1R – 428 - 41

WORK PLAN

DATE:
04-09-2007

1R428-41
Work Plan
April 9, 2007

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Environmental Bureau
Oil Conservation Division

Corrective Action Plan

I-29 Vent Site

Section 29, T18S, R 38E

NMOCD Case #: 1-R0428-41

Prepared for:

Rice Operating Company
122 West Taylor
Hobbs, NM 88240

R.T. Hicks Consultants, Ltd.
901 Rio Grande Blvd. NW, Suite F-142,
Albuquerque, NM 87104

R. T. HICKS CONSULTANTS, LTD.

901 Rio Grande Blvd NW ▲ Suite F-142 ▲ Albuquerque, NM 87104 ▲ 505.266.5004 ▲ Fax: 505.266-0745

April 12, 2007

Mr. Wayne Price
Environmental Bureau Chief
New Mexico Oil Conservation Division
1220 South St. Francis Drive
Santa Fe, New Mexico 87505

RE: NMOCD Case # 1R0428-41, I-29 Vent
Hobbs SWD System Abandonment
Corrective Action Plan

Dear Mr. Price:

On behalf of Rice Operating Company, R.T. Hicks Consultants, Ltd. is pleased to submit the attached Corrective Action Plan for the I-29 Vent site. This plan presents characterization activities, evaluations and conclusions as well as a proposal for closure of the site after the selected remedy is implemented.

If you have any questions or concerns, please do not hesitate to contact us.

Sincerely,
R.T. Hicks Consultants, Ltd.

Katie Lee

Katie Lee
Staff Scientist

Copy: Rice Operating Company
Hobbs NMOCD Office

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1.0 INTRODUCTION

The I-29 Vent, located west of Hobbs, New Mexico, in section 29, T18S, R38E, was a junction box in the Hobbs Salt Water Disposal (SWD) system, which disposed of produced water from the late 1950s until 2002, when the system was closed. Future impacts from the system are not possible. With the abandonment of the system in 2002, Rice Operating Company (ROC) excavated and removed the SWD I-29 Vent and the uppermost 5–10 feet of the vadose zone. At the time of investigation, the excavation was filled with a mixture of sand-clay-caliche. Activities at the site followed the NMOCD-approved workplan (August 6, 2004).

This Corrective Action Plan presents:

1) A description of the characterization activities performed by R.T. Hicks Consultants (Hicks Consultants) and Rice Operating Company (ROC) at the I-29 Vent site located in the Hobbs SWD,

2) Evaluation and conclusions drawn from activities performed,

3) A proposal for closure of the site after the selected remedy is implemented.

2.0 WORK ELEMENTS PERFORMED

Detailed descriptions of characterization activities are provided in Appendix A. Appendix B shows the results of field chloride measurements. Plate 1 is an aerial photograph of the site when it was active, taken between 1996 and 1998, showing the locations of the boring and background boring.

Activities included:

1. I-29 soil boring characterization.

2. Background soil boring characterization.

3. Field measurements consisting of chloride titration and PID readings for volatiles.

4. Submission of two selected soil samples for laboratory analysis in accordance with the workplan.

5. Completion of the soil boring as a monitoring well.
6. HYDRUS-1D simulation of the site.
7. Quarterly monitoring of ground water at the site from December, 2004, to the present day.
8. Development of a corrective action plan.

3.0 CONCLUSIONS

3.1 ACTIVITIES AT THE I-29 VENT HAVE NOT CAUSED COCs TO REACH GROUND WATER.

From chloride concentration and PID measurement profiles (confirmed by laboratory analysis), Hicks Consultants concludes that saturated conditions between the surface and ground water never developed and that constituents of concern (COCs) reside in the upper two-thirds of the vadose zone. Ground water monitoring also shows that ground water remains unimpaired and that activities at this site have not caused COCs to reach ground water.

3.2 CHLORIDE CONCENTRATIONS WILL NOT EXCEED WQCC GROUND WATER STANDARDS.

Using highly conservative input data, HYDRUS-1D modeling of the vadose zone chlorides predicts that resulting ground water chloride concentrations will be below the 250 ppm Water Quality Control Commission (WQCC) secondary drinking water standard. At a nearby background monitoring well, over four years of data show that chloride concentration ranges from 111 mg/L to 301 mg/L, with an average concentration of 159 mg/L. The predicted chloride concentration increase at the I-29 site (42 mg/L) could not be differentiated from natural vegetation. The model inputs and methodology are discussed in Appendix C.

3.3 THE SITE PRESENTS NO THREAT TO FRESH WATER, PUBLIC HEALTH OR THE ENVIRONMENT.

Ground water quality exhibits background levels of chloride concentrations and no detection of hydrocarbons. Because residual petroleum hydrocarbons and chloride are not present in sufficient concentration or sufficient mass, Hicks Consultants concluded

that the site represents no threat to fresh water, public health, or the environment (see discussion in Appendix A and Appendix C).

4.0 RECOMMENDATION

Hicks Consultants recommends that ROC create an infiltration barrier through re-vegetation of the ground surface at the I-29 Vent site. This remedy is protective of ground water quality, human health, and the environment. Upon documentation of this action, a closure report/request will be submitted to NMOCD.

ROC will leave the monitoring well in place pending investigation of other Section 29 sites.

Plates

Aerial Photo: http://rgis.unm.edu

0 500 1,000 2,000 3,000 4,000 Feet

R.T. Hicks Consultants, Ltd 901 Rio Grande Blvd NW Suite F-142 Albuquerque, NM 87104 Ph: 505.266.5004	2004 Aerial Photograph showing the I-29 Vent Site	Plate 1
	Rice Operating Company : I-29 Vent Site (NMOCD#: 1R0428-41)	February 2007

N
W E
S

Logger:	David Hamilton / Mort Bates	**Client:**	**Well ID:**
Driller:	Eades Drilling (0-62 feet) / Atkins Engineering (60-75	Rice Operating Company	
Drilling	Air Rotary / Hollow Stem Auger	**Project Name:**	
Start Date:	11/4/2004 / 11/12/2004	Hobbs I-29 Vent	
End Date:	11/4/2004 / 11/12/2004	**Location:**	**I-29 Vent MW**
		T18S R38E	
		Section 29, Unit I	

Depth (feet)	Description	Lithology	Comments	Well Construction	Field data: Depth ft.	Chloride mg/kg	PID ppm
0.0	Surface, light tan, 0-1 feet			Cement, 4 inches thick			
2.0	Caliche, sand, tan, 1-8 feet						
4.0							
6.0			Some odor		6.0	205	2.9
8.0	Caliche, sand, silt, 8-17 feet						
10.0					11.0		24.6
12.0							
14.0							
16.0	Well indurated caliche, 17-19 feet				16.0	366	202.0
18.0	Caliche, sand, silt, 19-20 feet						
20.0	Very well indurated caliche, 20-22 feet				20.0	423	504.0
22.0	Very fine grained sand silt, yellow-tan, 22-29 feet		Odor				
24.0							
26.0				Grout, 0.3-54 feet	26.0	512	1049.0
28.0	Very fine grained sand silt, reddish-tan, 29-34 feet						
30.0					31.0	454	26.3
32.0							
34.0	Caliche, sand, 34-35 feet						
36.0	V. f.grained sand silt, reddish-tan, 35-38 feet				36.0	374	10.2
38.0	Caliche, 38-38.75 feet		Hard drilling				
40.0	Very fine grained sand silt, reddish-tan, 38.75-46 feet				41.0	209	7.8
42.0							
44.0							
46.0	Sand silt, some caliche, 46-51 feet				46.0	284	17.3
48.0							
50.0	Very fine grained sand silt, reddish-tan, 51-60 feet				51.0	123	5.7
52.0							
54.0				Bentonite, 54-57 feet	56.0	85	6.9
56.0							
58.0							
60.0	Silty sands with broken sandstone, tan, dry, 60-65 feet		Dry		61.0	56	7.4
62.0							
64.0							
66.0	Silty fine sand,loose,tan, wet, 65-75 feet		Wet	12/20 Silica sand, 57-75 feet. 0.010 Slot Screen, 60-75 feet			
68.0							
70.0							
72.0							
74.0							

2 inch Sch. 40 PVC Casing

R.T. Hicks Consultants, Ltd
901 Rio Grande Blvd NW Suite F-142
Albuquerque, NM 87104
505-266-5004

Hobbs I-29 Vent Site

Monitoring Well Boring

Plate 2

April 2007

HYDRUS-1D Vadose Zone Soil Profile	Client: Rice Operating Company Project Name: I-29 Vent	Location: T18S R38E Section 29

Depth (feet)	Description	Model Profile	Depth (feet)
0.0	Sandy loam 0-1 feet		0.0
2.0	Loamy sand, 1-19 feet		2.0
4.0			4.0
6.0			6.0
8.0			8.0
10.0			10.0
12.0			12.0
14.0			14.0
16.0			16.0
18.0	Sand, silt 19-20feet		18.0
20.0	Caliche, 20-22 feet		20.0
22.0	Sand, silt 22-34 feet		22.0
24.0			24.0
26.0			26.0
28.0			28.0
30.0			30.0
32.0			32.0
34.0	Caliche, 34-35 feet		34.0
36.0	Sand, silt, 35-45 feet		36.0
38.0			38.0
40.0			40.0
42.0			42.0
44.0	Sand , caliche, 45-47 feet		44.0
46.0	Sand, silt, 47-60 feet		46.0
48.0			48.0
50.0			50.0
52.0			52.0
54.0			54.0
56.0			56.0
58.0			58.0
60.0			60.0

R.T. Hicks Consultants, Ltd 901 Rio Grande Blvd NW Suite F-142 Albuquerque, NM 87104 505-266-5004	I-29 Vent Site	Plate 3 April, 2007

Details of Characterization Activities At the I-29 Vent Site

Appendix A

APPENDIX A

1) I-29 SOIL BORING CHARACTERIZATION

The boring at the I-29 Vent site was drilled in November, 2004, to a depth of 75 feet within the capillary fringe at the site. Plate 2 illustrates the lithology and distribution of constituents of concern.

From 0-35 feet bgs, the split spoon obtained samples at 5-foot intervals. The dry and unconsolidated nature of the sand-silt from 35–60 feet bgs caused loss of split spoon samples during retrieval. In the interval between 35 feet bgs and 60 feet bgs, samples were collected from cuttings. This is the only material deviation from the NMOCD-approved workplan. Moist soil was observed at 61 feet bgs and depth to ground water was estimated at approximately 63 feet bgs. The boring was completed as a monitoring well.

2) BACKGROUND SOIL BORING CHARACTERIZATION

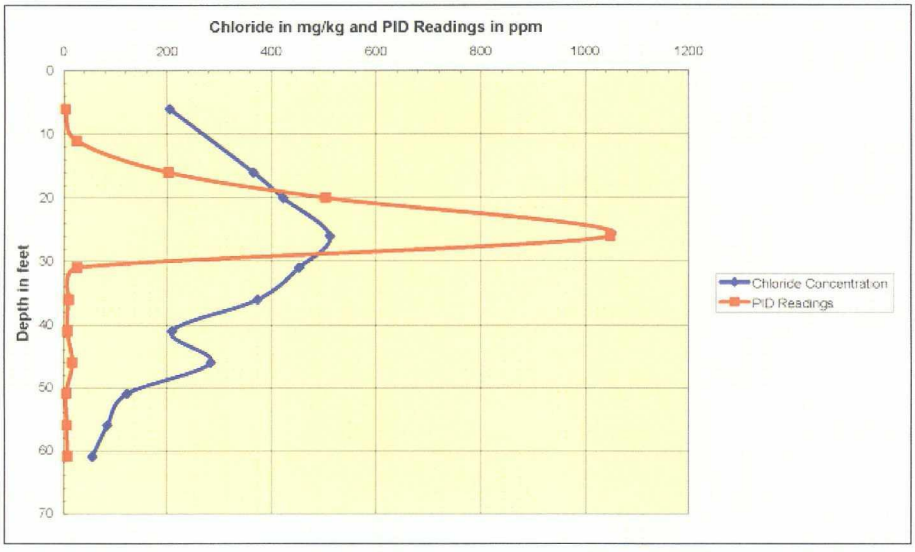
Samples taken from a background boring located about 2,000 feet northwest of the site show that background chloride concentrations in the area are approximately 80 ppm. Appendix B presents the field data from this boring.

3) FIELD MEASUREMENTS

ROC took field measurements from each 5-foot sampling interval for chloride and volatiles in the field using the heated headspace method to measure total organic vapors by photoionization detector (PID). Samples were submitted to a laboratory from depths showing the highest field chloride and PID measurements (26 feet bgs) and from the capillary fringe (61 feet bgs); see Figure A-1. Plate 2 is a lithologic log of the boring with field chloride concentrations and PID measurements. Appendix B provides additional chemical data for the soil samples.

The maximum chloride concentration in the soil is 512 ppm at 26 feet bgs and chloride declines with depth, as shown by Figure A-1.

Figure A-1: Chloride Concentrations and PID Readings From Soil Boring Samples, I-29 Vent Site, November 4, 2004



Chloride concentrations reach approximate background levels (about 80 ppm) at a depth of 51 feet bgs. Field evidence demonstrates that the chloride mass resides in the upper two-thirds of the vadose zone.

PID readings follow a pattern similar to that of chloride, peaking at 26 feet bgs with 1049 ppm total organic vapors, and reaching background concentrations below 36 feet bgs.

Laboratory analysis of the soil sample from 26 feet bgs showed benzene, toluene, ethylbenzene, and zylene (BTEX) are present in total aggregate concentratins below 50 ppm (see Table A-1).

Table A-1: Laboratory Analysis Results of Samples From the I-29 Boring.

SWD B-5 (I-29 Vent), November, 2004				
Constituent of Concern	26 ft. bgs	65 ft. bgs	Detection Limit	NMED Screening Guideline October, 2006
	mg/kg (dry)			
Benzene	0.0531	ND	0.025	0.0201
Toluene	0.311	ND		21.7
Ethyl benzene	0.546	ND		20.2
Xylene (p/m)	1.58	ND		81.4
Xylene (o)	0.245	ND		2.06

BTEX was not detected in field laboratory analysis of the soil sample from the capillary fringe (61 feet bgs).

4) GROUND WATER MONITORING

As Table A-2 shows, quarterly monitoring since December, 2004, indicates that activities at the site have not adversely impacted ground water.

Table A-2: Quarterly Ground Water Data From the I-29 Vent Site

Date	Chloride	Sulfate	TDS	Benzene	Toluene	Ethyl Benzene	Total Xylenes
	(mg/L)						
12/2/2004	103	97.7	521	ND	ND	ND	ND
3/21/2005	116	96.6	617	ND	ND	ND	ND
5/19/2005	104	89.7	647	ND	ND	ND	ND
8/9/2005	97.7	87.5	538	ND	ND	ND	ND
11/1/2005	82.7	68	600	ND	ND	ND	ND
1/31/2006	83.1	59.6	508	ND	ND	ND	ND
5/2/2006	102	69.6	572	ND	ND	ND	ND
8/14/2006	98.9	65.9	526	ND	ND	ND	ND
10/31/2006	100	80.3	454	ND	ND	ND	ND
2/3/2006	132	96.4	504	ND	ND	ND	ND

"ND" (non-detect) indicates a concentration that is below detection limits.

Field Measurements & Laboratory Results For Soil Samples

Appendix B

I-29 Vent

Soil Bore

System: Hobbs Location: Vent I-29 GW: Landowner:

Soil Bore: Vent I-29 GPS: Coord. System UTM 13 671919 E

ULI Sec. 29 T 18 R 38 Map Datum Nad83 3621379 N

Depth	Cl.	PID	Color	Time
6'	205	2.9	Tan caliche with rocks	
11'		24.6	white caliche	
16'	366	202	Tan caliche some sand	
20'	423	504	" "	
26'	512	1049	Tan caliche strong smell	10:20
31'	454	26.3	Tan caliche a little "	
36'	374	10.2	" " "	
41'	209	2.8	Red sand & caliche	
46'	284	17.3	" "	
51'	123	5.7	Red sand	
56'	85	6.9	" "	
61'	56	7.4	" with Rock "	11:24
			some moisture	

Notes: Ground water around 62- Maybe. Took pictures @ bore

Signature [signature] Date 11/4/04

COPY

Soil Bore

System: Hobbs Location: Vent I-29 GW: 62' Landowner: OXY

Soil Bore: M.W. #1 Vent I-29 GPS: Coord. System UTM 13 · 671919 E

UL/I Sec. 29 T 18 R 38 Map Datum Nad83 3621329 N

Depth	Cl.		PID		Color	Time
60	Spoon Sampled @		11-4-04			
65-67	62		0.4		Fine silty SAND	0918.

Notes: Bore Down to 65' split Spoon, sample 67' very moist PID, Field Cl⁻ TEST. Bored down to 25' ck water Lvl @ 67.3 Allowed to set 15 min, GW @ 67.3 ck TD @ 73' Set Screen .010 @ 10' BGW & 5' AGW set Sand, set Ping Bentonite mix Grout. Developed well after Set up

Signature Doug R Rasem Date 11-12-04

COPY

Rice Operating Co.	Project: Vent I-29	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	Reported:
Hobbs NM, 88240	Project Manager: Roy Rascon	11/15/04 16:40

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
SB @ 26'	4K10008-01	Soil	11/04/04 10:20	11/10/04 07:50
SB @ 61'	4K10008-02	Soil	11/04/04 11:24	11/10/04 07:50

12600 West I-20 East - Odessa, Texas 79765 - (432) 563-1800 - Fax (432) 563-1713

Rice Operating Co.	Project: Vent I-29	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	Reported:
Hobbs NM, 88240	Project Manager: Roy Rascon	11/15/04 16:40

Organics by GC

Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Note
SB @ 26' (4K10008-01) Soil									
Benzene	**0.0531**	0.0250	mg/kg dry	25	EK41203	11/11/04	11/12/04	EPA 8021B	
Toluene	**0.311**	0.0250	"	"	"	"	"	"	
Ethylbenzene	**0.546**	0.0250	"	"	"	"	"	"	
Xylene (p/m)	**1.58**	0.0250	"	"	"	"	"	"	
Xylene (o)	**0.245**	0.0250	"	"	"	"	"	"	
Surrogate: a,a,a-Trifluorotoluene		*174 %*	*80-120*		"	"	"	"	*S-04*
Surrogate: 4-Bromofluorobenzene		*112 %*	*80-120*		"	"	"	"	
Gasoline Range Organics C6-C12	**277**	10.0	mg/kg dry	1	EK40906	11/10/04	11/11/04	EPA 8015M	
Diesel Range Organics >C12-C35	**468**	10.0	"	"	"	"	"	"	
Total Hydrocarbon C6-C35	**745**	10.0	"	"	"	"	"	"	
Surrogate: 1-Chlorooctane		*76.8 %*	*70-130*		"	"	"	"	
Surrogate: 1-Chlorooctadecane		*79.8 %*	*70-130*		"	"	"	"	
SB @ 61' (4K10008-02) Soil									
Benzene	ND	0.0250	mg/kg dry	25	EK41501	11/12/04	11/12/04	EPA 8021B	
Toluene	ND	0.0250	"	"	"	"	"	"	
Ethylbenzene	ND	0.0250	"	"	"	"	"	"	
Xylene (p/m)	ND	0.0250	"	"	"	"	"	"	
Xylene (o)	ND	0.0250	"	"	"	"	"	"	
Surrogate: a,a,a-Trifluorotoluene		*92.4 %*	*80-120*		"	"	"	"	
Surrogate: 4-Bromofluorobenzene		*103 %*	*80-120*		"	"	"	"	
Gasoline Range Organics C6-C12	ND	10.0	mg/kg dry	1	EK40906	11/10/04	11/11/04	EPA 8015M	
Diesel Range Organics >C12-C35	ND	10.0	"	"	"	"	"	"	
Total Hydrocarbon C6-C35	ND	10.0	"	"	"	"	"	"	
Surrogate: 1-Chlorooctane		*85.2 %*	*70-130*		"	"	"	"	
Surrogate: 1-Chlorooctadecane		*97.8 %*	*70-130*		"	"	"	"	

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RICE OPERATING
HOBBS, NM

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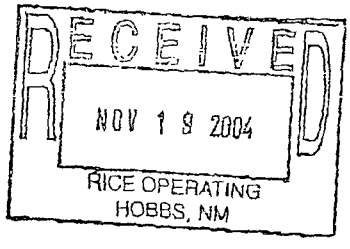
Rice Operating Co.	Project: Vent I-29	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	Reported:
Hobbs NM, 88240	Project Manager: Roy Rascon	11/15/04 16:40

General Chemistry Parameters by EPA / Standard Methods
Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
SB @ 26' (4K10008-01) Soil									
Chloride	404	20.0	mg/kg Wet	2	EK41209	11/10/04	11/11/04	SW 846 9253	
% Moisture	6.0		%	1	EK41101	11/10/04	11/11/04	% calculation	
SB @ 61' (4K10008-02) Soil									
Chloride	ND	20.0	mg/kg Wet	2	EK41209	11/10/04	11/11/04	SW 846 9253	
% Moisture	4.0		%	1	EK41101	11/10/04	11/11/04	% calculation	



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Soil Bore

System: Hobbs Location: GW: 62' Landowner:

Soil Bore: Background bore GPS. Coord. System UTM 13 671407 E

UL F Sec. 29 T 18 R 38 Map Datum Nad83 3621969 N

Depth	Cl.		PID		Color	Time
5'	127		1.0		Dark brown	
6'	107		.7		white caliche	
11'	121		0.5		white caliche	
16'	80		1.0		" "	
21'	51		4.3		" "	
26'	111		2.8		white caliche & brown sand	
31'	52		5.9		caliche with sand	
37'	56		3.3		red fine caliche sandy	
42'	20		4.7		Brown sand	
46'	106		3.4		" "	
51'	77		2.9		" "	
56'	57		4.3		" "	
61'	55		5.8		light brown sand	9:50
					Some moisture	

Notes: 4.4 ground water @ 62'. Took pictures of bore

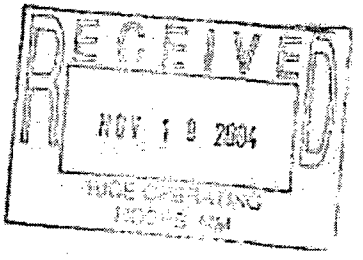
Signature [illegible] Date 11/?/04

COPY

Rice Operating Co.	Project: Background Bore	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	Reported:
Hobbs NM, 88240	Project Manager: Kristan Pope	11/12/04 16:02

General Chemistry Parameters by EPA / Standard Methods
Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
SB @ 61 ft (4K10006-01) Soil									
Chloride	ND	20.0	mg/kg Wet	2	EK41209	11/10/04	11/11/04	SW 846 9253	



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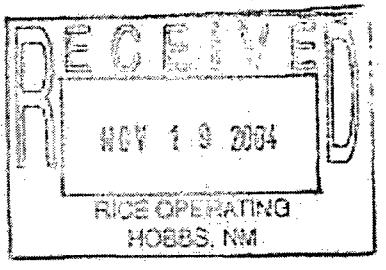
Rice Operating Co.	Project: Background Bore	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	Reported:
Hobbs NM, 88240	Project Manager: Kristin Pope	11/12/04 16:02

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
SB @ 61 ft	4K10006-01	Soil	11/03/04 00.00	11/10/04 07:50



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Modeling Input Parameters & Results

Appendix C

APPENDIX C

To model the impact of the vadose zone remedy on ground water at the I-29 Vent site, output from HYDRUS-1D is used as input to a ground water mixing model.

HYDRUS-1D modeling simulates water and chloride fluxes through the vadose zone. The HYDRUS-1D output becomes the input to a simple ground water mixing model to predict chloride concentration in a simulated monitoring well immediately down-gradient of the site. Section 3.0 of "Modeling Study of Produced Water Release Scenarios" (Hendrickx, et al., 2005) provides a general description of this modeling approach (see the Works Consulted section at the end of this document).

The observed vadose zone chloride profile was installed in the model. The present chloride load within the soil profile is the result of all previous activities at the site and is based upon field observation and analysis producing the most accurate modeling approach.

INPUT DATA:

Modeling inputs for the I-29 Vent site are presented in Table C-1.

Table C-1: I-29 HYDRUS-1D and Mixing Model Input Parameters

Input Parameter	Source
Vadose zone thickness - 60 feet	I-29 field data and professional judgement
Vadose zone texture (Plate 3)	I-29 field data
Dispersion length: <6% of model length	Professional judgement
Climate	2004 Hobbs, NM, data and Pearl Weather Station data
Soil moisture	HYDRUS-1D initial condition simulation
Initial soil chloride concentration profile	From ROC field measurements
Length of release parallel to ground water flow: 20 feet	Field measurement
Background chloride in ground water: 100 ppm	Chemical analysis
Ground water flux: 8.6 cm/day	Calculated from published data
Aquifer thickness: 10 feet	Conservative choice

SOIL PROFILE

The I-29 Vent model has a vadose zone soil profile constructed from the lithologic logs of the I-29 Vent boring and five other borings in Section 29. The model's soil profile is representative of a soil profile excavated to a depth of 19 feet bgs. Although the I-29 Vent site was not excavated to this great a depth, this choice is conservative of ground water quality in that the upper 19 feet of the model's soil profile have been replaced with materials featuring equal or greater hydraulic conductivities than the materials at the I-29 Vent site (See Plate 3).

Vadose zone thickness is about 67 feet at the I-29 Vent site. The model uses a thickness of 60 feet. The effect of this difference is to reduce time of transit of infiltrated water through the vadose zone.

DISPERSION LENGTHS

Because of Hicks Consultants' recent experience with similar soils conservative dispersion lengths were employed. Standard practice calls for employing a dispersion length that is 10% of the model length. For each lithologic unit identified in Plate 3, a dispersion length less than 6% of the model thickness was installed (Table C-2 presents the dispersion lengths for each lithology).

Table C-2: I-29 Dispersion Lengths

I-29 Hydrus-1D Soil Profile Properties				
Material	Description	Length (cm)	Dispersion (cm)	% of Profile Length
1	Sandy loam	30	50	2.78
2	Caliche-sand	60	30	1.67
3	Caliche	90	10	0.56
4	Sand-silt	1070	100	5.56
5	Loamy sand	550	100	5.56

CLIMATE

Weather data used in the predictive modeling include Hobbs data from November, 2003, to December, 2004, plus an additional 45 years from the Pearl Weather Station, approximately 11 miles west of the Hobbs Airport. The Pearl Weather Station is the closest station to the I-29 Vent site with sufficiently complete weather data for the HYDRUS-1D input files.

SOIL MOISTURE

An initial soil moisture condition was obtained running a HYDRUS-1D simulation for 45 years using the weather data from the Pearl Weather Station. Because soils are relatively dry in this climate and vadose zone hydraulic conductivity varies with moisture content, it is important that simulation experiments of different remedial strategies begin with an initial "steady state" soil moisture content. Vegetation was not allowed in order to create a "wetter" initial condition. This choice is conservative of ground water quality in that "wetter" soils have greater hydraulic conductivities.

The calculation of soil moisture content begins with an initial soil moisture input estimated by professional judgment. Then, sufficient years of weather data are run through the model to establish a "steady state" moisture content. Because only minimal changes in the HYDRUS-1D soil moisture content profile occurred after year 30 of the initial condition calculation, a 45 year simulation was considered acceptable to establish the initial moisture condition. Soil profiles hydrated in this manner were used in all simulations of chloride movement.

INITIAL CHLORIDE PROFILE

From the observed field data generated by ROC personnel, linearly interpolated chloride concentrations were assigned to the model's more finely spaced nodes of the hydrated soil profile.

MIXING MODEL INPUTS:

INFLUENCE DISTANCE

As the vent was oriented vertically, the affected surface area is small. Significant lateral impacts were not observed; therefore, the affected diameter of the site parallel to ground water flow was concluded to be less than or equal to 20 feet.

BACKGROUND CHLORIDE CONCENTRATION

From nearby well data, a value of 100 mg/L chloride for ground water was used for the predictive modeling.

HYDRAULIC CONDUCTIVITY

Hicks Consultants believes that the hydraulic conductivity of the saturated zone at the I-29 Vent site is similar to that observed for the Ogallala Aquifer throughout the general area. McAda (1984) simulated water level declines using a two-dimensional digital model and employed hydraulic conductivity values of 51–75 feet/day (1.9 E-4 to 2.8 E-4 m/s) in the area. According to Freeze and Cherry (1979), these values correspond to clean sand, which agrees with nearby lithologic descriptions of the saturated zone. A value of 45 feet/day was assumed for hydraulic conductivity of the uppermost saturated zone to be conservative of ground water quality.

GROUNDWATER GRADIENT

A hydraulic gradient of 0.0063 was calculated for this site (Intera Report and USGS Topographic Map). Using a hydraulic conductivity of 45 ft/day, ground water flux is calculated as 8.6 cm/day.

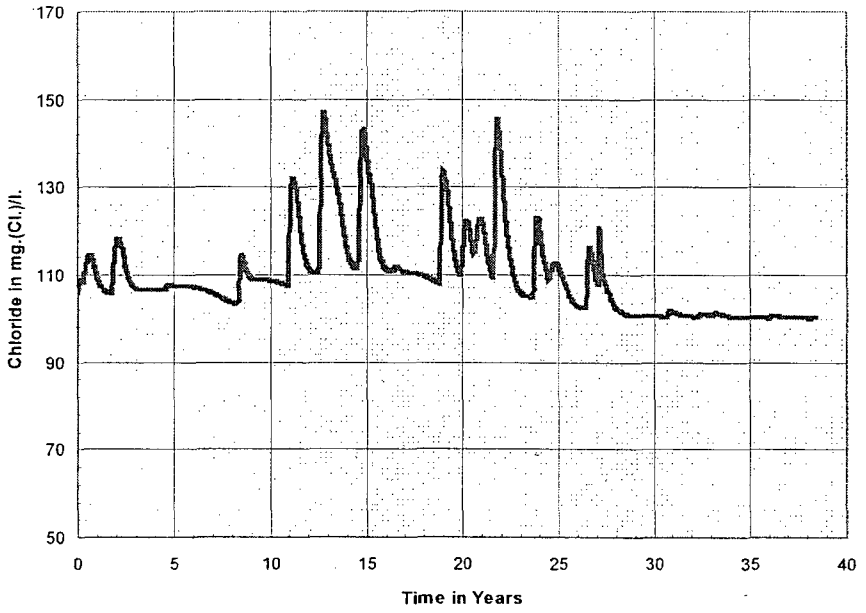
AQUIFER THICKNESS

Field data within Section 29 demonstrate that the aquifer is greater than 40 feet thick. A restricted aquifer thickness of 10 feet was employed in the mixing model in accordance with OCD request. This choice is conservative of ground water quality as it results in higher predicted chloride concentrations in a simulated monitoring well.

MODELING RESULTS:

Using the input data described above, HYDRUS-1D and the ground water mixing model predict no exceedance of WQCC ground water standards at the I-29 Vent site (see Figure C-1). For this simulation, it was assumed that no vegetation is present at the site.

Figure C-1: Predicted Chloride Concentration in the Aquifer for the I-29 Site with No Vegetation



As field chloride data demonstrate, impacts at this site are marginally greater than background; thus, an insignificant impact to ground water quality would be expected. As shown in Figure C-1, chloride concentration in the aquifer attains a maximum of 147 ppm approximately 13 years from now. The effect of the chloride load is no longer distinguishable 29 years from now.

Chloride concentration in ground water varies in response to natural causes. At a nearby background monitoring well, over four years of data show that chloride concentration ranges from 111 mg/L to 301 mg/L with an average concentration of 159 mg/L and a standard deviation of 59 mg/L. Therefore, the predicted chloride concentration increase at the I-29 site (47 mg/L) could not be differentiated from natural variation.

Works Consulted

Appendix D

APPENDIX D

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