) downgradient of the alkaline addition area, and, in the case of remining, those operations that used alkaline addition as opposed to a combination of other best management practice (BMP) methods. In all, 45 completed mines sites from across the state were analyzed by comparing pre- and post-mining water quality. Much of the initial guidance on alkaline addition was developed based on a method derived from DEP’s best professional judgement at the time.

¹ Less than 200 tons/acre is considered a best management practice (BMP).

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This study showed that sites with rates less than 500 tons/acre and that used calculations to achieve a net neutralization potential (NNP) of 6 (with thresholds) consistently produced alkaline water quality with low metals. The BMP rate for alkaline addition has been revised from 200 tons/acre to 500 tons/acre contingent upon an NNP of 6.0 (with thresholds) in the calculation. (See section “Determination of Alkaline Addition Rates” for a description of “thresholds”.) This change will mostly affect special protection watersheds as they are only eligible to be mined if BMP-only rates are necessary for permit issuance. The full study is published on the Bureau’s website.

PROCEDURE

DEP recommends that operators submit preapplications for those proposals that include alkaline addition to ensure that the operator has a clear understanding of the requirements that must be met, that the plan includes all necessary elements for success, and that the information submitted in a formal application is complete and correct to allow for expedient review.

Site Characteristics and Water Quality Criteria

Sites that primarily benefit from the use of alkaline addition are proposals for re-mining of previously affected areas and areas with receiving streams (the first perennial stream that receives water from the mine site) degraded by mine drainage.

For re-mining sites, alkaline addition, in conjunction with the proposed pollution abatement plan, may help prevent additional groundwater degradation. Therefore, DEP encourages this approach. Alkaline addition rates must be appropriate to ensure that postmining water quality meets effluent limitations.

For other sites, including sites that have not been previously mined, postmining water quality must meet the effluent limits in § 87.102 and not cause violation of any established in-stream criteria, including iron, manganese, and aluminum.

DEP will not consider alkaline addition for sites in special protection watersheds where a permit would not be issuable on its own without alkaline addition. Special protection watersheds are those watersheds with surface waters, including wetlands, that have existing or designated uses as High Quality Waters or Exceptional Value Waters under 25 Pa. Code Chapter 93. DEP will consult Chapter 93, stream reports developed by DEP’s Division of Water Quality, and other available information to determine current existing and designated uses. See 25 Pa. Code §§ 93.4a – 93.4d, 93.9 – 93.9z. DEP may consider exceptions in unique circumstances, where, in conjunction with re-mining, alkaline addition is predicted to result in overall water quality improvement.

Determination of Alkaline Addition Rates

In the permit application, the applicant describes the proposed alkaline material to be used including information regarding the type (e.g. lime, crushed limestone, baghouse lime, etc.), source(s), and grain (particle) size distribution. The proposed alkaline material should be tested for purity and/or neutralization potential (NP) and/or other indicators of alkaline potential. The application rate should reflect calcium carbonate equivalency.

Alkaline addition rates are calculated based on site-specific and representative acid-base accounting overburden analysis data, unless there are other reliable data available that can be used to calculate an

addition rate. The NNP should be calculated for a mine site or a portion of a mine site to be affected.² NNP is the neutralization potential minus maximum potential acidity (MPA) for the entire site or the portion of the site under consideration. MPA, for the purposes of this guidance, is calculated from the weight percent of total sulfur multiplied by the stoichiometric equivalence factor of 31.25. The weighting should consider the relative thickness and areal distribution of each sampling interval.

Mine site overburden is variable in acid-generating and neutralizing capability. Therefore, determining unique alkaline addition rates for each overburden drill hole then designing a plan to place that specific amount within the “area of influence” of that drill hole, is generally not appropriate unless there are substantial geologic differences among the drill holes. The operator must evaluate these geologic differences and their areal extent in the context of all available drilling data for the site. In most cases, it is more appropriate to determine an average alkaline addition value for a mine or a portion of a mine derived from averaging multiple overburden drill holes representing a particular geologic facies than a rate determined from a specific drill hole and its theoretical “area of influence.”

DEP employs two methods for calculating NNP – with or without thresholds. Without thresholds includes all values determined in acid-base accounting. With thresholds includes only values with NP > 30 ppt (with “fizz”) and percent total sulfur > 0.5.³ Lesser values are assigned a value of zero. The threshold method should not be used for deposits that are heterogeneous and not bedded, such as old mine spoil, because these situations will not result in accurate calculations for alkaline addition rates.

Application rates should be expressed as tons CaCO₃ per acre or tons CaCO₃ per tons of overburden material.

There is no definable upper volume limit of alkaline material that could be approved for a mine site. However, as part of the application review process, the applicant must demonstrate that the proposed mining activities can be feasibly accomplished. In cases where the applicant proposes to use unusually high alkaline addition rates (e.g., 2,000 tons per acre), DEP will request a cost analysis to justify that high alkaline addition importation rates are economical and feasible to handle and place on the proposed site.

The following table (Figure 1) summarizes the NNP target values for a given situation. The values reflect thresholds of 0.5% total sulfur and NP of 30 ppt (with a fizz). If thresholds are not used, double the table values. Values may require modification based on site-specific conditions. Meeting an NNP of 6 does not preclude production of high metal concentrations, particularly where high alkaline addition rates are required. Although the alkaline addition may be producing enough alkalinity to neutralize any acidity that is being generated through pyrite oxidation, it is frequently inadequate to prevent manganese dissolution or iron precipitation (generated by pyrite oxidation) within the backfill.

² Smith, M.W. and Brady, K.B.C., 1998. Alkaline Addition. In: Brady, K.B.C., Smith, M.W., Schueck, J.H. (Eds.), The Prediction and Prevention of Acid Drainage from Surface Coal Mines in Pennsylvania, Harrisburg, Pa., Pennsylvania Department of Environmental Protection, 5600-BK-DEP2256, pp. 13.1–13.13. The alkaline addition chapter in the coal mine drainage manual is available on DEP’s website and provides a more in-depth discussion on alkaline addition.

³ Individual strata with less than 0.5% sulfur and/or less than 30 ppt NP are considered insignificant producers of acidity or alkalinity. See Smith & Brady, 1998, Chapter 13.

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FIGURE 1: ALKALINE ADDITION MATRIX FOR TARGET NNP
Units - tons CaCO₃/1000 tons of material (i.e., parts per thousand CaCO₃)

		PREVIOUS MINING STATUS		
		Primarily remining and/or Sub F	Some remining	Virgin sites
RECEIVING STREAM QUALITY	Degraded – doesn't support aquatic life	2-6	4-6	6
	Supports aquatic life	3-6	6	6
	Special protection (including Class A Wild Trout Waters)	6	BMP only	BMP only

The receiving stream quality and previous mining status determine the requirements as follows:

A. Primarily remining

A Chapter 87 Subchapter F remining site is not necessarily required to produce alkaline drainage, but the pollution load must not increase. Remining sites without a preexisting discharge-related liability may still involve significant amounts of reclamation. Reduction of pollution can often be significantly accomplished by reclamation of disturbed land with restoration of positive drainage and revegetation of the site (part of a pollution abatement plan and BMPs). Thus, alkaline addition is not the sole element in assuring water quality improvement.

B. Areas with some remining and those virgin sites on streams degraded by mine drainage

These sites should meet an NNP (with thresholds) of 4 (for remining areas) and 6 (for virgin sites on streams degraded by mine drainage), or higher if needed to assure alkaline postmining drainage. Alkaline addition can be considered as a method to correct poor quality overburden on many of these sites provided alkaline postmining water quality that meets effluent standards for metals can be achieved.

C. Mining of virgin sites on streams not degraded by mine drainage pollution

These sites should meet an NNP of 6 with thresholds and 12 without thresholds. Because of the sensitivity of the stream, alkaline addition rates must be high enough to minimize the chance that failure will occur. Past experiences have demonstrated that mines that have NNP rates equal to or greater than those provided in Figure 1 consistently produce alkaline drainage, although elevated metals concentrations are not necessarily precluded.

D. *Special protection watersheds including Class A Wild Trout Waters*

These areas are not suitable to alkaline addition as a means of correcting poor-quality overburden. Failure (i.e., degradation) on these watersheds can have drastic consequences. Therefore, the risk often outweighs the potential benefit. In addition, high alkaline addition rates sufficient to assure alkaline drainage can increase the potential for elevated metals or result in other water quality degradation. The exception to this situation is for remining sites when, in conjunction with remining, alkaline addition will result in overall water quality improvement. The applicant must demonstrate to DEP that no presumptive evidence of pollution, such as increased metals, will occur (i.e., the applicant has satisfied its burden under § 86.37(a)(3)). For sites with little remining or a virgin site, alkaline addition should only occur as a BMP, as noted in the table. For sites that are not in special protection watersheds but are in watersheds with streams designated as Class B through D wild trout streams by the Pennsylvania Fish and Boat Commission under 58 Pa. Code § 57.11, this designation will be considered as an additional factor under Sections A through C, above, when determining alkaline addition rates in these areas.

Handling and Placement

The applicant should consider placement of alkaline material such that dissolution of the material will be optimized and the potential for coating with iron hydroxide will be minimized. Any handling plan should have the goal of inhibiting pyrite oxidation and/or *in situ* neutralization of acid mine drainage. With an aim to prevent AMD by replicating naturally alkaline overburden, the best practice is to mix most of the alkaline material into the mine spoil as thoroughly as possible. In the past, DEP has allowed up to 10% of the alkaline material to be placed on the pit floor. Although this provided a noticeable, short-term benefit, it does not contribute to the targeted NNP for the site. Therefore, any alkaline material placed on the pit floor should not be included in calculating the targeted NNP. If the pit floor may potentially produce acid, the applicant should account for at least 20 tons/acre on the pit floor.

The mining plan must be practical, verifiable, and enforceable by both the operator and DEP personnel. The applicant must include detailed descriptions, plan views, and/or maps showing areas where alkaline material will be applied and an explanation of how it will be placed. If alkaline addition is proposed in conjunction with selective handling of overburden materials, cross-sections should be provided showing the placement of the alkaline material relative to the selectively handled material.

Alkaline Addition Using Coal Ash

DEP will only approve coal ash certified under 25 Pa. Code Chapter 290 for use as an alkaline additive to supplement the rates of conventional types of alkaline materials. The full, calculated rates for an alkaline additive must first be met using conventional materials such as limestone, baghouse lime, hydrated lime, or quick lime. For example, if the calculated alkaline addition rate is 550 tons of calcium carbonate per acre, this rate must be achieved using conventional material before coal ash can be added to the plan. Coal ash used as a safety factor must have a calcium carbonate equivalency of at least 100 parts per thousand (i.e., 10% by weight). Additional quality requirements are contained in Chapter 290: Beneficial Use of Coal Ash.

If the applicant includes coal ash as part of a safety factor, the coal ash cannot be mixed with other alkaline materials because that may increase the likelihood of the ash becoming cementitious, thus

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reducing its neutralizing capacity. The ash placement plan must demonstrate that the ash will not “set up” (harden, like cement), thus reducing its alkalinity-generating potential.

Co-Products and General Permits

As with certified coal ash, DEP will only approve material that has been designated as a “co-product” or qualifies under a general permit (GP) issued by the Bureau of Waste Management (BWM) as an alkaline material for mine reclamation to supplement conventional types of alkaline materials. These materials are prohibited for use in special protection watersheds including Class A wild trout streams. The applicant must obtain approval to use a co-product or a GP at any specific mine site from the District Mining Office. The GP or co-product designation alone does not guarantee approval for alkaline addition or any other beneficial use. For more information on the process for approving use of GP material or co-products, refer to the “Beneficial Use of General Permit (GP) Materials at Active Coal Mines” technical guidance document (Document Number: 563-2112-001). DEP may also require additional water testing for these materials in accordance with Chapters 87 and 290.

Monitoring Requirements: Water and Materials

The applicant will be required to provide a self-monitoring plan to establish the effectiveness of the alkaline addition in preventing postmining water quality problems. This plan should include downgradient monitoring wells, or other suitable groundwater monitoring points, that adequately represent groundwater from the alkaline addition site. Sufficient background samples should be obtained prior to alkaline addition by implementing the monitoring plan prior to commencing mining activities – one per month for three months is a standard number of samples.

DEP will include in the permit site-specific information about additional monitoring well installation (locations and deadlines for completion), and the duration of monitoring at these points. Typically, screened monitoring wells should be placed in the backfill following completion of backfilling. These wells should be located over low points on the pit floor to ensure the wells encounter water. However, DEP may approve plans without backfill wells if other representative groundwater monitoring points already reflect the water quality of the postmining spoil.

At a minimum, the permit will require quarterly sampling of monitoring points until final bond release. However, monitoring after Stage 2 bond release may be waived if there is no trend indicating a decline in water quality.

If alkaline material is purchased for distribution on the mine site, copies of scale weight slips and/or other documentation of the amount of alkaline material imported should be kept at the mine site. The operator should also make available information that shows the type and purity of alkaline material used, the amount already applied, and the phase (or bonding increment) where it was placed. The operator will submit to the District Mining Office a quarterly report of the total amount of alkaline material applied during the preceding quarter and an identification of the phase/area to which it was applied. Additional reporting may be required on some permits depending on specific site considerations.

Implementation of Plan

Alkaline addition may make mining possible on some areas that could not be permitted without alkaline addition; this guidance contemplates such scenarios. Success of such projects is directly related to the proper implementation of the plan. If the plan is not carried out as described in the permit, there is a

high probability that the operator will have postmining discharge liabilities. Therefore, it is imperative that implementation of the plan is feasible and that its execution components can be verified and documented.

The issued permit will include site-specific permit conditions where necessary to document stages and procedures in the plan. An example of such a condition would be a requirement for the coal operator to notify the mine inspector during or immediately after the alkaline material is applied, so the inspector can verify that this component has been implemented. The operator should not cover the alkaline material with topsoil or spoil until the mine inspector approves. If the mine inspector (or other DEP representative) is unable to inspect the alkaline addition placement within 48 hours, the coal operator can supply DEP with photographs of the placement area. Another similar condition might require the coal operator to maintain a stockpile of alkaline material of a certain volume at the mine site during active mining to assure that alkaline material would always be available when needed.

Because uncertainties remain regarding implementing successful alkaline addition, some permits may be conditioned such that issuance of future bonding increments is contingent upon the water quality success of earlier phases of mining.

If the operator wishes to change the approved alkaline addition plan such as type, amount, or placement plan of the alkaline material the operator may accomplish this through a minor revision to the permit. Where appropriate, permits could be issued with alternate alkaline addition plans. When this is the case, prior approval from DEP is not necessary if one of the alternate plans is being used, but the operator should notify DEP of the change.

Temporary Cessation

Extended exposure to the atmosphere can cause pyrite-rich rocks to oxidize and produce soluble acid products. The operator should discuss this potential situation and any other contingencies with the permit reviewer during the permitting process. The operator and permit reviewer should reach an agreement on the BMPs that the operator will employ during any temporary cessation and the permit conditions that document procedures for this situation.