A finite difference groundwater model for the East Decker, Montana mine
by Richard H Engelmann

A thesis submitted in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE in Civil Engineering
Montana State University

Abstract:
As part of a U. S. Environmental Protection Agency funded project, a groundwater model was developed for the proposed East Decker coal mine. The model is capable of simulating flow before and during mining, accounting for drainage into the mine cut and resultant aquifer drawdowns.

The literature was reviewed for previous field research on groundwater flow at existing mines, modeling attempts made at existing mines, and for available groundwater models. On the basis of the review, a two-dimensional, finite difference model based on the Prickett and Lonnquist model was chosen for application at the East Decker site. Modifications of the Prickett and Lonnquist model were developed to handle mutliple aquifers, merging aquifers, regions of confined and unconfined flow, and aquifer drainage into the mine cut, all conditions which would exist in the aquifer-mining environment.

Using the site data available, a simulation of the premining conditions was run in order to roughly calibrate the model for aquifer recharge. This simulation was followed by a simulation of the aquifer system with the first mine cut in place. The mining simulation produced realistic drawdowns in the affected aquifers, although no data existed that could be used to verify the results.

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Signature Ralph H. Engel

Date December 19, 1980

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by

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ABSTRACT

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Chapter I

INTRODUCTION

In the process of surface mining coal in the Northern Great Plains of the United States, large amounts of overburden and interburden material are stripped and moved to reach coal seams. As a result, groundwater aquifers that may exist in coal, overburden, and interburden are truncated, so that a mine cut can act as a very large groundwater sink for these aquifers. Should confined aquifers lie below a mine cut, they may also discharge into the cut by leaking through the material above them. The aquifer discharges will produce drawdowns that can dry up springs and wells some distance from a mine.

After the removal of coal, reclamation of mined-out areas is begun by backfilling old cuts with overburden and interburden materials (spoils) stripped from new, adjacent mine cuts. Thus, aquifers destroyed by mining are rebuilt with new materials that could have hydraulic properties differing from the original aquifer material. If the properties are significantly different, the lateral groundwater flow through a completely reclaimed mine site may be quite different from the flow in the original site. This could also hold true for the vertical flow of groundwater in a reclaimed mine.

A capability to predict the effects of mining on groundwater flow is desirable for several reasons. Estimation of aquifer discharge rates into a mine cut would be useful in planning for the pumping and treatment of mine water. A prediction of resulting drawdowns would indicate

what wells and springs might be adversely affected by a mine. In addition, a prediction of the quantity and depth of flow through spoils material would aid in predicting the degree of groundwater contamination by the spoils material, and in how deeply toxic spoils (i.e. spoils containing soluble metals, etc.) could be placed.

THESIS OBJECTIVE

The intent of this thesis is to produce a model capable of simulating flow in the saturated, shallow groundwater aquifer system surrounding the East Decker coal mine in southeastern Montana. The location of the mine is shown in Figures 1 and 2. The model should be capable of simulating flow before, during, and after mining. This includes the capacity to approximate the aquifer discharges into the mine cut and to estimate the aquifer drawdowns.

SCOPE OF WORK

The System to be Modeled

The aquifer system at East Decker contains several aquifers that will be significantly affected by mining and that must be included in the model. These include the three coal bed aquifers that are the object of mining, the clinker aquifers, and the alluvial aquifers that lie along the shore of the Tongue River Reservoir and through the valleys (Van Voast and Hedges, 1975; USGS, 1977). The clinker, alluvial, and coal aquifers, with their very different and variable hydraulic

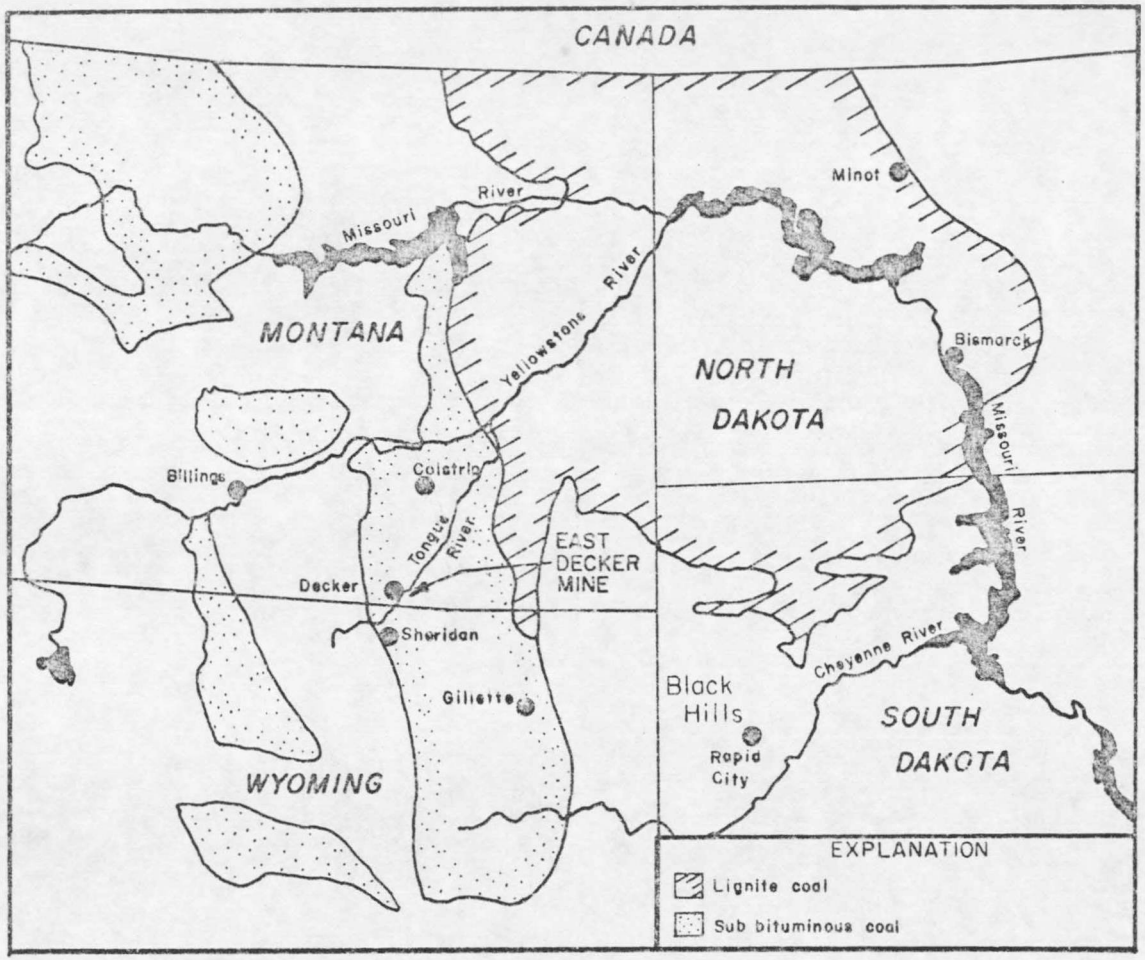

Fig. 1. Map of the Northern Great Plains coal fields showing the location of the East Decker mine in southeastern Montana (from Permack, 1973).