



Pilot Study Report

for

Z-92™ Uranium Treatment Process



conducted at the

Mountain Water & Sanitation District, Conifer, Colorado

**Revised
November 11, 2004**

Executive Summary

Mountain Water & Sanitation District in Conifer, Colorado have a number of wells in their water system that contain concentrations of uranium in excess of the Maximum Contaminant Level (MCL). Mountain Water & Sanitation District tested Water Remediation Technology's (WRT) Z-92™ Uranium Removal Process as a possible cost effective solution for their uranium problem. WRT provided a 1.5 GPM (gallons per minute) pilot plant, which was installed on July 1, 2003.

The purpose of this pilot study is to test, evaluate and demonstrate the effectiveness of the treatment process and establish design parameters for the full scale systems.

This pilot study was conducted in five successive phases over a period of approximately nine months. The final Phase V, Test C study clearly and effectively reduced the level of uranium to less than the MCL (Figure 1) for its entire 70 days of continuous operation, without media change.

Table 1. Phase V – Test C

Test	Start Date	End Date	Number of Columns	Media	Target Flow Rate	Hydraulic Loading Rate	Lbs of media per Column	Media Type
Ph V - C	4/21/04	7/1/04	2	Z-92 Rev. B	0.75	9	6	Expanded Bed

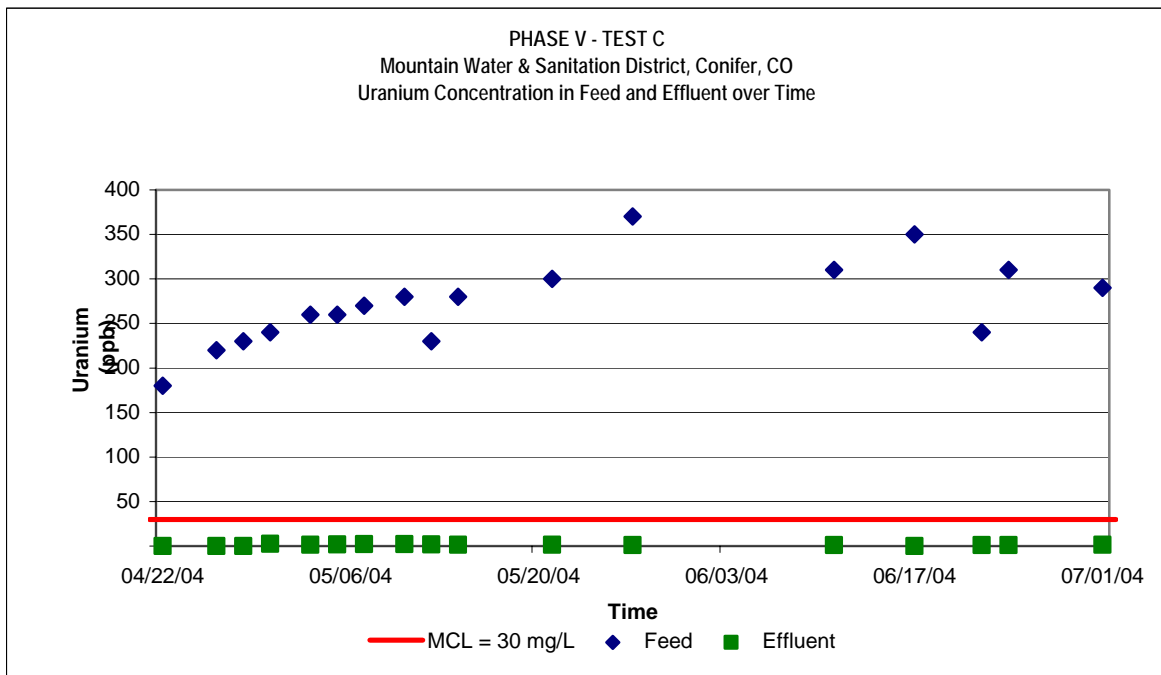


Figure 1

**Table 2. Phase V – Test C
Uranium level in feed and discharge water.**

	Feed (ppb)	Discharge @ Column 2 (ppb)
Uranium MCL	NA	30
Average	271.8	1.2
Highest value	370.0	2.6
Lowest Value	180.0	0.0

Statistical results from the study are shown in Table 2. On average, the concentration of uranium in the system dropped from 271.8 ppb in the feed to 1.2 ppb in the discharge. The discharge did not exceed the MCL of 30 mg/L during Phase V, Test C of the pilot study. The system operated continuously throughout this phase of testing, without interruption.

Application Information

Mountain Water & Sanitation District is located approximately 30 miles west of Denver in Conifer, Colorado. Mountain Water supplies water to a community of approximately 950 residents.

Source water for the pilot unit was taken at the point where the water exits the existing 222,000 gallon storage tank, after it has been chlorinated. The source water for the pilot unit was therefore a blend from the operating wells. Discharge water from the pilot unit went into a natural sump located adjacent to the pilot unit.

Technology Overview

Water Remediation Technology's (WRT) Z-92™ Uranium Treatment Process utilizes Z-92™ patent pending adsorptive media in a series of upflow treatment vessels to remove uranium from drinking water. The water is moved through the treatment system using the water pressure generated from the distribution system pump. No other chemicals are typically added to the water for the treatment process, however one test scenario presented here, utilized pH adjustment. After the media is loaded with uranium, it is removed from the circuit and permanently disposed of in a licensed facility. WRT designs, manufactures and provides the process equipment and media used in the treatment process and provides for residual management of spent media.



WRT Z-92™ pilot unit

The handling and exchange of new media for spent media, as well as the shipping and disposal into licensed disposal sites, is handled by WRT. The Z-92™ process media is ANSI/NSF Standard 61 certified for use in drinking water.

Equipment Overview

The pilot equipment consists of several treatment trains which are installed in a self contained trailer. One treatment train was selected for this long term study after some initial scoping. This treatment train contains two 4" diameter by 4' vertical height columns, each containing Z-92™ process media. The source water enters the unit through a ¾" diameter hose and passes through a control valve and flow meter. In Phase IV testing, the pH was adjusted to 6.5 prior to entering the bottom of the first column. All columns operate in an up-flow mode, with the flow exiting the top of the first column, then following the same flow path through column 2 (see Figure 2). Sample ports are located prior to the first column, and after each of the columns in the series.

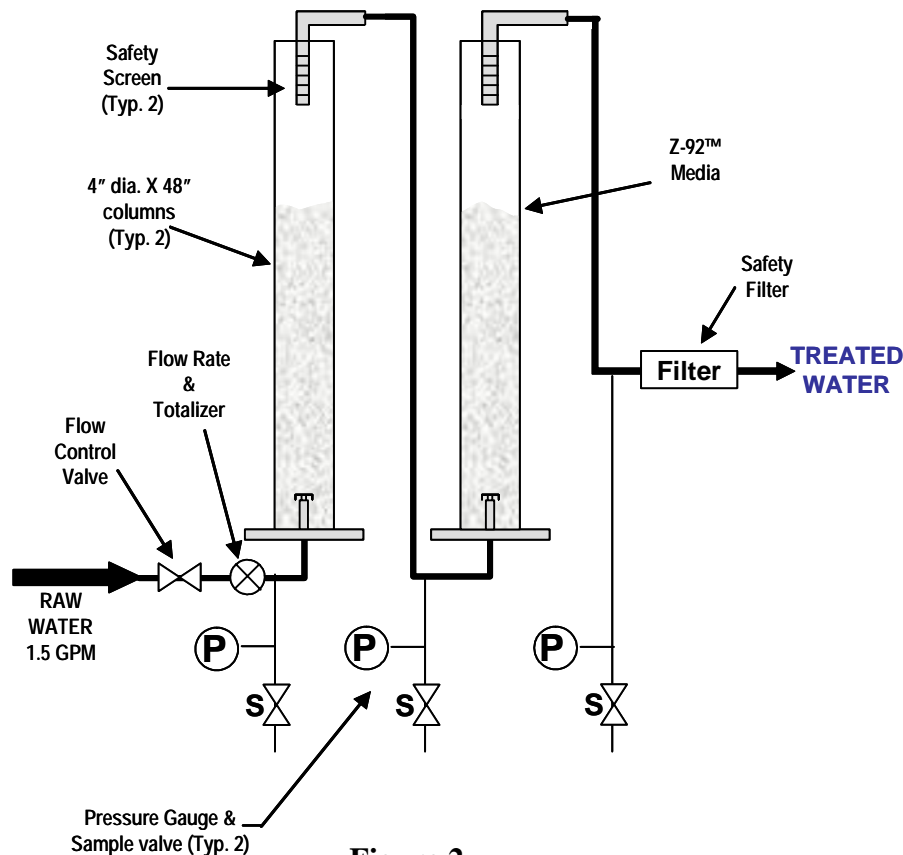


Figure 2

Other than hydraulic treatment capacity, the pilot unit differs from a permanent equipment installation only in quantity, diameter and vertical height of the columns. Both systems utilize the same multiple column design, but the permanent equipment will have columns of larger diameter to accommodate the production capacity of the well. The purpose of the short columns in the pilot plant is to allow more data to be collected and faster evaluation of the uranium loading on the Z-92™ media.



Mountain Water Z-92™ pilot study.





Statement of Purpose

The uranium level at the Mountain Water & Sanitation District's storage tank was as high as 370.0 ppb during the pilot study, and exceeds the Environmental Protection Agency (EPA) mandated MCL of 30 mg/L.

The purposes of this pilot study are to:

- Test, evaluate and demonstrate the ability of the WRT Z-92™ Uranium Treatment Process to consistently and effectively reduce the uranium content to below the MCL in the field.
- Demonstrate the reliability and ease of operation of the WRT Process.
- Comply with regulatory piloting requirements.
- Develop design criteria for the full-scale facility.

Installation of Pilot Unit

The self contained trailer pilot unit, with multiple two column treatment trains was initially installed on July 1, 2003. Set up consists of securing the trailer and connecting the water source and a discharge line. The next phase of pilot testing began the same day, and initial water samples were taken at that time.

Operator training for pilot unit operation, monitoring and sampling was conducted on the day of installation, and a schedule for sampling was established. Both WRT and the Utility operating staff collected water samples during the pilot study. Samples were collected from ½ inch valves located in the feed line and after discharge from each respective test column, at predetermined sample intervals.

Analytical

The samples were sent to the Evergreen Analytical Laboratory Inc. located in Wheat Ridge, Colorado. Evergreen Analytical Laboratory is a National Environmental Laboratory Accreditation Program certified laboratory. Methods of analysis were:

Uranium Analysis EPA 200.8

Results

Since this was the first pilot study for Z-92™ media in the field, the protocol was, by design, to conduct a number of test scenarios, each with an evaluation and modification step prior to the next test. The high uranium level in the raw water made this an ideal test site for rapidly evaluating media and process performance. At such time that a test scenario was produced that provided a high probability of generating commercially acceptable performance, that scenario would be developed into a more detailed pilot study report format.

Below is a summary of the sequence of tests conducted, prior to developing a final test scenario. The analytical laboratory certificates supporting these results are not included in this report, but are available upon request. The data from the final specific test is then presented and discussed in greater detail, and considered as baseline data for the full scale installation. Analytical laboratory certificates supporting this final phase of testing are attached as Appendix A.

Phase I – Initial Z-92™ Field Evaluation Test

Table 3.

Test	Start Date	End Date	Number of Columns	Media	Target Flow Rate	Column Height	Lbs of media per Column
Phase I	7/1/03	7/28/03	6	Z-92 Rev. A	1.25	12'	65

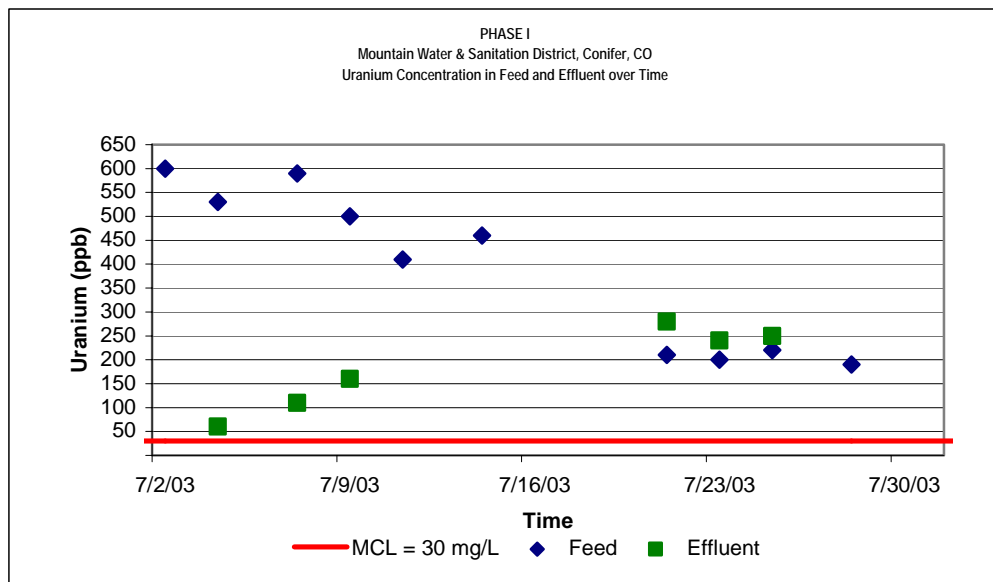


Figure 3

Phase II – Secondary Z-92™ Field Evaluation Test

Table 4.

Test	Start Date	End Date	Number of Columns	Media	Target Flow Rate	Column Height	Lbs of media per Column
Phase II	11/17/03	12/16/03	4	Z-92 Rev. A	0.5	4'	10

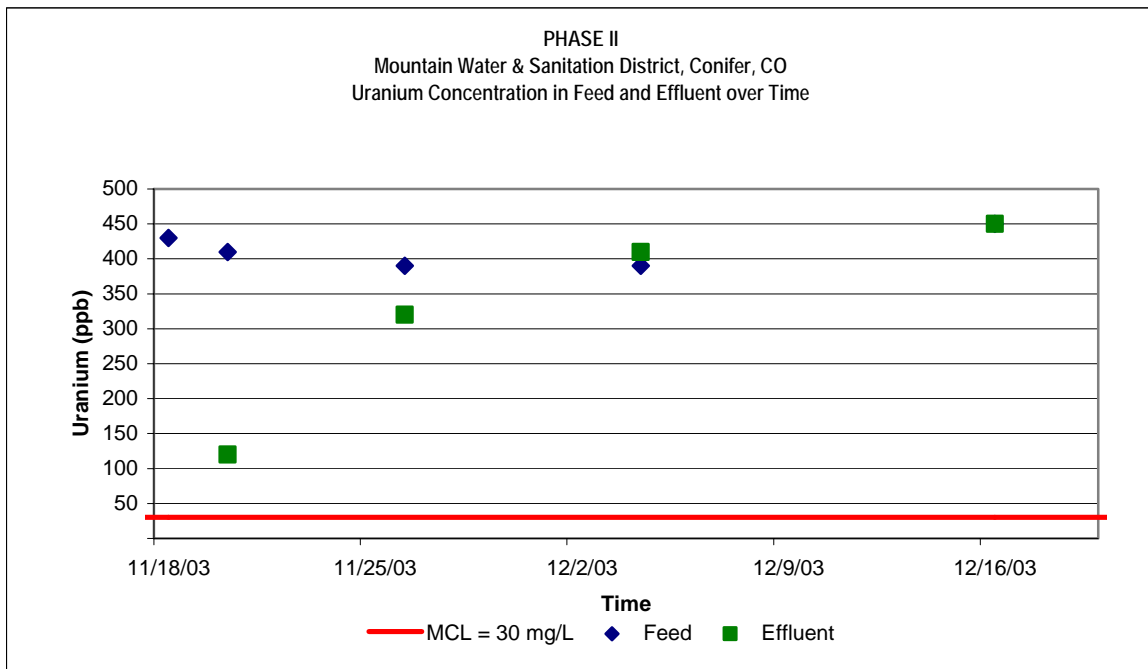


Figure 4

Phase III – Acid regeneration of media – reactivation 6 times

Table 5.

Test	Start Date	End Date	Number of Columns	Media	Target Flow Rate	Column Height	Lbs of media per Column
Phase III	12/17/03	3/5/04	4	Z-92 Rev. A	0.5	4'	10

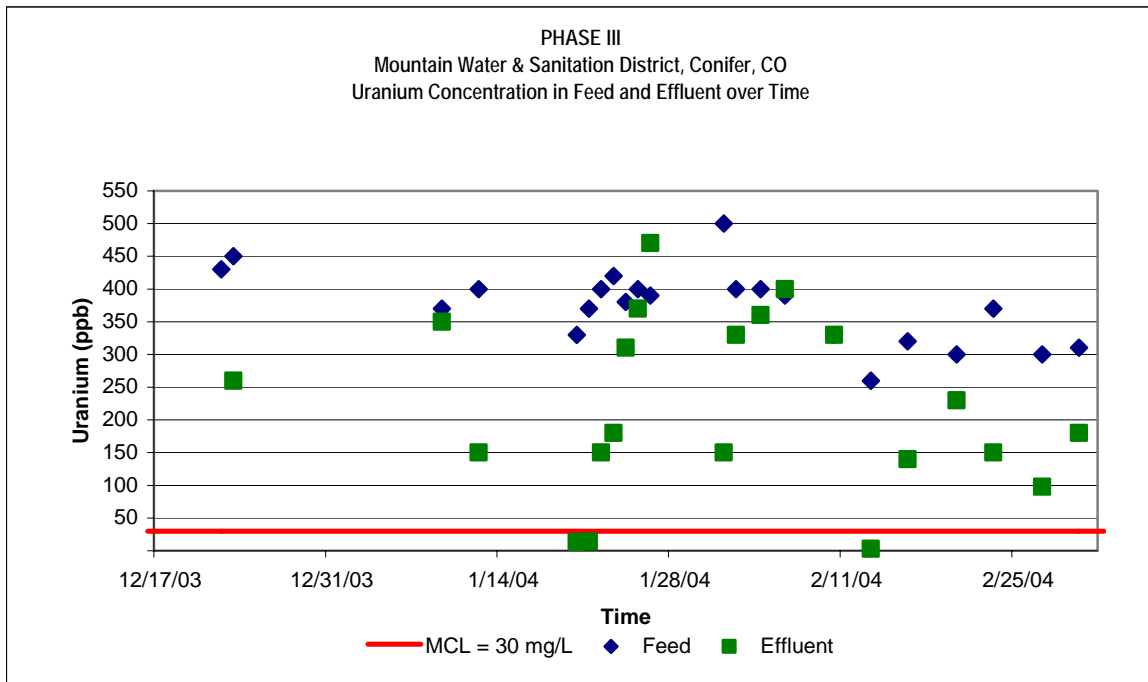


Figure 5

Phase IV – pH Control of raw water continuously adjusted to 6.5 pH

Table 6.

Test	Start Date	End Date	Number of Columns	Media	Target Flow Rate	Column Height	Lbs of media per Column
Phase IV	3/8/04	4/20/04	4	Z-92 Rev. A	0.5	4'	10

Natural pH at this site is 7.7 pH. Sulfuric acid is used to adjust the feed water pH prior to the treatment through the pilot system. Four and one half gallons of sulfuric acid, 1.84 g/mL grade, were added over the course of this study through the use of a pH probe and metering pump. The pH set point was 6.5.

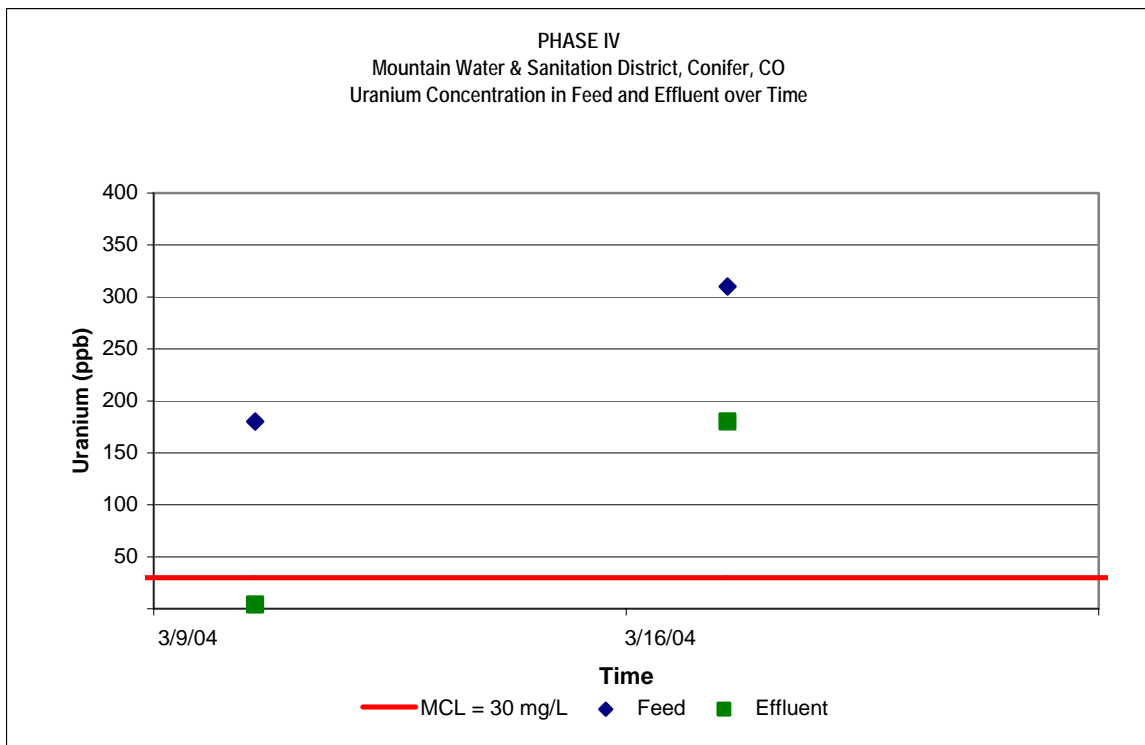


Figure 6

Phase V – Initial Field test of Z-92™ Rev. B media (5 tests A, B, C, D & E conducted simultaneously)

Table 7. Phase V – Test A

Test	Start Date	End Date	Number of Columns	Media	Target Flow Rate	Hydraulic Loading Rate	Lbs of media per Column	Media Type
Ph V - A	4/21/04	5/12/04	2	Z-92 Rev. B	0.25	3	6	Expanded Bed

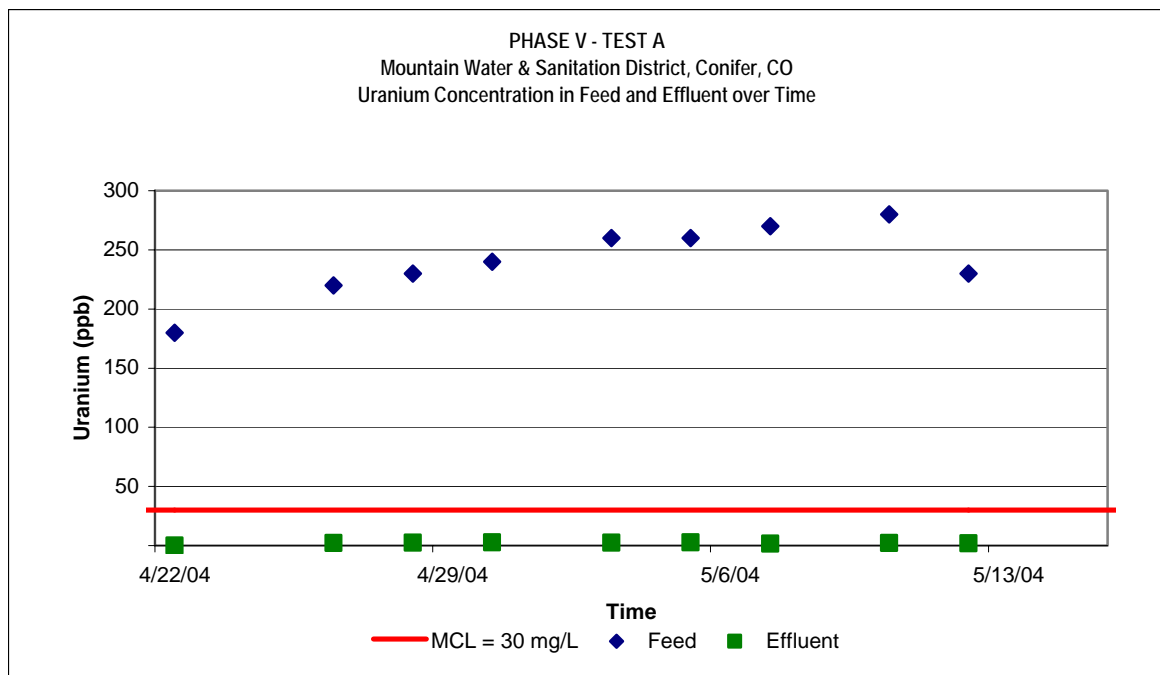


Figure 7

Table 8. Phase V – Test B

Test	Start Date	End Date	Number of Columns	Media	Target Flow Rate	Hydraulic Loading Rate	Lbs of media per Column	Media Type
Ph V - B	4/21/04	5/12/04	2	Z-92 Rev. B	0.50	6	6	Expanded Bed

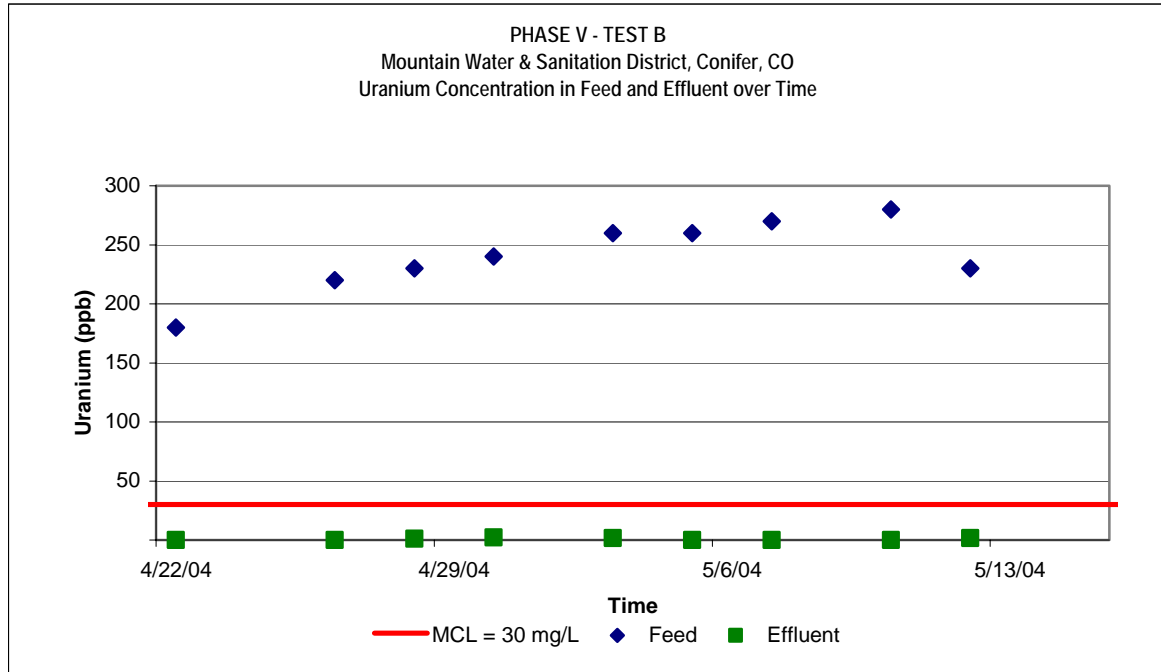


Figure 8

Table 1. Phase V – Test C

Test	Start Date	End Date	Number of Columns	Media	Target Flow Rate	Hydraulic Loading Rate	Lbs of media per Column	Media Type
Ph V - C	4/21/04	7/1/04	2	Z-92 Rev. B	0.75	9	6	Expanded Bed

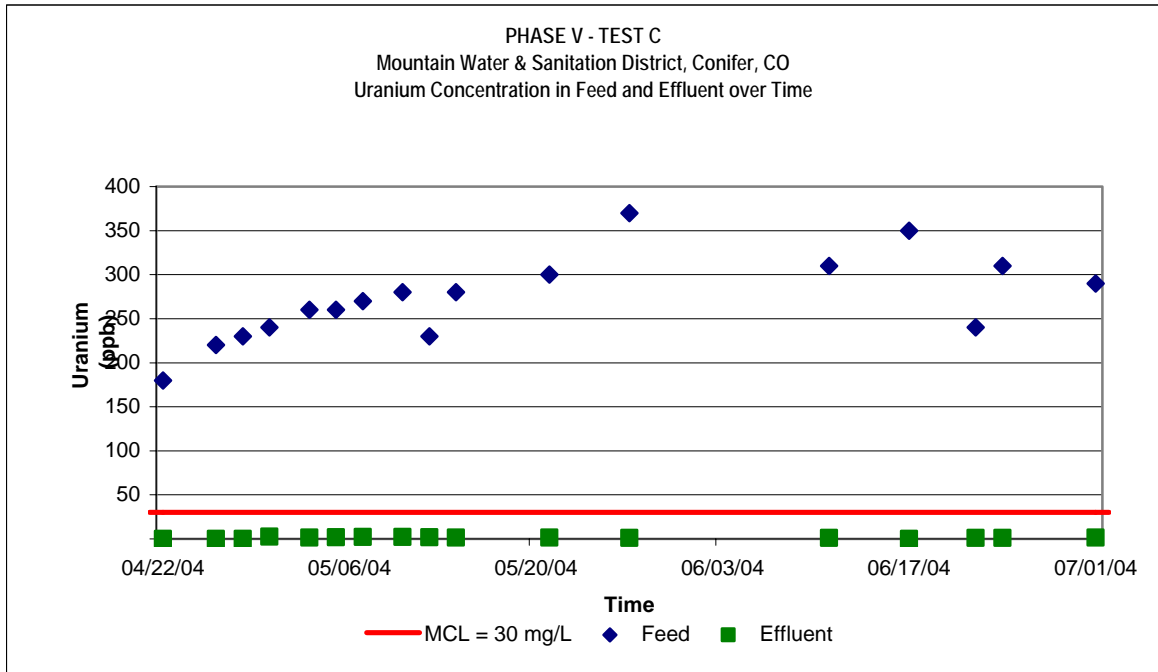


Figure 1

Table 9. Phase V – Test D

Test	Start Date	End Date	Number of Columns	Media	Target Flow Rate	Hydraulic Loading Rate	Lbs of media per Column	Media Type
Ph V - D	5/4/04	5/12/04	1	Z-92 Rev. B	1.20	13	6	Packed Bed

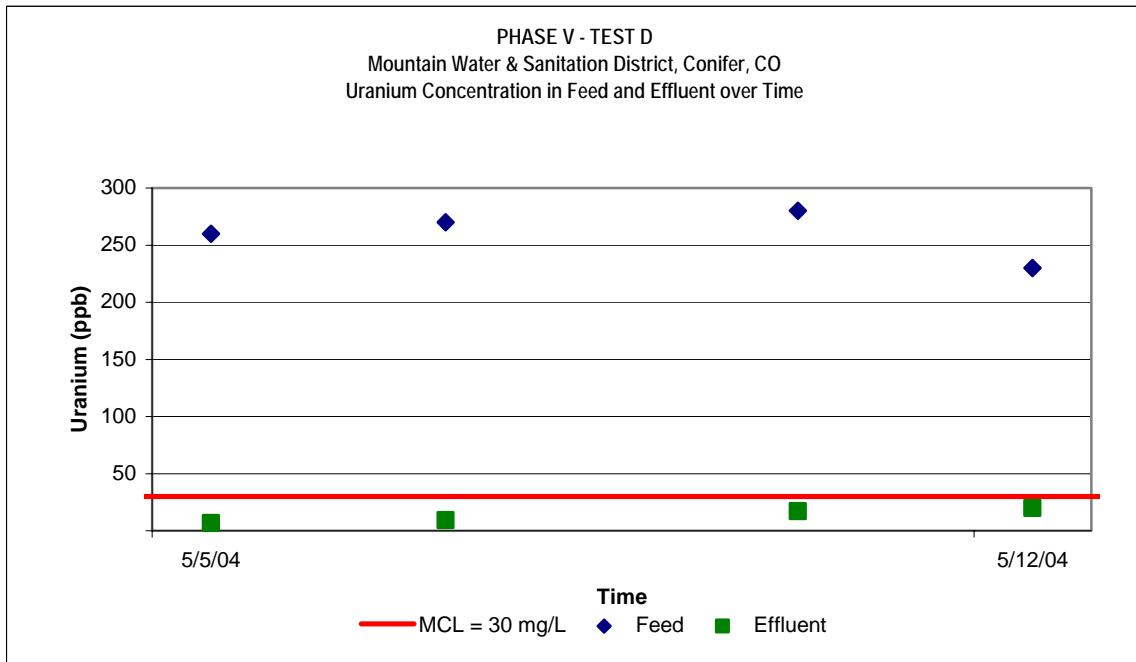


Figure 9

Table 10. Phase V – Test E

Test	Start Date	End Date	Number of Columns	Media	Target Flow Rate	Hydraulic Loading Rate	Lbs of media per Column	Media Type
Ph V - E	5/4/04	6/22/04	1	Z-92 Rev. B	2.40	27	6	Packed Bed

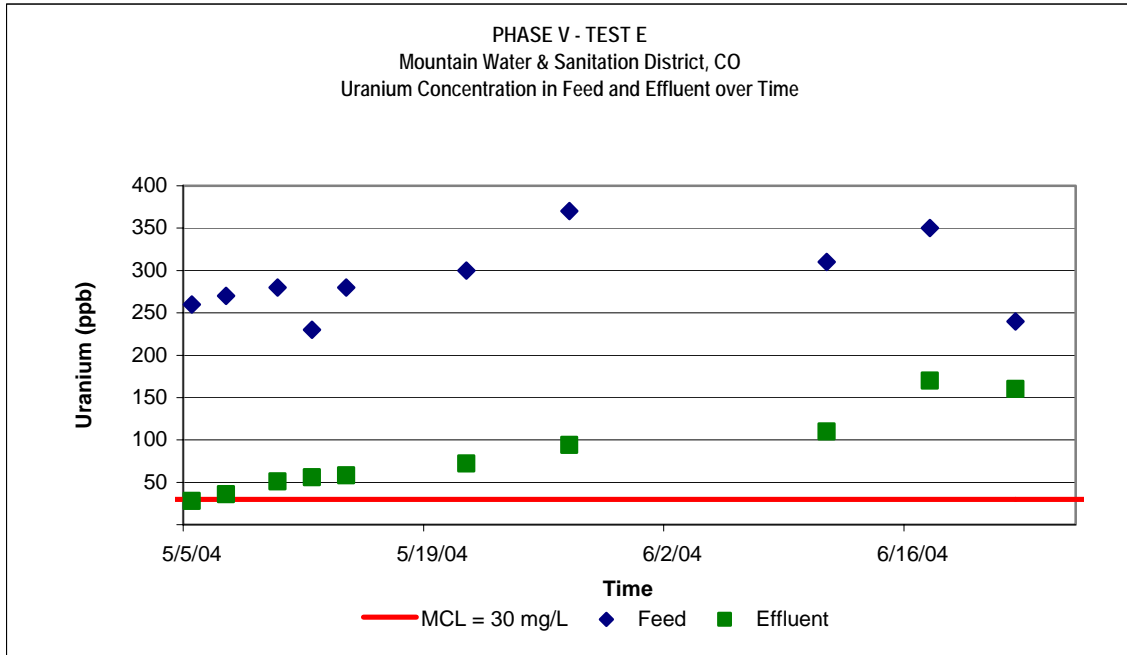


Figure 10

Initial Conclusion

Based upon evaluation of data from Phase V tests A, B, C, D & E, it was concluded that Test C returned the best results and should be used as the basis of this pilot study report.

The sampling results from Test C are shown in Table 11 below. Feed samples were collected immediately prior to the first column of Z-92™. Samples were taken after each respective column. Discharge samples were collected after column 2. Analytical laboratory certificates are attached as Appendix A.

**Table 11. Phase V – Test C
Uranium Test Sample Results**

Uranium	Concentration (ppb)			
	Date	Feed	C-1	C-2
	4/21/04			
	4/22/04	180.0	12.0	0.0
	4/26/04	220.0	4.4	0.0
	4/28/04	230.0	14.0	0.0
	4/30/04	240.0	23.0	2.6
	5/3/04	260.0	14.0	1.4
	5/5/04	260.0	13.0	1.7
	5/7/04	270.0	22.0	2.2
	5/10/04	280.0	21.0	2.0
	5/12/04	230.0	21.0	1.9
	5/14/04	280.0	20.0	1.3
	5/21/04	300.0	21.0	1.3
	5/27/04	370.0	20.0	1.2
	6/11/04	310.0	12.0	1.0
	6/17/04	350.0	19.0	0.0
	6/22/04	240.0	20.0	1.0
	6/24/04	310.0	21.0	1.1
	7/1/04	290.0	17.0	1.5

Figure 1 shows uranium levels in the feed water entering the pilot unit, and treated water exiting each column the pilot unit. The graph shows that the pilot unit successfully reduced the uranium level to below the MCL of 30 mg/L throughout the test.

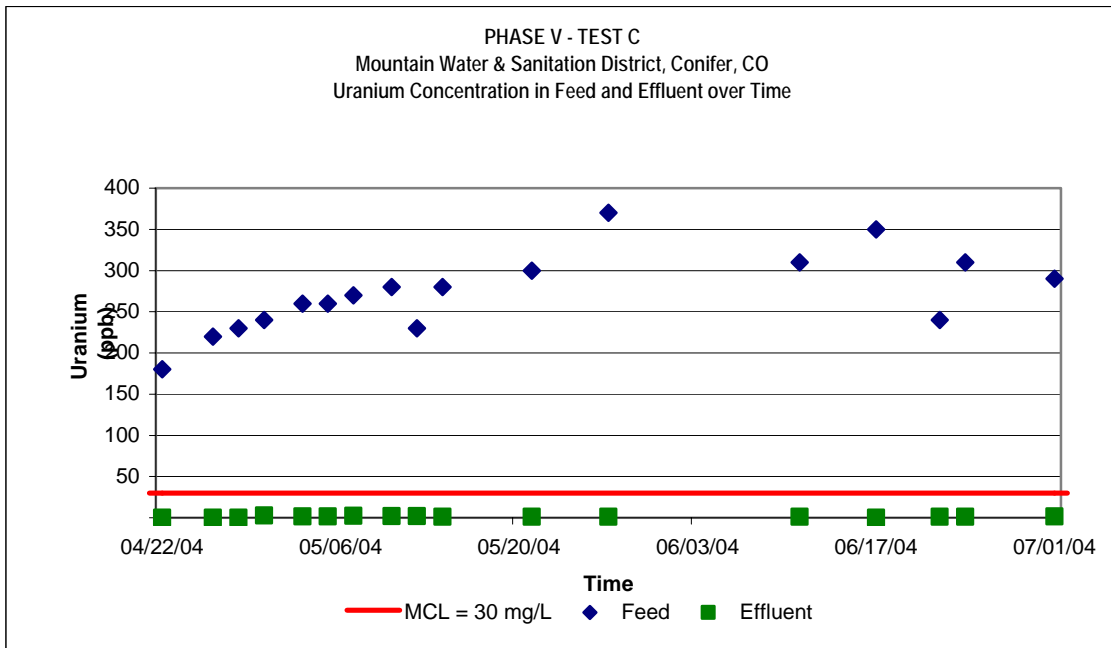


Figure 1

Figure 11 shows uranium levels in the untreated water entering the pilot unit, treated water exiting the pilot unit, and discharge uranium levels and after column 1 as taken from Table 11.

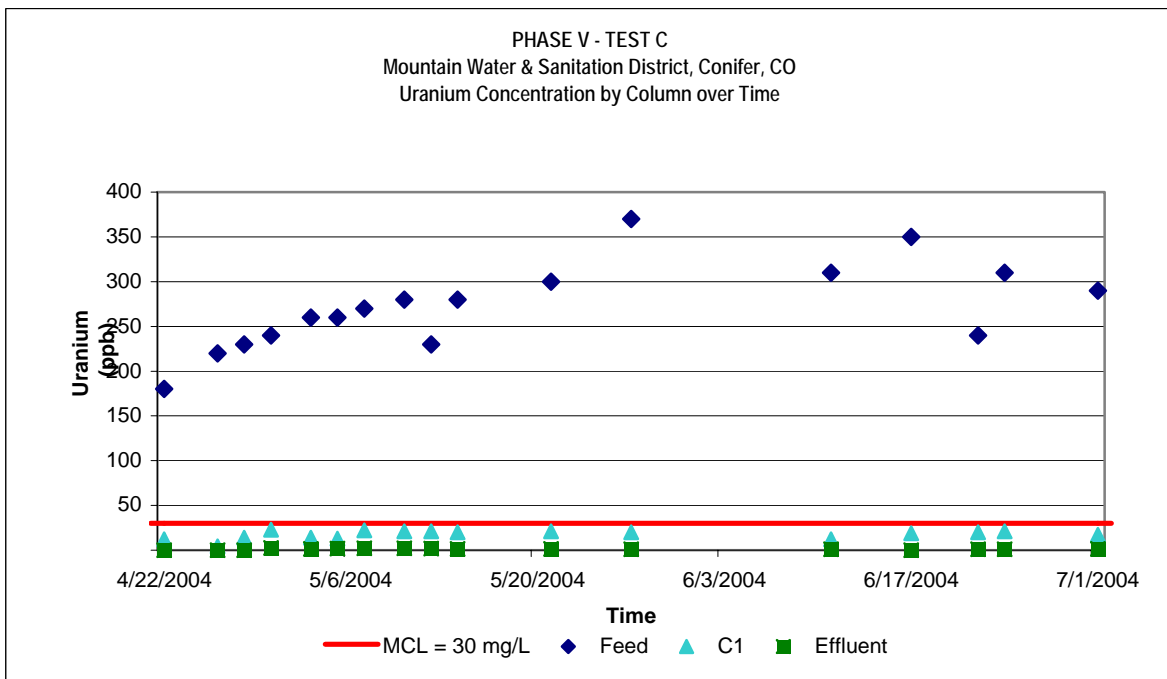


Figure 11

Treatment through column 2 indicates that the pilot system successfully reduced the uranium level to below the MCL of 30 gm/L for 70 days, without a media change.

Gross Alpha Results

The gross alpha sampling results are shown in Tables 12. Feed samples were collected immediately prior to the first column of Z-92™ and at discharge. Analytical laboratory certificates are attached as Appendix B. The results clearly show that the pilot unit successfully reduced gross alpha to below its respective MCL.

Table 12. Gross Alpha Test Results

Gross Alpha	Column Concentrations (pCi/L)		
Date	Feed	Discharge	MCL
9/1/04	275	9.36	15.0

Water Quality

A water quality analysis was performed on feed water to the pilot unit and on treated water exiting the WRT pilot unit treatment process to document any changes in water quality through the Z-92™ treatment process. The results of those tests are shown in Table 13. Other than the reduction of gross alpha and uranium, there is no significant change to the water quality. Support documentation for Table 13 is attached as Appendix C.

Table 13. Water Quality Data entering and exiting the Z-92™ treatment process

Mountain Water Sanitation District – Water Quality Data			
Item	Pre WRT Process	units	Post WRT Process
Alkalinity	83	mg/L	85
Antimony	<	mg/L	<
Arsenic	<	mg/L	<
Barium	0.1190	mg/L	0.1180
Beryllium	<	mg/L	<
Cadmium	<	mg/L	<
Calcium	24.7	mg/L	35.7
Chromium	0.0002	mg/L	0.0001
Chloride	24	mg/L	25
Copper	0.0221	mg/L	0.0231
Fluoride	1.0	mg/L	1.1
Hardness	82	mg/L	118
Iron	0.04	mg/L	0.03
Lead	0.0017	mg/L	0.0012
Magnesium	5.0	mg/L	7.0
Manganese	<	mg/L	<
Mercury	<	mg/L	<
Potassium	0.7	mg/L	0.5
Selenium	<	mg/L	<
Silica	18.6	mg/L	18.4
Sodium	10.1	mg/L	12.9
Sulfate	10	mg/L	20
Thallium	0.00007	mg/L	0.00006
Total Dissolved Solids	190	mg/L	190
Uranium	0.316	mg/L	0.00136
Zinc	0.02	mg/L	0.03

Hydraulic Loading Rate, EBCT

The flow rate during the pilot test period averaged 0.63 GPM, which equates to a hydraulic loading rate (HLR) of 7.2 gallons per minute per square foot. The Empty Bed Contact Time (EBCT) with 6 pounds of Z-92 media at this HLR is 2.6 minutes. Table 6 shows the total treated flow by sample date. Data for Table 12 can be found in Appendix C.

**Table 14. Phase V – Test D
Cumulative treated flow in gallons**

Sample Date	Cumulative Treated Flow In Gallons
4/21/04	0
4/22/04	2,120
4/26/04	4,240
4/28/04	5,075
4/30/04	6,967
5/3/04	9,682
5/5/04	11,515
5/7/04	13,680
5/10/04	16,895
5/12/04	19,106
5/14/04	21,109
5/21/04	27,997
5/27/04	33,602
6/11/04	45,725
6/17/04	51,207
6/22/04	55,945
6/24/04	57,491
7/1/04	63,640



Operational Results

An operation log was maintained during the pilot study, and is attached as Appendix C. There were no equipment failures or maintenance procedures required during the term of the pilot study. The unit operated continuously during the course of each phase of the pilot study without interruption.

Conclusion

The WRT Z-92™ Uranium Treatment Process as operated in Phase V, Test C consistently produced uranium discharge levels below the EPA mandated MCL of 30 mg/L for a period of 70 days. The pilot equipment operated without fault or modification during all the various phases of this study. Full scale plant design parameters such as hydraulic loading rate and empty bed contact time will be interpreted from the data collected and incorporated into the final plant design.

WRT would like to thank the Colorado Department of Public Health and Environment for allowing this field testing to be conducted, and the staff of the Mountain Water & Sanitation District for their invaluable cooperation and assistance during this test.



Appendices available upon request