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Cincinnati OH 45268

Research and Development

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Project Summary

Demonstration of Debris Basin Effectiveness in Sediment Control

R E. Bednar and D J. Fluke

This study was conducted to determine the effectiveness of sedimentation ponds, as built during the mid-1970's, in the removal of suspended solids discharged in the runoff from lands disturbed by a typical surface mine in eastern Kentucky. The information in this report should be of interest to any program concerned with suspended solids control in runoff. The selected site included two watersheds in which very little erosion-causing activities had occurred, although strip mining was scheduled for one (Rhoades Branch).

Mining activities began with construction of a haul road and nine debris basins in August 1976 and were halted by the UMWA strike in December 1977. During this period, only four of the basins received runoff from disturbed areas. Monitoring showed that efficiency was much lower during storm events than during normal flows, due in part to construction and maintenance practices. The efficiency decreased with time because accumulated sediment was not removed from the ponds.

This study was conducted in cooperation with The Kentucky Department of Natural Resources and Environmental Protection, Office of Planning and Research, Frankfort, Kentucky.

The final report was submitted in fulfillment of Grant S-801276 by L. Robert Kimball and Associates, Consulting Engineers and Architects, Ebensburg, Pennsylvania, under the partial sponsorship of the Environmental Protection Agency. Work was completed as of December 1979.

Introduction

Two similar and adjacent watersheds in eastern Kentucky were selected for study in an area where very little erosion-causing activity had occurred Mining was proposed in only one valley (Rhoades Branch) The adjacent control watershed (Dick Branch) was selected to provide background data on water quality where man's activities continued to be limited

The Rhoades Branch - Dick Branch Study Area (Figure 1) constitutes a small portion of the eastern Kentucky coal field in the upper reaches of Rock-house Creek, a tributary to the North Fork of the Kentucky River. Although coal was mined in local areas within this watershed, no surface mining had been done in the study area prior to its selection for this demonstration

Permission to establish the monitoring station in Rhoades Branch was obtained from Beth-Elkhorn Corporation, the surface and mineral owner Beth-Elkhorn Corporation also pledged the cooperation of its contract miner, Tackett and Manning Corporation, who had earlier signed a cooperation agreement with KDNREP

Tackett and Manning submitted a

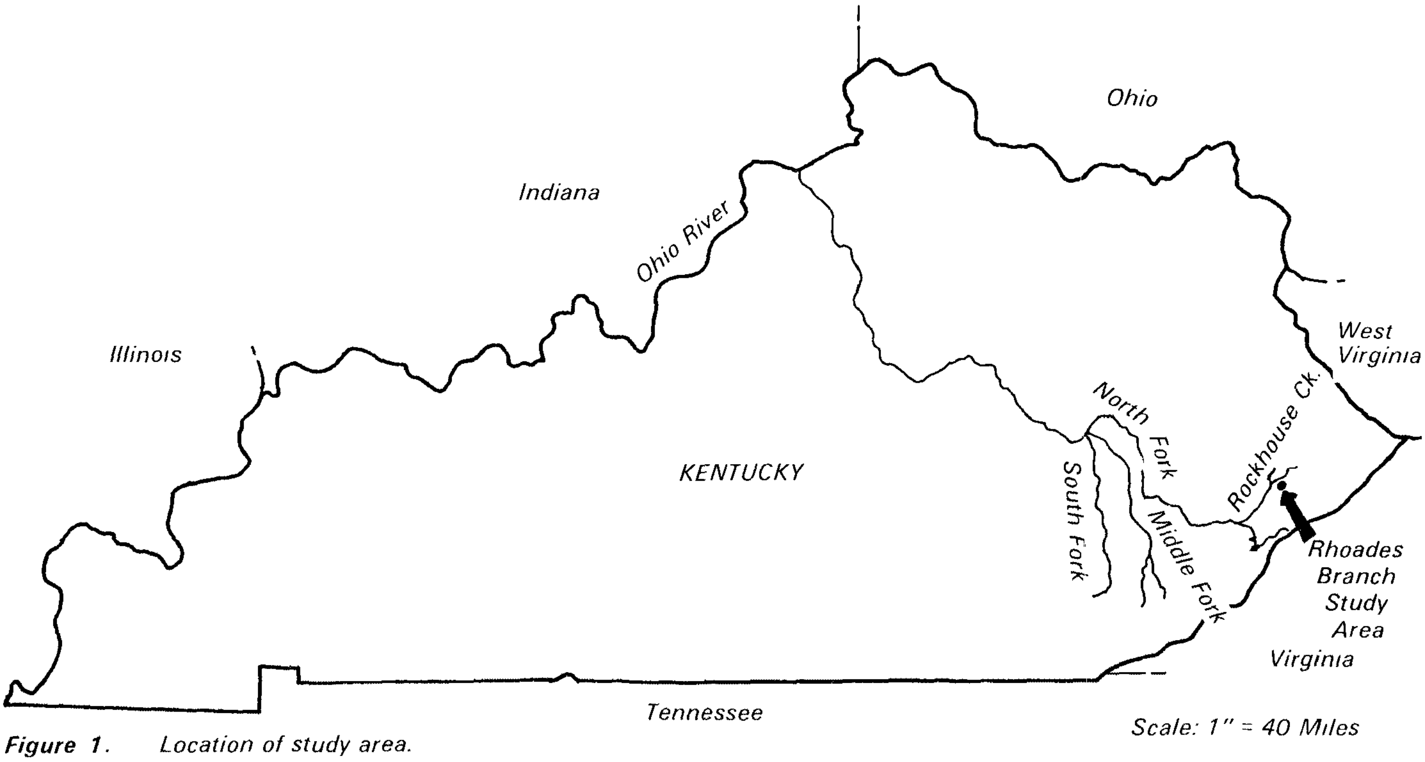

Figure 1. *Location of study area.*

mining plan for Rhoades Branch to KDNREP in June 1975, but indicated that a change in the coal market was necessary before they would begin mining Construction of the monitor housing and weir was completed in March 1976, and electric power was installed in June. Equipment installation was complete by August 31, 1976 In August 1976, Tackett and Manning constructed an access and haul road in Rhoades Branch They also constructed the debris basins as shown on their mining plan These smaller earthen basins were designed in the field by the bulldozer operator, a common practice at that time in this area. Very little mining was done in Rhoades Branch until March 1977, although a head-of-hollow fill had been constructed earlier. Mining continued through the spring and summer of 1977 By the fall of 1977, the main sediment basin on Rhoades Branch upstream of the monitoring station had completely filled, and rather than clean the pond, the company built a dumped rock barrier across the stream 52 meters (170 feet) upstream of the monitor station

Mining ceased with the advent of the UMWA strike, December 6, 1977, and was not resumed at the conclusion of the strike on March 27, 1978. The disturbed area was hydroseeded in August 1978, and monitoring continued through March 1979

The project demonstrated the effectiveness of debris basins, as built in eastern Kentucky, in reducing the sediment load from strip mining disturbances to Rhoades Branch It provided information on the change in water quality in Rhoades Branch during and after mining when compared to Dick Branch

Conclusions

A system of sediment basins, as built in the Rhoades Branch demonstration area, was studied to determine their efficiency over the life of a surface mining operation With time, efficiency of the basins decreased due to lack of maintenance (no clean-out of the ponds, reduced sediment storage, and shorter retention time). On the whole, the pond system delayed off-site sedimentation but did not prevent it

The pond system consisted of instream ponds, where a bulldozer was used to escavate a portion of the stream channel, using the excavated material to form the downstream embankment. The principal spillway was usually a corregated metal pipe, with the open channel emergency spillway located at a slightly higher elevation on the opposite side of the embankment Once the ponds were constructed, they were not maintained Clogging of outflow pipes by floating debris and accumulated sediment caused excess use and rapid deterioration of the emergency spillway and embankment and short circuiting of the ponds

The unplanned stoppage of mining in Rhoades Branch indicates that future mining within the basin will be done. New ponds, designed according to existing regulations will be required before this mining begins The permanent monitoring installation coupled with the high likelihood of future mining makes this area a prime candidate for future sediment basin research

The exposure of fresh rock surfaces during mining resulted in rapid chemical weathering Significantly increased concentrations of sulfates, hardness, and conductivity occurred in Rhoades Branch during mining. Although the entire mining area was hydroseeded in August 1978, little change in the rate of weathering was apparent by the end of the study period in March 1979. Sulfates, hardness, and conductivity values have increased by factors of 4 5, 3.5 and 3, respectively over their premining values

The poor overall performance of the sediment basins studied may be attributed in part to the following factors

1. The ponds did not have the required storage capacity
2. No maintenance was performed
3. The ponds were not cleaned out when they were filled
4. The outlet pipes became clogged resulting in excessive use and deterioration of the emergency spillway
5. No provision was made for removing the pond embankment and contents when no longer operable

Recommendations

It was apparent during field work that maintenance and cleaning of the ponds were necessary. The importance of maintenance should be addressed and emphasized to inspection officials A schedule for cleaning and disposition of dredge material should be required when the sediment basin plans are submitted. Pond embankments should be removed and properly reclaimed when mining has ceased to prevent gradual deterioration and eventual failure

The required storage area is difficult to construct because of terrain constraints in the study area, even with ponds in a series To overcome this problem, several techniques and operating procedures should be encouraged, including "at-source" controls such as minimizing disturbed areas, providing vegetative buffers, and constructing sediment traps. Methods to slow the velocity of runoff before it reaches the sediment ponds will decrese the amount and size of suspended sediment.

Following the field work in this study, the permanent station was turned over to the Department of Civil Engineering, University of Kentucky, so monitoring could be continued, at least intermittently. The interruption in mining strongly indicated that future mining will occur, and with changes regarding sediment basin design, occurring due to previous studies and the Office of Surface Mining Regulations, new basins would be constructed, and should be monitored.

The monitoring equipment has been in operation since September 1976, with random stoppages from extended power outages and during low or zero flow conditions A general overhaul and equipment reconditioning should be performed before mining begins again.

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The complete report, entitled "Demonstration of Debris Basin Effectiveness in Sediment Control," (Order No. PB 80 222730; Cost· $9.00, subject to change) will be available from:
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Project Summary

Fugitive Dust from Western Surface Coal Mines

Frank Cook, Arlo Hendrikson, L Daniel Maxim, and Paul R Saunders

In this study, field measurements of fugitive dust levels were made 250 to 500 meters downwind of mining activities and areas at four surface coal mines in the Northern Great Plains during three different climatic conditions. Ambient dust levels were also monitored. Wide ranges of temperature, wind speed, wind direction, precipitation, soil moisture, and mining activity levels are represented in the field data.

Introduction

Some fundamental findings were mine-to-mine differences in average total suspended particulates (TSP) levels were significant, the evidence for seasonal differences is weaker, but consistent with physical theory and prior judgements; and on the average, downwind TSP levels were 35 percent higher than ambient (upwind) levels.

Most strippable western coal is located in semi-arid, high plains areas characterized by sparse vegetation, erodable soils, and high winds High ambient dust levels are a result of these factors Disturbance of land by surface coal mining may worsen these dust conditions

There exist theoretical models for use in estimating the dispersion patterns for particulate matter emanating from a point source, such as a power plant stack Recently, attempts have been made to model emission, dispersion, and deposition of fugitive dust from point and non-point sources typical of those from western surface coal mines. To date, however, there have been few attempts to apply statistical techniques to determine empirical relationships between suspended particulate levels in mining areas and explanatory variables, such as mining activity levels and meteorological variables. This study employs such techniques to examine the effects of mine operations on air quality under various meteorological and operational conditions.

It is recommended that a large-scale, long-term experimental program be conducted to develop and validate empirical relationships between total suspended particulate levels in western surface coal mining areas and explanatory variables which measure the characteristics of the real dust sources found at such mines Total suspended particulate levels should be measured at two or more mines over a period long enough to ensure that a wide range of mining and meteorological variables are observed. Empirical results should be systematically compared to those estimated using published emission factors and dispersion/deposition assumptions

In brief, the data collection plan included three visits during different seasons to each of four surface mines Four high volume air samplers were used to measure dust concentrations during these visits Additional data were collected on soil moisture, weather conditions, and activity levels of various mining or mining-related operations. These data are candidate explanatory factors to describe the observed variability in dust concentrations

Observations for this project were taken at several sites within four mines Three visits were made to each mine to ensure that a wide variety of operating conditions were observed and, additionally, to study the effect of seasons of the year on particulate values

Variables measured during the mine visits included dust concentrations, soil moisture, quantitative data on the pattern and intensity of mining activities, and meteorological variables such as wind speed and direction, temperature, and precipitation. Aerial photographs were taken from which maps were drawn

Several factors must be considered in the design of a sampling plan for measuring the atmospheric concentration of particulates Some of these are

1 Emissions sources to be measured
2. Direction of the air sampler from the source
3 Distance of the air sampler from the source
4 Duration of sampling interval.

The goal is to place the monitors in such a manner that a profile of the concentration of particulates can be obtained. Sampler locations and sampling intervals are such that sufficient amounts of particulates will be collected to give reliable estimates of the air concentration at the receptor point We first considered sampling intervals

Dust concentrations were measured with General Metal Works GMWL 2000 high volume air samplers These draw in particulate matter and pass them through a graded series of paper filters At the end of each observation period, the filters were removed and weighed, and the accumulated dust was converted to a concentration in units of micrograms per cubic meter

Soil moisture as percent of total weight was recorded at locations designed to reflect diverse soil conditions haul roads, the pit and bench, off-mine roads, topsoil or spoil piles, areas of contouring or reclamation, and the surrounding landscape

Mining activities were recorded during shifts when dust sampling was active Twelve potential dust-producing activities were observed dragline operation, coal haulage, vehicular traffic on mine roads, vehicular traffic on nearby public roads (usually unpaved), water trucks, scraping, grading, coal loading, coal unloading, blasting, and drilling of overburden and coal

The report summarizes the results of various statistical analyses of the data collected as part of this study It judges differences in particulate values measured at various locations, mines, and seasons that can be held to be statistically significant Estimates of main and interaction effects and complete components of variance analysis are furnished in the report The report presents the findings of differences among samplers such as differences arising between the ambient sampler and those downwind of the mining operation Shown also is the relationship between particulates and activity variables at the mining operations visited

Reported, in particular, are the results of preliminary statistical analysis of the data and analysis of variance (ANOVA) on total particulates The results of the analysis of variance support the contention that there were significant differences in readings among sampler locations

Also discussed are some of the results of regression analysis to determine the relationship between observed TSP and activity levels for various mining operations

The independent variables consisted of observations on some twelve activities at the mine operation, including dragline operation, coal haulage, drilling, blasting, loading, scraping, grading, etc Additionally, wind speed and precipitation were employed in view of their observed or postulated relationships in previous analyses The first observation of interest in examining the relationship between mine activity and resulting TSP values is the pattern of simple correlation coefficients Two points are worthy of note the exception of variable Q_3 (on-mine vehicles) TSP is positively correlated with each of the activity variables and the correlation coefficients are not great

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The complete report, entitled "Fugitive Dust from Western Surface Coal Mines," (Order No. PB 80 221955; Cost. $15.00, subject to change) will be available from:
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