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WORK PLAN

DATE:

04-02-2007

1R428-43
Work Plan
April 2, 2007

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Environmental Bureau
Oil Conservation Division

Corrective Action Plan

F-29-1b Junction Site

Section 29, T18S, R 38E
NMOCD Case #: 1-R0428-43

Prepared for:
Rice Operating Company
122 West Taylor
Hobbs, NM 88240

R.T. Hicks Consultants, Ltd.
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April 2, 2007

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

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Environmental Bureau
Oil Conservation Division

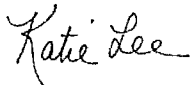
RE: NMOCD Case # 1R0428-43, F-29-1b Junction Boot
Hobbs SWD System Abandonment
Corrective Action Plan

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 F-29-1b Boot 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
Staff Scientist

Copy: Rice Operating Company
Hobbs NMOCD Office

Table of Contents

| | |
|-----------------------------------|---|
| 1.0 Introduction | 1 |
| 2.0 Work Elements Performed | 1 |
| 3.0 Conclusions | 2 |
| 4.0 Recommendation | 3 |

Plates

Plate 1: 2004 Aerial Photograph of F-29-1b Vent Site

Plate 2: F-29-1b Boring Log

Plate 3: HYDRUS-1D Vadose Zone Soil Profile

Appendices

Appendix A: Details of Characterization Activities At the F-29-1b Vent Site

Figure A-1: Chloride Concentrations and PID Readings
From F-29-1b Soil Boring Samples A2

Table A-1: Laboratory Analysis Results of F-29-1b Boring
Samples A3

Appendix B: Field Measurements & Laboratory Results For Soil Samples

Appendix C: Model Input Parameters and Results

Figure C-1: Predicted Chloride Concentration In the
Aquifer At the F-29-1b Site Without Vegetation C2

Table C-1: Hydrus-1D and Mixing Model
Input Parameters C3

Table C-2: Dispersion Lengths C5

Appendix D: Works Consulted

Table of Contents

1.0 EXECUTIVE SUMMARY

The F-29-1b Junction Boot, located west of Hobbs, New Mexico, in section 29, T18S, R38E, was a component in the Hobbs Salt Water Disposal system (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 F-29-1b Junction Boot 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. The activities at the followed the NMOCD-approved workplan (August 6, 2004).

This Corrective Action Plan presents:

- 1) Characterization activities performed by R.T. Hicks Consultants (Hicks Consultants) and Rice Operating Company (ROC) at the F-29-1b Vent site located in the Hobbs SWD system,
- 2) Evaluations 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. F-29-1b soil boring characterization.
2. Background soil boring characterization.
3. Field measurements consisted of chloride titration and PID readings for volatiles.
4. Two selected soil samples were submitted for laboratory

analysis in accordance with the workplan.

5. HYDRUS-1D simulation of the site.
6. Development of a corrective action plan.

3.0 CONCLUSIONS

3.1 ACTIVITIES AT THE F-29-1B SITE 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, that constituents of concern (COCs) reside in the upper two-thirds of the vadose zone and, therefore, that activities at this site have not caused COCs to reach ground water.

3.2 HYDRUS-1D MODEL SIMULATIONS INDICATE THAT CHLORIDE CONCENTRATIONS WILL NOT EXCEED WQCC GROUND WATER STANDARDS.

Using highly conservative input data, HYDRUS-1D modeling of the vadose zone residual chlorides predicts that resulting ground water chloride concentrations will be less than 40 ppm above background concentrations (100 ppm) in the future and below the 250 ppm Water Quality Control Commission (WQCC) secondary drinking water standard. Chloride concentrations are predicted to fluctuate between 110–136 mg/L for less than 9 years of the time interval from 11 and 27 years from now. The modeling inputs and methodology are discussed in Appendix C.

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

Vadose zone samples demonstrate no presence of toxic pollutant(s) as defined in 20.6.2.7 NMAC. Further, 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 F-29-1b Junction 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.

**Detail of Characterization
Activities At the F-29-1b Site**

Appendix A

APPENDIX A

1) F-29-1B SOIL BORING CHARACTERIZATION

The boring at the F-29-1b site was drilled in November, 2004, to a depth of 65 feet. Plate 2 illustrates the lithology and distribution of constituents of concern. From 0–36 feet below ground surface (bgs), the split spoon obtained samples at 5-foot intervals.

The dry and unconsolidated nature of the sand-silt from 40–60 feet bgs caused the loss of split-spoon samples during retrieval.

Due to increased soil moisture at 60 feet bgs, the split spoon was able to retain samples. In the interval between 40 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 water was estimated at approximately 63 feet. The boring was plugged with Bentonite.

2) BACKGROUND SOIL BORING CHARACTERIZATION

Samples taken from a background boring located about 4000 feet northwest of the site show that background chloride concentrations in the area are approximately 80 mg/kg. Appendix B presents the field data from this boring.

3) FIELD MEASUREMENTS

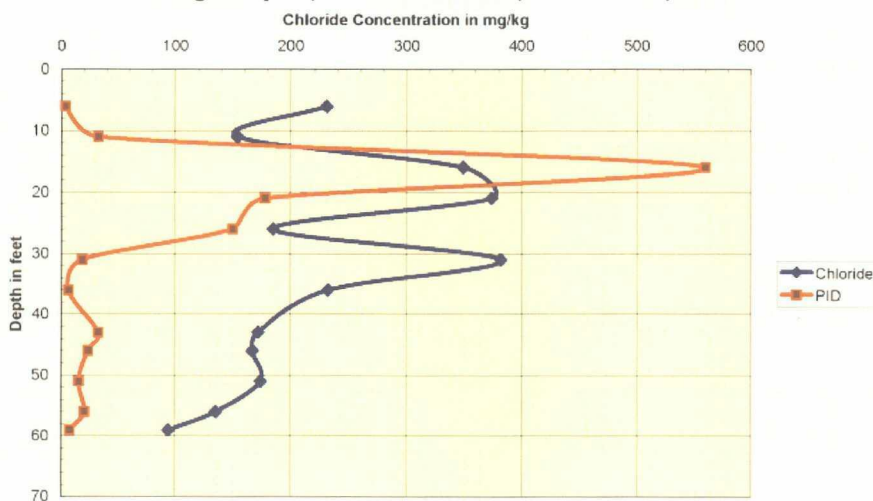
ROC took field measurements from each 5-foot sampling interval for chloride and volatiles in the field using the heated headspace method to measure total organic vapors by photoionization detector (PID). Samples were submitted to a laboratory from depths showing the highest field chloride and PID measurements (16 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 382 ppm at 31 feet bgs and chloride declines from that depth, as shown by Figure A-1.

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Chloride concentrations reach approximate background levels at a depth of 56 feet bgs. Field evidence demonstrates that the chloride mass resides in the upper two-thirds of the vadose zone.

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



The soil sample obtained at 16 feet bgs contained 560 ppm total organic vapors. PID readings decline from 16 feet bgs, reaching background concentrations below 26 feet bgs.

Laboratory analysis of the soil sample from 16 feet bgs showed benzene, toluene, ethylbenzene and xylene (BTEX) are present in total aggregate concentration below 50 ppm (Table A-1).

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

| F-29-1b Junction Boot, November, 2004 | | | |
|---------------------------------------|-------------|------------|--------------------|
| Constituent of Concern | 16 ft. bgs | 61 ft. bgs | Detection Limit |
| | mg/kg (dry) | | |
| Benzene | ND | ND | 0.025 |
| Toluene | 0.0691 | ND | |
| Ethyl benzene | 0.349 | ND | |
| Xylene (p/m) | 1.53 | ND | |
| Xylene (o) | 0.379 | ND | |
| | mg/kg (wet) | | |
| Chloride | 362 | 42.5 | 0.20 |

PAGE

A2

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

PAGE

A3

**Field Measurements
& Laboratory Results
For Soil Samples**

Appendix B

Soil Bore

System: 444 Location: 100 ft. E. of R. 100 GW: 60 Landowner: Day
 Soil Bore: 6 ft. of 100 ft. R. 100 GPS: Coord. System UTM 15N 714 997
 UTM 1 Sec. 29 T. 14 R. 37 Map Datum NAD83 36.2 10.2 9.2

| Depth | CL | PID | Color | Time |
|-------|-----|------|------------------------|----------|
| 6" | 231 | 37.4 | Dark brown sand & silt | |
| 11" | 154 | 37.4 | Tan silt & sand | |
| 16" | 249 | 37.4 | Dark brown sand & silt | 11:01 AM |
| 21" | 174 | 177 | Tan silt & sand | |
| 26" | 125 | 150 | Dark brown sand & silt | |
| 31" | 322 | 175 | Dark brown sand & silt | |
| 36" | 232 | 64 | Dark brown sand & silt | |
| 41" | | | Dark brown sand & silt | |
| 46" | 372 | 37.4 | Dark brown sand & silt | |
| 51" | 167 | 33.7 | Dark brown sand & silt | |
| 56" | 174 | 37.4 | Dark brown sand & silt | |
| 61" | 150 | 37.4 | Dark brown sand & silt | |
| 66" | 444 | 37.4 | Dark brown sand & silt | 11:13 AM |
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| 81" | | | | |
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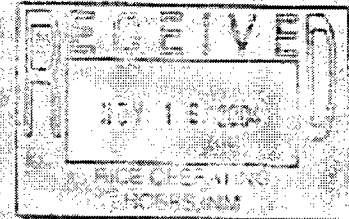
Rice Consulting Co.
122 W. Taylor
Hobbs N.M. 88249

Project: F-29-1B
Project Number: None Given
Project Manager: Kristin Payne

Page 15051 187-1471
Reported:
11/12/04 16:02

ANALYTICAL REPORT FOR SAMPLES

| Sample ID | Laboratory ID | Matrix | Date Sampled | Date Received |
|------------|---------------|--------|----------------|----------------|
| SD 0101 n | 4K10007-01 | Soil | 11/03/04 00:00 | 11/10/04 07:50 |
| SD 0101 fl | 4K10007-02 | Soil | 11/03/04 00:00 | 11/10/04 07:50 |



COPY

Rice Operating Co
 422 W. Taylor
 Hobbs NM 88240

Project: P-254-B
 Project Number: None Given
 Project Manager: R. John Pope

File# (505) 197-147
 Reported:
 11/12/04 15:07

Organics by GC Environmental Lab of Texas

| Analysis | Result | Reporting Limit | Unit | Detected | Method | Preserved | Analyst | Lab | Notes |
|-------------------------------------|--------|-----------------|-----------|----------|----------|-----------|----------|----------|------------|
| SB 10 B (4K10007-01) Soil | | | | | | | | | |
| Benzene | ND | 0.0250 | mg/kg dry | 11/11/04 | 11/11/04 | 11/11/04 | 11/11/04 | 11/11/04 | |
| Toluene | 0.0851 | 0.0250 | | | | | | | |
| Ethylbenzene | 0.149 | 0.0250 | | | | | | | |
| Xylene (pm) | 1.53 | 0.0250 | | | | | | | |
| Xylene (o) | 0.379 | 0.0250 | | | | | | | |
| S surrogate: 1,2,4-trichlorobenzene | | 84.7 | % | 86-120 | | | | | |
| S surrogate: 1,2,4-trichlorobenzene | | 724 | % | 86-120 | | | | | |
| Gasoline Range Organics C6-C12 | 86.5 | 10.0 | mg/kg dry | 11/11/04 | 11/11/04 | 11/11/04 | 11/11/04 | 11/11/04 | 5-01 |
| Diesel Range Organics >C12-C25 | 153 | 10.0 | | | | | | | |
| Total Hydrocarbon C6-C25 | 140 | 10.0 | | | | | | | |
| S surrogate: 1-Chloronaphthalene | | 69.6 | % | 70-130 | | | | | |
| S surrogate: 1-Chloronaphthalene | | 75 | % | 70-130 | | | | | |
| SB 2 61 B (4K10007-02) Soil | | | | | | | | | |
| Benzene | ND | 0.0250 | mg/kg dry | 11/11/04 | 11/11/04 | 11/11/04 | 11/11/04 | 11/11/04 | |
| Toluene | ND | 0.0250 | | | | | | | |
| Ethylbenzene | ND | 0.0250 | | | | | | | |
| Xylene (pm) | ND | 0.0250 | | | | | | | |
| Xylene (o) | ND | 0.0250 | | | | | | | |
| S surrogate: 1,2,4-trichlorobenzene | | 81.3 | % | 86-120 | | | | | |
| S surrogate: 1,2,4-trichlorobenzene | | 77.3 | % | 86-120 | | | | | |
| Gasoline Range Organics C6-C12 | ND | 10.0 | mg/kg dry | 11/11/04 | 11/11/04 | 11/11/04 | 11/11/04 | 11/11/04 | EPA 801-SM |
| Diesel Range Organics >C12-C25 | ND | 10.0 | | | | | | | |
| Total Hydrocarbon C6-C25 | ND | 10.0 | | | | | | | |
| S surrogate: 1-Chloronaphthalene | | 107 | % | 70-130 | | | | | |
| S surrogate: 1-Chloronaphthalene | | 124 | % | 70-130 | | | | | |

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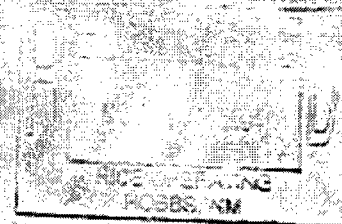
Project: R-29-113
Project Number: 1000000000
Project Manager: Erin Pope

File: (505) 397-1471

Reported:
11/12/04 16:02

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

| Parameter | Result | Reporting Limit | Units | Location | Batch | Prepared | Analyzed | Method | Notes |
|------------------------------|--------|--------------------|-------|----------|---------|----------|----------|---------------|-------|
| SR # 16 ft (4K10007-01) Soil | | | | | | | | | |
| Chloride | 362 | 20.0 mg/kg soil | | 1 | ES41100 | 11/11/04 | 11/11/04 | SW 146-9253 | |
| % Moisture | 10.0 | | % | 1 | ES41101 | 11/11/04 | 11/11/04 | % calculation | |
| SR # 61 ft (4K10007-02) Soil | | | | | | | | | |
| Chloride | 42.5 | 20.0 mg/kg soil | | 2 | ES41100 | 11/11/04 | 11/11/04 | SW 146-9253 | |
| % Moisture | 11.0 | | % | 2 | ES41101 | 11/11/04 | 11/11/04 | % calculation | |



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| | | | | | | | |
|-------------------------------------|--|---|--|---|--|----------------------------------|--|
| System: <i>Hobbs</i> | | Location: <i>1000 ft. NW 1/4 Sec. 29 T. 12 N. R. 3 E.</i> | | GW: <i>2</i> | | Landowner: <i>State of Texas</i> | |
| Soil Bore: <i>200 ft. deep</i> | | | | GPS. Coord. System UTM <i>18 671407 E</i> | | | |
| ULF Sec. <i>29 T. 12 N. R. 3 E.</i> | | | | Map Datum Nad83 <i>7/2/1969</i> | | | |

[The following text is extremely faint and largely illegible due to poor scan quality. It appears to be a continuation of a document or report.]

UL F. Sec. 29 T. 12 R. 32 Map Datum Nac83 302 1969 ✓

| Depth | Cl | FIG | Color | Time |
|-------|----|-----|-------|------|
|-------|----|-----|-------|------|

[illegible]

11. 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000 1001 1002 1003 1004 1005 1006 1007 1008 1009 1010 1011 1012 1013 1014 1015 1016 1017 1018 1019 1020 1021 1022 1023 1024 1025 1026 1027 1028 1029 1030 1031 1032 1033 1034 1035 1036 1037 1038 1039

(continued)

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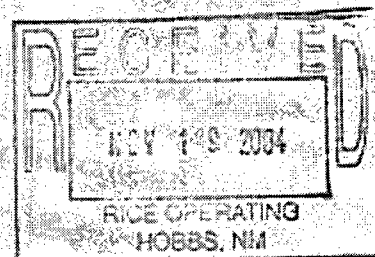
Project: Background Bore
Project Number: None Given
Project Manager: Kristin Pope

Fax: (505) 397-1471

Reported:
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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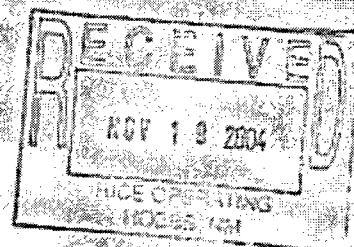
Rice Operating Co.
122 W. Taylor
Hobbs NM, 88240

Project: Background Bore
Project Number: None Given
Project Manager: Kristin Pope

Fax: (505) 397-1471
Reported:
11/12/04 16:02

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

| Analyte | Result | Reporting Limit | Units | Detection Limit | Batch | Prepared | Analyzed | Method | Notes |
|------------------------------|--------|--------------------|-----------|--------------------|---------|----------|----------|-------------|-------|
| SB @ 61 ft (4K10006-01) Soil | | | | | | | | | |
| Chloride | ND | 20.0 | mg/kg Wet | 2 | EX41209 | 11/10/04 | 11/11/04 | SW 146-9253 | |



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The results in this report apply to the samples analyzed in accordance with the methods received in the laboratory. This analytical report must be reproduced in its entirety with written approval of Environmental Lab of Texas.

Page 2 of 4

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Modeling Input Parameters & Results

Appendix C

APPENDIX C

To model the effect of the vadose zone remedy's impact on ground water at the F-29-1b 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 Appendix D for references).

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.

HYDRUS-1D INPUTS:

A synopsis of modeling inputs for the F-29-1b site is presented in Table C-1.

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

| Input Parameter | Source |
|--|---|
| Vadose zone thickness - 60 feet | F-29-1b field data and professional judgement |
| Vadose zone texture (Plate 3) | F-29-1b 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: 15 feet | Field estimate |
| 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 F-29-1b model has a vadose zone soil profile constructed from the lithologic logs of the F-29-1b 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 (See Plate 3). Although the F-29-1b 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 F-29-1b site.

Vadose zone thickness is 63 feet at the F-29-1b 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: Dispersion Lengths

| F-29-1b Hydrus-1D Soil Profile Properties | | | | |
|---|--------------|-------------|-----------------|---------------------|
| Material | Description | Length (cm) | Dispersion (cm) | % of Profile Length |
| 1 | Sandy loam | 30 | 50 | 2.778 |
| 2 | Caliche-sand | 60 | 30 | 1.667 |
| 3 | Caliche | 90 | 10 | 0.556 |
| 4 | Sand-silt | 1070 | 100 | 5.556 |
| 5 | Loamy sand | 550 | 100 | 5.556 |

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 F-29-1b 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 Boot was oriented vertically, the affected surface area is small. Significant lateral impacts were not observed. The affected diameter of the site parallel to ground water flow was taken as 15 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 F-29-1b 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 NMOCD request. This choice is conservative of ground water quality as it results in higher predicted chloride concentrations in a simulated monitoring well.

MODELING RESULTS:

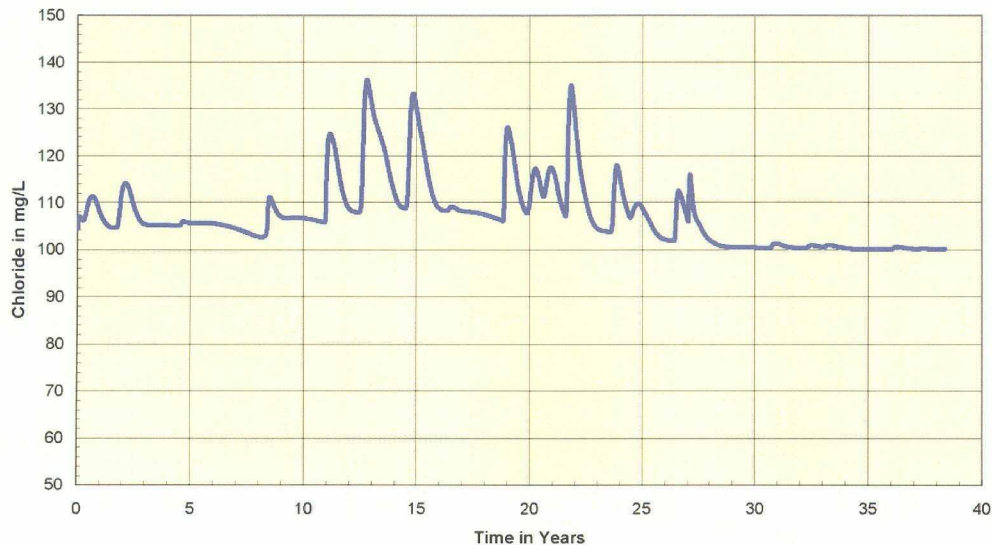
Using the input data described above, HYDRUS-1D and the ground water mixing model predict no exceedance of WQCC ground water standards at the F-29-1b site (Figure C-1). For this simulation, it was assumed that no vegetation is present at the site.

As field chloride data demonstrate, impacts at this site are marginally greater than background; thus, an insignificant

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impact to ground water quality would be expected. As shown in Figure C-1, chloride concentration in the aquifer attains a maximum of 136 ppm approximately 13 years from now. The effect of the chloride load is no longer distinguishable 28 years from now.

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



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 F-29-1b site (36 mg/L) could not be differentiated from natural variation.

Works Consulted

Appendix D

APPENDIX D

Ash, S.R., 1963, Ground water conditions in northern Lea County, U.S.
Geological Survey Hydrologic Investigations Atlas HA-62

Hendrickx, J., Rodriguez, G., Hicks, R. T., and Simunek, January 2005,
Modeling Study of Produced Water Release Scenarios, API Publication Number 4734, 11 pp.

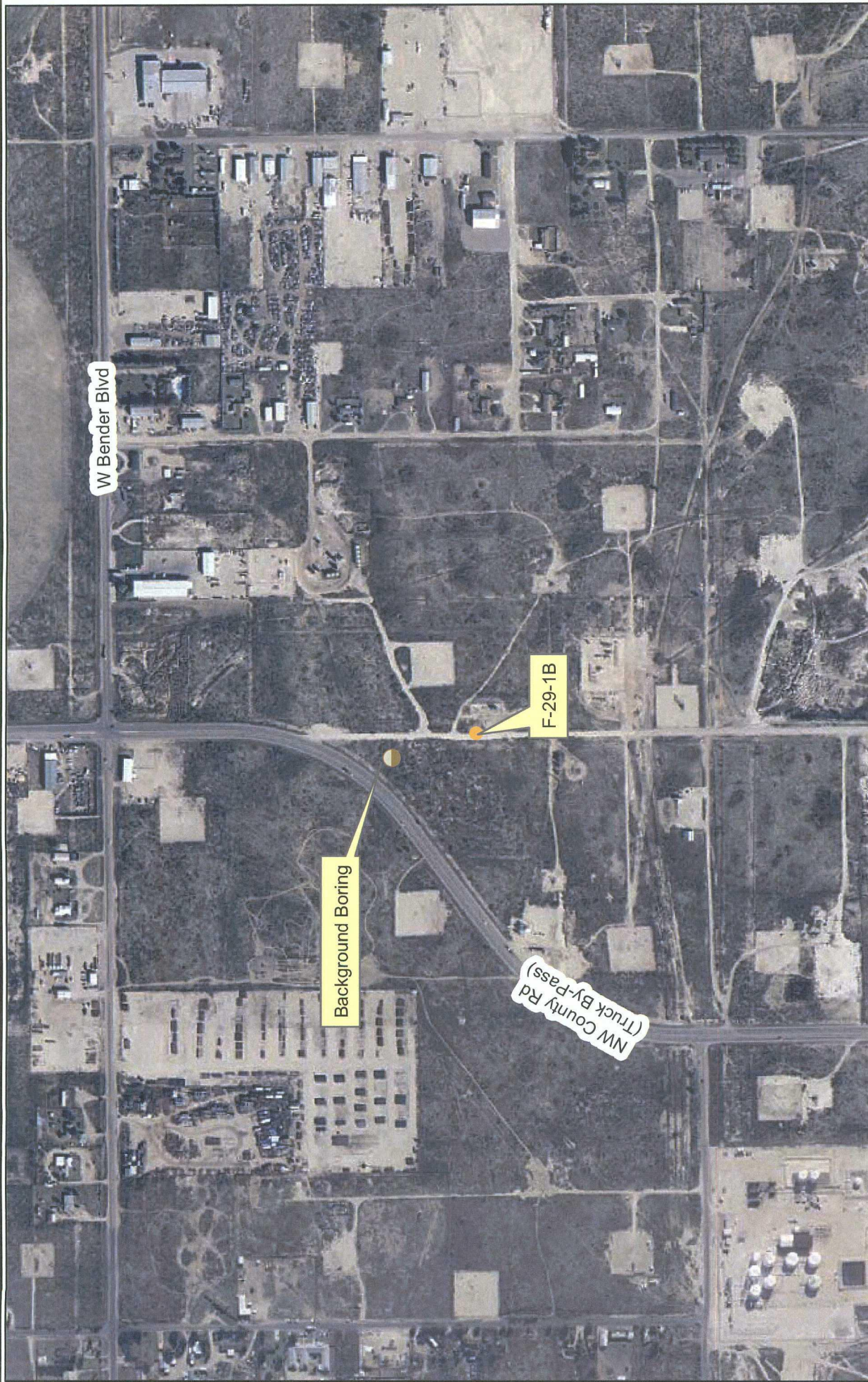
Intera Incorporated, July 8, 2003, Windmill Oil Site Ground Water Sampling Results, prepared for the New Mexico Oil Conservation Division, 3 pp.

McAda, D.P., 1985, Projected water-level declines in the Ogallala aquifer in Lea County, New Mexico, US Geological Survey Water-Resources Investigations Report 84-4062, 84 pp.

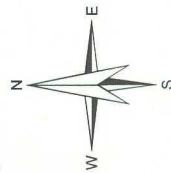
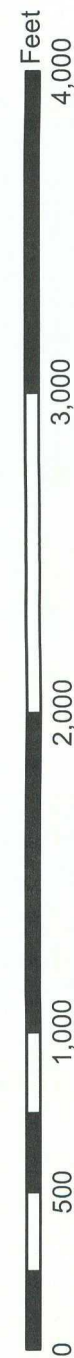
Musharrafieh, G. and Chudnoff, M., January 1999, Numerical Simulation of Groundwater Flow for Water Rights Administration in the Lea County Underground Water Basin New Mexico, New Mexico Office of the State Engineer Technical Report 99-1, 6 pp.

Nicholson Jr., A. and Clebsch, A., 1961, Geology and Ground Water Conditions of Southern Lea County, New Mexico, Ground Water Report 6, US Geological Survey, New Mexico Bureau of Mines and Mineral Resources

Plates



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



| | | |
|---|---|---|
| <p>R.T. Hicks Consultants, Ltd 901 Rio Grande Blvd NW Suite F-142 Albuquerque, NM 87104 Ph: 505.266.5004</p> | <p>2004 Aerial Photograph showing the F-29-1B Site Rice Operating Company : F-29-1B Site (NMOCD#: 1R0428-45)</p> | <p>Plate 1 February 2007</p> |
|---|---|---|

| | | | | | | | |
|---|---|------------------|---------------------------------|-------------------|---|----------------|--|
| Logger: | | David Hamilton | Client: | | Boring ID: F-29-1b B-1 (65 feet) | | |
| Driller: | | Eades Drilling | Rice Operating Company | | | | |
| Drilling Method: | | Air Rotary | Project Name: | | | | |
| Start Date: | | 11/3/2004 | Hobbs F-29-1b Site | | | | |
| End Date: | | 11/3/2004 | Location: | | | | |
| | | | T18S R38E | | | | |
| | | | Section 29, Unit F | | | | |
| | | | | | | | |
| Depth (feet) | Description | Lithology | Comments | Field data | | | |
| | | | | Depth | Chloride mg/kg | PID ppm | |
| 0.0 | Surface, 0 - 1 feet | | Strong odor, some discoloration | | | | |
| 2.0 | Sand, caliche, clay, dark brown, 1-10 feet | | | | | | |
| 4.0 | | | | 6.0 | 231 | 3.7 | |
| 6.0 | | | | | | | |
| 8.0 | | | | | | | |
| 10.0 | Sand, caliche, tan, 10-17 feet | | Strong Odor | 11.0 | 154 | 32.4 | |
| 12.0 | | | | | | | |
| 14.0 | | | | | | | |
| 16.0 | | | | 16.0 | 349 | 560.0 | |
| 18.0 | Sand, caliche, tan, 18-20 feet | | Some discoloration and odor | | | | |
| 20.0 | Caliche, well indurated, 20-21 feet | | | 21.0 | 374 | 178.0 | |
| 22.0 | Very fine grained sand, silt, tan, 21-27 feet | | | | | | |
| 24.0 | | | | | | | |
| 26.0 | | | | 26.0 | 185 | 150.0 | |
| 28.0 | | | | | | | |
| 30.0 | Caliche, well indurated, 30-31 feet | | | 31.0 | 382 | 18.5 | |
| 32.0 | Very fine grained sand, silt, reddish tan, 31-44 feet, Caliche , 36-36.5 feet | | | | | | |
| 34.0 | | | | | | | |
| 36.0 | | | | 36.0 | 232 | 6.4 | |
| 38.0 | | | | | | | |
| 40.0 | Caliche, sandstone, 44-45 feet | | | | | | |
| 42.0 | | | | 43.0 | 172 | 32.6 | |
| 44.0 | | | | | | | |
| 46.0 | | | | 46.0 | 167 | 23.7 | |
| 48.0 | Very fine grained sand silt, reddish tan, 45-65 feet | | | | | | |
| 50.0 | | | | 51.0 | 174 | 15.6 | |
| 52.0 | | | | | | | |
| 54.0 | | | | 56.0 | 135 | 20.6 | |
| 56.0 | | | | | | | |
| 58.0 | | | | 59.0 | 94 | 7.6 | |
| 60.0 | | | | | | | |
| 62.0 | | | | | | | |
| 64.0 | | | | | | | |
| 66.0 | | | | | | | |
| | | | | | | | |
| R.T. Hicks Consultants, Ltd 901 Rio Grande Blvd NW Suite F-142 Albuquerque, NM 87104 505-266-5004 | | | Hobbs F-29-1b Site | | Plate 2 | | |
| | | | Exploratory Boring | | February, 2007 | | |

| | | | | | |
|---|--|----------------------------|-------------------------|--|-------------------------|
| HYDRUS-1D Vadose Zone Soil Profile | | Client: | Location: | | |
| | | Rice Operating Company | T18S R38E Section 29 | | |
| | | Project Name: | | | |
| | | F-29-1b Junction Boot | | | |
| | | | | | |
| 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 | | F-29-1b Site | Plate 3 | | |
| | | | March, 2007 | | |