

8 ERID#:

8
7
4

88743

LOS ALAMOS NATIONAL LABORATORY
ENVIRONMENTAL RESTORATION (RRES-R)
Records Processing Facility
ER Records Index Form

Date Received: 6/8/2005

Processor:

Page Count: 7

Privileged: (Y/N) N

Record Category: P

Administrative Record: (Y/N) Y

FileFolder: N/A

Miscellaneous Comments: SUBMITTED BY P. LONGMIRE

Record Documents:

Start Pg	Doc Type	Doc Date	Title	Box	Package
1	COVER PAGE	10/15/1998	UNSATURATED GROUNDWATER FLOW BENEATH UPPER MORTANDAD CANYON LOS ALAMOS NEW MEXICO - AUTHORS DAVID DANDER WQH GROUP ESH-18 LOS ALAMOS NATIONAL LABORATORY LA-UR-98-4759 N/A N/A	1633	
3	TOC		TABLE OF CONTENTS RE: UNSATURATED GROUNDWATER FLOW BENEATH UPPER MORTANDAD CANYON LOS ALAMOS NEW MEXICO N/A N/A N/A		
4	ABSTRACT		ABSTRACT RE: UNSATURATED GROUNDWATER FLOW BENEATH UPPER MORTANDAD CANYON LOS ALAMOS NEW MEXICO N/A N/A N/A		
5	STATEMENT		STATEMENT BY AUTHOR RE: UNSATURATED GROUNDWATER FLOW BENEATH UPPER MORTANDAD CANYON LOS ALAMOS NEW MEXICO N/A N/A N/A		
7	ACKNOWLEDGMENT		ACKNOWLEDGMENTS RE: UNSATURATED GROUNDWATER FLOW BENEATH UPPER MORTANDAD CANYON LOS ALAMOS NEW MEXICO N/A N/A N/A		



14255

LA-UR-98-4759

c.1

Title:

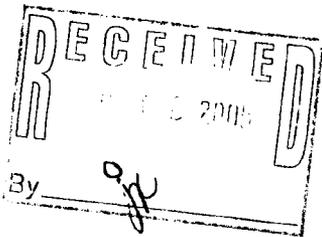
Unsaturated Groundwater Flow
beneath Upper Mortandad Canyon,
Los Alamos, New Mexico

Author(s):

David Carl Dander
Water Quality and Hydrology Group,
ESH-18,
Los Alamos National Laboratory

October 15, 1998

Submitted to:



Los Alamos
NATIONAL LABORATORY

Los Alamos National Laboratory, an affirmative action/equal opportunity employer, is operated by the University of California for the U.S. Department of Energy under contract W-7405-ENG-36. By acceptance of this article, the publisher recognizes that the U.S. Government retains a nonexclusive, royalty-free license to publish or reproduce the published form of this contribution, or to allow others to do so, for U.S. Government purposes. The Los Alamos National Laboratory requests that the publisher identify this article as work performed under the auspices of the U.S. Department of Energy.

Form No. 836 R5
ST 2829 10/91

**UNSATURATED GROUNDWATER FLOW
BENEATH UPPER MORTANDAD CANYON,
LOS ALAMOS, NEW MEXICO**

by

David Carl Dander

A Thesis Submitted to the Faculty of the
DEPARTMENT OF HYDROLOGY AND WATER RESOURCES

In Partial Fulfillment of the Requirements

For the Degree of

MASTER OF SCIENCE

WITH A MAJOR IN HYDROLOGY

In the Graduate College

THE UNIVERSITY OF ARIZONA

1998

TABLE OF CONTENTS

<u>STATEMENT BY AUTHOR</u>	2
<u>ACKNOWLEDGMENTS</u>	3
<u>TABLE OF CONTENTS</u>	4
<u>LIST OF ILLUSTRATIONS</u>	6
<u>LIST OF TABLES</u>	10
<u>ABSTRACT</u>	11
<u>1. INTRODUCTION</u>	12
1.1. INTRODUCTION.....	12
1.2. OBJECTIVES AND SCOPE OF WORK.....	18
<u>2. SITE DESCRIPTION</u>	20
2.1. LOCATION AND PHYSIOGRAPHY.....	20
2.2. CLIMATE.....	21
2.3. VEGETATION.....	21
2.4. LAND USE.....	22
2.5. PHOTOGRAPHS	23
<u>3. HYDROGEOLOGY</u>	32
3.1. GEOLOGIC SETTING.....	32
3.2. GEOLOGIC UNITS.....	32
3.3. MATERIAL PROPERTIES.....	38
3.4. HYDROGEOLOGIC LONGITUDINAL SECTION.....	47
3.5. HYDROLOGY	51
3.5.1. Surface Water	51
3.5.2. Groundwater.....	52
3.6. WATER BUDGET.....	52
<u>4. NUMERICAL FLOW MODEL</u>	59
4.1. INTRODUCTION.....	59
4.2. SIMULATION CODE	59
4.3. CODE OPTIONS USED.....	63
4.4. BOUNDARY CONDITIONS.....	67
4.5. FINITE ELEMENT GRIDS	70
<u>5. SIMULATION APPROACH, RESULTS, AND DISCUSSION</u>	71
5.1. MODELING APPROACH.....	71
5.2. VERTICAL RECTANGULAR GRID NUMBER 1, SIMULATION 1	76
5.3. TILTED RECTANGULAR GRID NUMBER 2, SIMULATION 2	84
5.4. FIRST REFINED TILTED RECTANGULAR GRID NUMBER 3, SIMULATION 3	93
5.5. SECOND REFINED TILTED RECTANGULAR GRID NUMBER 4, SIMULATION 4	108
5.6. GRID NUMBER 3 WITHOUT BASALT, SIMULATION 5.....	110
5.7. VARYING UPPER BOUNDARY FLUX WITH GRID NUMBER 3	112
5.7.1. Variations in Recharge Magnitude Simulations 6-9.....	112
5.7.2. Variations in Recharge Magnitude with Respect to Horizontal Position, Simulations 10 and 11	128

5.8. MORTANDAD CANYON GRID NUMBER 5, SIMULATION 12.....	132
5.9. COMPARISON OF MODELED AND FIELD DATA	147
<u>6. CONCLUSIONS</u>	152
6.1. CONCLUSIONS	152
6.2. RECOMMENDATIONS FOR FUTURE WORK	154
<u>APPENDIX A: INPUT FILES</u>	156
<u>APPENDIX B: LIST OF SYMBOLS</u>	160
<u>REFERENCES</u>	161

ABSTRACT

Mortandad Canyon is a discharge site for treated industrial effluents containing radionuclides and other chemicals at Los Alamos National Laboratory, New Mexico. This study was conducted to develop an understanding of the unsaturated hydrologic behavior below the canyon floor. The main goal of this study was to evaluate the hypothetical performance of the vadose zone above the water table. Numerical simulations of unsaturated groundwater flow at the site were conducted using the Finite Element Heat and Mass Transfer (FEHM) code. A two-dimensional cross-section along the canyon's axis was used to model flow between an alluvial groundwater system and the regional aquifer approximately 300 m below. Using recharge estimated from a water budget developed in 1967, the simulations showed waters from the perched water table reaching the regional aquifer in 13.8 years, much faster than previously thought. Additionally, simulations indicate that saturation is occurring in the Guaje pumice bed and that the Tshirege Unit 1B is near saturation. Lithologic boundaries between the eight materials play an important role in flow and solute transport within the system. Horizontal flow is shown to occur in three thin zones above capillary barriers; however, vertical flow dominates the system. Other simulations were conducted to examine the effects of changing system parameters such as varying recharge inputs, varying the distribution of recharge, and bypassing fast-path fractured basalt of uncertain extent and properties. System sensitivity was also explored by changing model parameters with respect to size and types of grids and domains, and the presence of dipping stratigraphy.

STATEMENT BY AUTHOR

This thesis has been submitted in partial fulfillment of requirements for an advanced degree at The University of Arizona and is deposited in the University Library to be made available to borrowers under rules of the Library.

Brief quotations from this thesis are allowable without special permission, provided that accurate acknowledgment of source is made. Requests for permission for extended quotation from or reproduction of this manuscript in whole or in part may be granted by the head of the major department or the Dean of the Graduate College when in his or her judgment the proposed use of the material is in the interests of scholarship. In all other instances, however, permission must be obtained from the author.

SIGNED: _____

APPROVAL BY THESIS DIRECTORS

This thesis has been approved on the date shown below:

<p style="text-align: center;">Dr. James E. Smith Adjunct Assistant Professor of Hydrology and Water Resources</p>	<p style="text-align: center;">Date</p>
<p style="text-align: center;">Dr. Thomas Maddock III. Professor of Hydrology and Water Resources</p>	<p style="text-align: center;">Date</p>

ACKNOWLEDGMENTS

Funding for this research was provided by Los Alamos National Laboratories (LANL's) Water Quality and Hydrology Group, ESH-18 with some assistance by a partial Graduate Research Fellowship granted from Associated Western Universities.

Thesis committee members who provided much appreciated assistance, guidance, and knowledge included Dr. David B. Rogers of LANL; Dr. James Smith and Dr. Thomas Maddock III. of the UA Department of Hydrology and Water Resources; and Dr. Arthur Warrick of UA Department of Soil, Water and Environmental Sciences.

Many members of LANL's Geoanalysis Group, EES-5, provided greatly appreciated help and assistance in using their own Finite Element Heat and Mass Transfer Code (FEHM) which was used extensively in this study.

Secretarial and administrative assistance from both LANL and UA are also appreciated, thanks. And finally, thanks to friends and family for support.

<u>Contributors</u>	<u>Affiliation</u>	<u>Summary of Contribution</u>
James Smith	UA, HWR	Thesis supervisor, committee member
Thomas Maddock III	UA, HWR	Academic supervisor, committee member
Arthur Warrick	UA, SWES	Thesis committee member
David Rogers	LANL, ESH-18	Research advisement/supervisor, committee member
Steve Rae	LANL, ESH-18	Funding arrangements
Bruce Gallaher	LANL, ESH-18	Funding arrangements, Hydrology guidance
Steve McLin	LANL, ESH-18	Hydrology guidance
Ernestine Martinez	LANL, ESH-18	Clerical assistance
Chris McLean	LANL, ESH-18	Computing and editorial assistance
Ramon Naranjo	LANL, ESH-18	Technical and editorial assistance
Larry Pratt	LANL, ESH-18	Technical and editorial assistance
William Turney	LANL, ESH-18	Technical and editorial assistance
Bill Purtymun	LANL, ESH-18	Research and x-section development assistance
Carl Gable	LANL, EES-5	Grid, code output, and FEHM assistance
Katherine Birdsell	LANL, EES-5	Hydrology and modeling knowledge
Andy Wolfsburg	LANL, EES-5	FEHM code support, Modeling guidance
George Zyvolski	LANL, EES-5	FEHM code support
Bruce Robinson	LANL, EES-5	FEHM code support
Lynn McDonald	LANL, EES-5	Computing assistance
Phil Stauffer	LANL, EES-5	FEHM code support, Modeling guidance
Daniel Tartakovsky	LANL, EES-5	Grid and modeling assistance
Guy Romer	LANL, EES-5	FEHM code support, Modeling guidance
Alan Stoker	LANL, SAIC	Research and x-section development assistance
Richard Koch	LANL, SAIC	Research and x-section development assistance
Patrick Longmire	LANL, CST-7	Research and cross-section development assistance
David Broxton	LANL, EES-1	Research and cross-section development assistance
Josh Smith	LANL, CST-DO	Technical editing and illustration assistance
Corrie Thies	UA, HWR	Editing Assistance
Terrie Thompson	UA, HWR	Academic Advisement and Clerical assistance
Carol Johnson	Friend, PC support	Assistance with home computing problems
Robert & Carla Dander	Parents, family	Financial assistance, use of computer/other resources