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Task Order: ST05-102-20
Control No: 1000-T05-1932

August 8, 2005

Mr. Don Aragon
Wind River Environmental Quality Commission
Building 10, Washakie Street
Fort Washakie, Wyoming 82514

SUBJECT: Transmittal of Final ASCG Report: *Evaluation of the Alternate Supply System, Riverton, Wyoming*

Dear Mr. Aragon:

On behalf of the U. S. Department of Energy, Stoller is distributing the final report from ASCG, which documents their assessment of the alternate water supply system. Enclosed is a copy of the report entitled *Evaluation of the Alternate Supply System, Riverton, Wyoming*, along with a memorandum from ASCG highlighting the major changes between the draft report and the final report.

At our last meeting in Fort Washakie, a meeting was scheduled for August 31, 2005, to discuss the results of the final report; however, this meeting has been postponed because Ms. Tracy Plessinger has been temporarily assigned additional responsibilities and will not be able to attend the August meeting. Ms. Plessinger will contact you to reschedule the meeting.

Please feel free to contact me at (970) 248-6654 with any questions.

Sincerely,

Sam Campbell

Sam E. Campbell
Stoller Site Lead

SEC/lac
Enclosure

cc: John Arum, Ziontz, Chestnut, Varnell, Berley, and Slonim
Steve Babits, Wind River Environmental Quality Commission
Richard Brannan, Northern Arapaho and Eastern Shoshone Joint Business Council
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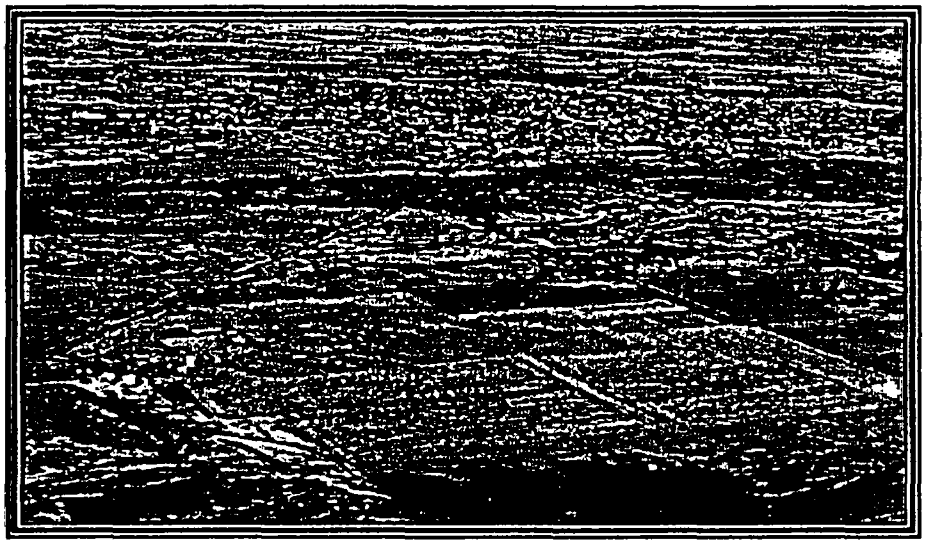

Evaluation of the Alternate Supply System

RIVERTON, WYOMING

July 2005

Project No. 500723

Presented to S.M. Stoller Corporation
By:

ASCG
INCORPORATED
ENGINEERS • ARCHITECTS • SURVEYORS • PLANNERS

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SECTION I

EXECUTIVE SUMMARY

PURPOSE

ASCG Incorporated of Colorado (ASCG) has been contracted by S. M. Stoller to conduct an evaluation of the alternate water supply system serving the Institutional Control Boundary (ICB) area on the Wind River Reservation. The study tasks include:

1. Analysis of data suggesting increased levels of radionuclides in the system, determination of the probable source of the radionuclides, and suggestions to reduce the radionuclide level to below regulatory levels.
2. Determine 100-year integrity of supply system and provide suggestions regarding modifications necessary to maintain 100-year life.
3. Review growth projections for 100-year period and determine capability of system to meet those demands and system improvements that may be required to support 100-year growth.

BACKGROUND

The Northern Arapahoe Utility Organization (NAUO) provides conventional water and sanitary sewer service to approximately 800 customers that are primarily single family residences. Water service is provided to the Arapaho area. The latter includes land within the boundaries of the Wind River Reservation, which was used for uranium processing and tailings disposal. Now that land is owned by the State of Wyoming. Leachate from the tailings has contaminated ground water in that area which may have impacted twenty-five homes. The Department of Energy (DOE) funded construction of the "Alternate Water Supply System," in 1998, to provide safe drinking water to the residents of the area. The Alternate Water Supply System included almost five-miles of pipeline to the east that connected to the NAUO 1.0 MG storage tank.

Random testing has shown levels of radium-226 (Ra-226) and radium-228 (Ra-228) in excess of the U.S. Environmental Protection Agency (EPA) standards and that has raised concern regarding the source of the radium. The fact that portions of the waterline are within the former tailings site raises concern over whether the contamination could be entering the public water system from groundwater surrounding the pipe. NAUO, the DOE, Indian Health Service, and EPA have all attempted to resolve whatever problems exist. The major area of concern appears to be determination of the source of the radium.

APPROACH

ASCG provided the following steps for this report.

1. Gather and review existing data regarding:
    - Water quality
    - Sampling data
    - Historical land use data
    - Construction drawings of the alternate water supply system
    - Growth data
    - Construction records
2. Site Observation was conducted December 14, 2004. Meetings on site with Stoller, NAUO, and other stakeholders provided useful information.
3. Evaluation of radionuclides.
4. Evaluation of physical characteristics of the supply system and determination of longevity.
5. Evaluation of future growth needs.
6. Development of report.

FINDINGS AND CONCLUSIONS

Evaluation of Radionuclides

ASCG contracted with Summit Technical Resources for the review of the water quality of the Alternative Water Supply system. Summit reviewed previous reports for their analysis: *UMTRA Program-Phase II Groundwater/Drinking Water Final Report*; *Data Validation Report for the Riverton Wyoming Processing Site*; and *Verification Monitoring Report for the Riverton, Wyoming, UMTRA Project Site.* What was found was that uranium and molybdenum concentrations in the surface unconfined aquifer were elevated above the MCL and were migrating from the former processing site southeasterly to the Little Wind River.

Sampling and testing of contents of the Alternate Water Supply system within the ICB area included yard hydrants, taps, and service lines fed by wells within that area. Monitoring of the ground water had been previously conducted. Radionuclides in samples collected in the Alternate Water Supply system were elevated relative to the samples collected from the NAUO water supply wells. The most probable source of the radionuclides is the primary water supply – either of two wells pumping from the Wind River Formation which have background radium levels much lower than the MCL's. There could have been an initial contamination from cross connections and residual contamination from construction activities but these are not a continuing source.

Based on analysis of the information, the following conclusions are drawn.

1. The probable source of radionuclides in the alternate supply system comes from the supply water and not from cross connections or entry through pipe.
2. The supply water does not exceed regulatory levels of radionuclides and the samples above limits are most likely due to stale and stagnant areas of the system or biofilm capture and concentration of radionuclides.

Longevity of Water Distribution System

ASCG investigated the materials of construction for the alternative water supply system and utilized EPA tables and AWWA studies to determine the probable life of system

components. Site conditions were also considered regarding influence upon materials to determine the impact on longevity of the system.

The pipeline material is projected to last 100 years, but other system components will require maintenance and replacement in order to provide service for 100 years. The table found in Appendix D provides the summary and costs of replacement of those appurtenances. The conclusion is that approximately $4,074,000 will need to be invested into the alternate water supply system over a 100-year period to maintain the 100-year service life.

ASCG reviewed the impact of site conditions on the longevity of the system. The ICB site contains levels of radioactivity and sulfates from previous uses. Upon consultation with equipment suppliers, it appears these constituents in the soils will not have a negative impact on brass, PVC, and/or ductile iron components. However, the gasket materials probably used may not be considered resistant to radioactivity depending upon the strength of the radioactivity. The site is down-gradient of a sulfur processing facility and, therefore, impact of sulfuric acid was evaluated. The primary materials that are subject to degradation are the gaskets and carbon steel. However, no sulfuric acid has been found in the ground water, and, therefore, there is no anticipated impact on the life of the pipeline.

<u>**Future Growth and Associated Costs**</u>

Previous reports by others determined the population served by NAUO by dividing the total annual use in 2000 by an assumed annual average per capita use of 100 gpd. The population thus obtained was 1,716. The increase in total annual water use from 1991 to 2000 was computed to be at an annual rate of 0.97%. The Indian Health Service (IHS) uses a long term historical population growth of 2.11% and the U.S. Bureau of Reclamation (USBR) uses 1.76%. It is prudent that long term growth be considered at both the IHS or USBR rates. Two scenarios were developed to determine the impact of growth on the alternative supply system. The first is to look at growth strictly within the ICB based on the current number of potential taps and applying the growth rates over the

100-year period and is referred Approach 1. The second is to look at total system growth and allocate 25% of the needs of that growth to the ICB area and is Approach 2.

A population and water requirement was then calculated for both approaches. The capacity of the existing system was then evaluated to determine ability to serve the ICB area. Needed additions to the system were then established and cost estimates assigned to those facilities based on 2005 construction costs. The following provides a summary of the costs associated with growth required facility expansion for the ICB area for both approaches.

Approach 1 Costs

- $ 298,000 Pipeline loop to enhance flow
- $ 392,000 New well

- **$ 690,000 Total costs for growth specific to ICB**

Approach 2 Costs

Estimates of probable cost are given in tables found in the Report. The costs to provide adequate service to the area within the Institutional Control Boundary are:

- $ 1,190,000 to provide an adequate water supply;
- $ 1,526,000 to provide adequate transmission;
- $ 804,000 to provide adequate storage capacity;

- **$ 3,520,000 Total Cost for growth related water system improvements within the Institutional Control Boundary.**

The NAUO charges existing customers a flat fee of $17.00 per month for unmetered service. This fee was compared to 3 other similar tribal regions in Arizona and Montana.

The following are the results and comparisons.

- The Navaho Tribal Utility Authority charges $5.50 per month as the service charge. They then charge $2.20 per 1000 gallons for the first 3,000 gallons used and $3.35 per 1,000 gallons for any additional usage above that level. Using the

averages for the NAUO service area, the comparable charge would be $25.50 based on an average use of approximately 7,000 gallons per month. Absence of metering at individual units would make this impossible to implement.

- The Blackfeet Tribe in Montana charge a single monthly rate of $10.45 with no metered usage fees.
- The Confederated Salish and Kootenai Tribe (CSKT) charge a single monthly amount of $19.50 per month with no metered water fees.

The range of $10.45 to $25.50 for other regions indicates the current NAUO rate of $17 is within range, but there is also justification for some growth.

RECOMMENDATIONS

The following recommendations are a result of this study.

A regular alternate supply system flushing program should be established to prevent radionuclide buildup from stagnant water or biofilm buildup. ASCG would recommend a complete system flush every six (6) months. This will be accomplished by starting at the upper portions of the system and flushing a volume of water equal to the volume held in the selected section. Working down the pipeline with this method will provide a complete turnover of water in the system and most probably, eliminate the radionuclide concentration problem. If a standard flushing program is ineffective, either a more frequent flush or use of high pressure flushing methods to increase flow rates should be considered as the next step.

A capital improvement program should be established to proactively replace components of the system to support the 100-year life expectation. This will require establishing expected service life of each component of the alternate water supply system and set appropriate time frames to refurbish or upgrade the specified component. Typically, capital improvements are funded by tap fees for new system connections. New

connection fees should be considered and a fund established to cover the costs of capital improvements in the future.

Future 100-year growth has been evaluated two ways and two different sets of requirements have been established. Regardless of which method is agreed upon, future capacity improvements will be required. These are also capital improvements which are typically funded from a pool of money established by connection fees for new users. Plans to fund growth will be required at a level between $690,000 and $ 3,520,000 depending on methodology chosen.

ASCG looked at comparable community systems to determine reasonable levels of monthly charges to fund operations, maintenance, and debt reduction costs. Based on the analysis, it would appear that the current monthly fee of $17.00 per customer with unlimited usage is within the range of the charges by other tribal communities. Additional maintenance will be required to reduce the radionuclides but is expected to require the equivalent of 8 man weeks per year. If the recommended flushing program does not prove satisfactory, significant increases in cost are expected.

SECTION II

EVALUATION OF RADIONUCLIDES

INTRODUCTION

Water quality data has been developed for the area within the ICB (refer to Fig. I-A); and was provided to ASCG by S.M. Stoller. Summit Technical Resources, Inc. was commissioned by ASCG to conduct a statistical analysis of that data, and to assist in making a determination of the source of the radionuclides in the public water supply system. Summit provided its analysis in the form of a memorandum[11], a copy of which is found at the end of this section of the report.

Summit's Figure 4 of the report summarized the locations where radionuclides were found in the public water supply. That figure shows levels of radionuclides exceeding regulatory limits in four hydrants connected to the Alternate Water Supply system (identified as sample locations 0818, 0819, 0820, and 0821). Each of these sampling points has been identified as a fire hydrant[2] connected to the Alternate Water Supply system. Wells 0818, 0819, and 0820 are located outside the uranium plume whereas 0821 is located at the southwest edge of that plume.

Concentration of radionuclide contaminants in samples from those wells are shown in Table II-A. Well 0821 showed no contamination that exceeded MCL's. Gross alpha MCL was exceeded by approximately nine percent in 018 and approximately 24-percent in 0819. All contaminants, except uranium, exceeded the MCL in well 0820. None of the samples exceeded the MCL for uranium.

TABLE II-A CONTAMINANT LEVELS AT FIRE HYDRANTS					
Sample Point	Gross Alpha pCi/L	Gross Beta pCi/L	Ra-226 pCi/L	Ra-228 pCi/L	Uranium mg/l
MCL	15.00	20	5.00	5.00	0.0003[b]
0818[a]	16.4	24.3	1.58	2.31	0.00009
0819[a]	18.6	24.1	1.64	2.33	0.00011
0820[a]	70.70	53.50	7.98	7.93	0.00012
0821[a]	11.7[c]	18.0[c]	1.2[c]	1.66[c]	0.000095[c]
[a] Date of sampling: May 2004					
[b] Refer to Reference 2					
[c] Average of two samples					

SOURCES OF RADIONUCLIDES

Introduction of Radionuclides through Cross Connections

There appear to be two plausible cross connections: connection to private shallow wells, and openings in water pipeline components such as hydrants and stop-and-waste valves.

The Scope of Work presented in Stoller's Statement of Work listed only a cross connection to shallow wells. It has been stated that one cross connection to a well has been eliminated. However, there may be others. The date of the disconnect was not provided and, therefore, its potential for contribution of contamination is unknown.

ASCG has concluded that hydrants could allow introduction of contaminated ground water. The fire hydrants are of the dry barrel type. The AWWA manual of practice (M17) states that "When a (fire) hydrant is installed in an area with a high water table, it may be necessary to plug the drain outlets." This is not always practical because of the necessity to pump water from the barrel after use. Dry barrel fire hydrants, freeze-proof yard hydrants, and stop-and-waste valves drain when the main valve is closed. The drain is at the bottom of the barrel; thus it may have been installed below the ground water surface. Barrels of yard hydrants are drained in a similar fashion to the fire hydrants. Thus the drain point, under certain conditions such as when the main pipeline develops low pressure at the opening when high use occurs at other locations, could provide a point of entry for contaminated groundwater. Yard hydrants are typically required to be isolated from the potable water

supply with a back-flow preventer.

The data do not indicate the exact protocol used when taking the samples from hydrants. It has been indicated to us through discussions with Stoller that EPA sampled flows immediately upon opening the hydrant and then again after 30 minutes of flow. Stoller's samples were taken after allowing the hydrants to flow for 30 minutes.

Drawings of the public water supply system call for installation of dry barrel fire hydrants, yard hydrants, frost free yard hydrants, and flush hydrants. Catalog cuts were provided only for fire hydrants. It is concluded that each of these installations is a potential cross connection but would not contribute to sustained high level radionuclide levels. This conclusion is based on the sampling methods used since contamination at the hydrant would only contribute a small amount of water volume to the total flow that would flush out prior to the test at the 30 minute flow time.

Therefore, it is concluded that contamination via a cross connection is possible. However, there is no indication that contamination from cross connections has definitely occurred nor is ongoing.

Introduction of Radionuclides during Installation of Piping in Areas with Contaminated Ground Water

Contamination could have occurred if the pipeline was not properly cleaned before testing and disinfection. ASCG was shown picture(s) taken during construction that showed ground water entering the pipeline during construction. ASCG cannot state for certain this would be a source of radionuclides. Technical specifications governing installation were not provided. It is normal to require pipelines to be installed in a de-watered trench; and to require any contamination that does enter pipelines be flushed out. Daily reports of construction observation are lacking in detail; and results of testing for bacteria, radionuclides and/or leaks are not indicated.

Therefore, it has to be concluded that contamination of the pipeline during construction is a possibility. However, this is a one-time occurrence; further contamination would not occur; and, therefore, there would be no long term buildup.

Introduction of Radionuclides During Low Pressure Periods

This method of introducing contamination implies there are structural problems with the pipelines. Bury of the pipeline is between 6- and 7-feet. At this depth, the pipe would normally not be deflected to out-of-round. The joints are gasketed; if the pipe were adequately seated during construction, the pipe can expand and contract longitudinally without losing its seal. If the pipe were adequately tested upon installation and leaky joints corrected, there should be no joints that will pass water in either direction through the joints. The depth of bury would put a static ground-water pressure on the pipe of less than five psi – which is much less than the pipeline pressure.

There is no record of line breaks or large volumes of water being lost. Permeation of the materials through the water pipeline material is covered elsewhere and is not considered a factor at this time.

It is concluded that the radionuclides were not introduced in this manner.

Buildup of Radionuclides in a Biofilm on Pipe Walls

According to Linda Figueroa, PhD, Colorado School of Mines, (private conversation, December 23, 2004) bacteria (read biofilm) is a good absorber of radioactive solids such as radium. She is currently investigating adsorption of radium by biofilm in water pipelines on a Navajo Reservation. When the biofilm sloughs, the absorbed materials will also be released into the water resulting in a hit, or spike, in the concentrations. This implies, then, that if there is no sloughing, concentration of radionuclides would not be in excess of that in the water supply source.

The Center for Biofilm Engineering at Montana State University is investigating biofilms in industry, medical and public water supply system. A listing of some work in the latter is provided in the REFERENCES. The following is paraphrased from a publication by Camper[20]:

> "The low nutrient environment present in drinking water treatment plants and distribution systems would not appear to be a hospitable environment for bacterial growth. However, biofilms are found on almost every submerged surface in treatment plants and distributions systems. Distribution biofilms can release indicator organisms and may cause taste and odor problems. Control of these biofilms is difficult. Disinfection alone is usually ineffective.

Reduction of organic matter, improved disinfection, and control of corrosion in unlined iron pipes, or a combination of these methods is helpful in controlling distribution system biofilms."

Other studies[15, 16, 18] have concentrated on biofilm accumulation in iron pipelines. However, based on the above statement from Camper, it would appear that a biofilm will develop on almost any surface, including plastic and the bituminastic coating on cement mortar linings of ductile iron pipe fittings.

EPA conducted sampling of flushed water from fire hydrants and noticed radium concentrations of an amount exceeding the MCL and then a drop off over time. This implies that the flushing may have moved a slug of water containing higher levels of radionuclides with a varying concentration.

No physical evidence was provided to ASCG confirming or disproving existence of a biofilm in the Alternate Water Supply System. However, as presented previously, there is considerable evidence that such films commonly exist in water distribution system pipeline and could exist in the Alternate Water Supply. Therefore, it is presumed to exist in the Alternate Water Supply System. Then it follows that radionuclides will be adsorbed by the biofilm and later released as the biofilm sloughs off at a concentration that is high but probably not indicative of the average in the water.

Increased Radionuclides Due to Stagnant Flows

The alternate water supply pipeline, due to its size and length contains a large volume of water and has only 19 service connections within the ICB area. The total volume of water in the pipe below the intersection of White Tail Drive and Mission Road is over 36,000 gallons. The nineteen connections to the system below this point would use enough water to only turn the volume over once every seven days. This would create a low flow in the pipeline and allow settling and stagnation at deadends and low points. At least three of the sampling points indicating above standard radionuclides are on deadend lines or at low points of the system. The radionuclide contaminates can settle out in a manner similar to manganese and iron, which is typically problematic at deadends and low points of public water systems. Accumulation of radionuclides in these areas would allow for concentrations higher than desired and also create a plug of contaminated water that could appear

after 30 minutes of flushing. Given this analysis, it is likely that low water use and settling of radionuclides in the supply water could build up higher concentrations of radionuclides over time.

ANALYSIS OF RAW WATER SUPPLY

The Summit analysis shows water from three (of four) hydrants tested high for gross alpha and beta radiation. All were sampled on the same day. The triangle formed by the system at the northeast corner may or may not be looped according to information provided by Stoller personnel (Sam Campbell). It is not known if the leg running north-south connects to the Alternate Supply Water line in Goes in Lodge Road and in Rendezvous Road. In either case, the flow of water would be from the storage tank to Red Crow Lane and to Littleshield Road to Goes in Lodge Road to Rendezvous Road. The pipeline is down-gradient from the tank to the intersection of Goes-in-Lodge Road and Rendezvous Road.

The rise in gross alpha between 0818 and 0819 is relatively small and is probably not significant. Levels of gross beta, Ra-226, Ra-228 and uranium are about the same in both hydrants. Sample points 0818 and 0819 are considered to be outside the area of influence of the mill site, tailings pond, and sulfuric acid plant. Hydrant 0818 is at the highest elevation and hydrant 0819 is at the lowest elevation of the four hydrants. Water could flow from 0820 to 0819 if the main to 0820 were connected at both ends to the Alternate Water Supply line. Water could also flow from 0821 to 0819 but that would create a vacuum in the line, but this is highly unlikely. Therefore, it is concluded that the water to hydrants 0818 and 0819 is of the same origin and tested differences was not caused by a cross connection or new source between them.

Hydrant 0820 is outside the plume where the uranium concentration is at least 0.100 mg/l. Hydrant 0821 is within the plume of uranium bearing ground water but it showed less uranium concentration than the other three hydrants. This would imply the source of the radionuclides is from elsewhere; i.e. not from groundwater within the ICB.

The description of the wells given in the HKM report[1] does not give the water bearing formation for the existing water supply wells. Stoller noted the source as being the Wind River Formation. This is

a formation from which significant amounts of uranium were mined in the 1900's. Radium is typically found in uranium bearing formations and has been found, in small concentrations, in the water from the NAUO wells.

Presence of radionuclides in the well water, at levels well below the MCL, has been proven. It has been hypothesized that a biofilm or stagnant areas in the pipelne probably exists that will concentrate the radionuclides and then periodically release the radionucledes having the effect of increasing the radionuclides to concentrations greater than the MCL.

It is concluded the most likely source of the radionuclides is in the primary water supply, but alternate water supply system operation, or biofilm are possibly allowing increases in concentration to above acceptable levels.

REDUCTION OF RADIONUCLIDES

Introduction

ASCG contacted the Denver Water Board and three private contractors experienced in removal of biofilms. All expressed concern that the waste would be considered hazardous; and Denver Water Board personnel stated that they could not discharge such material according to their discharge permit issued by the Colorado Department of Public Health and Environment. Thus the waste products from the pipeline cleaning may have to be collected and disposed of as a hazardous material.

Any of the alternatives presented herein will require cleaning the entire Alternate Water Supply pipeline resulting in removal and disposal of the complete volume of water in the pipeline. The 8-inch portion has a capacity of approximately 90,000 gallons and the 6-inch approximately 10,400 gallons. Thus each cleaning will result in removal and discharge of approximately 100,400 gallons.

Monitoring

Any program that will reduce, or remove, radionuclides will have to be proven effective much the same as other operations of water utilities are. The program will have to be designed to assure no

back-contamination occurs and the effectiveness of the program will have to be proven by a monitoring program. Such program will consist of sampling and testing water flushed out of the system and followed by additional sampling and testing of water from flushing points at specified intervals between the main flushing programs.

__Reduction of Radionuclides__

Radium will be present because it is in the water supply, and will be expected to concentrate in the biofilm. In that event, the system will require periodic cleaning. EPA (conversation with Bob Clement, June 29, 2005) believes that a large percentage of the radium deposits can be removed if the pipelines are flushed with water at a velocity exceeding 2 feet-per-second (fps). The Denver Water Department runs it flushing program at velocities varying from 3 to 5 fps (conversation with Mike Ranger, 06 July, 2005). The Denver Water Board annually flushes 900 dead end lines and 2,500, or more, reaches with blowoffs.

It is also the experience of the Denver Water Board that flushing at 3 fps is adequate to remove sediment and particles loosely attached to the biofilm; and that the biofilm can be stripped from plastic pipe at a flushing velocity of 5 fps. The Alternate Water Supply system is capable of creating those velocities during flushing.

EPA engineers believe the system should be flushed twice yearly in order to prevent undue buildup of radionuclides. Presence of radionuclides may require the flush water be collected and disposed of in a controlled manner. Denver Water Board experience is that reaches generally have to be flushed 2 or 3 times to achieve the desired level contaminant removal.

There are two options to deal with reduction of radionuclides or removal of biofilm. ASCG suggests starting with a standard flushing program to deal with stagnant water and to remove radionuclides from the biofilm. The next option if the flushing is ineffective is to attempt to remove the biofilm. There are three alternative methods to remove the biofilm. ASCG suggests that a monitoring program be implemented as the basis of determining the adequacy of an adopted option or alternative. It is suggested that Option 1 be adopted initially as a simple flushing program. Samples should then be obtained from the four locations previously indicating higher levels of radionuclides

in the study area immediately after the first flushing. If unacceptable results are obtained, it is recommended the system to be flushed again and sampled. Upon receiving acceptable samples at the hydrants, it is recommended that two random home connections also be sampled to verify success. Samples at the hydrants and the random taps should then be conducted at the 30-day point and again 90 days later. After the system is flushed once again at the 6-month point, samples should once again be obtained. If still acceptable, it is suggested that sampling occur each 90 days for a 2-year period.

If Option 1 proves unsuccessful, Option 2, alternative 1, 2, or 3, whichever is most economical and convenient should be instituted. The same sampling frequency is recommended for these alternatives as previously stated.

Option 1: Conventional Flushing

Municipal water systems have a periodic flushing program designed to maintain water quality in dead end lines and troublesome areas. Although the flushing is not expected to remove the biofilm, it will (1) remove other contaminants, perhaps including some solids absorbed by the biofilm; (2) reduce the rate of accumulation of radium and other contaminants by the biofilm; (3) remove biofilm that has sloughed rather than allowing it to be moved, with adsorbed contaminants, into the service lines; and (4) remove despots of minerals that may have precipitated out of the water.

The flushing program will require installation of additional flushing points and pipeline valves depending primarily upon the method of collection and disposal of the water removed. The system would be flushed starting at the higher end to the first flushing point; and then flushed sequentially downstream thus preventing contamination of previously flushed pipelines by new flushing. Flushing rate would be monitored to assure a minimum velocity of 3 fps is attained throughout the flushing period. The pipelines would be checked for contaminants before and after each flushing; and detailed records of the work accomplished would be maintained. The program would include an initial system flush followed by a second within a relatively short time (6 months).

Option 2: Removal of Biofilm

Alternative 1: High Flow Flushing. To achieve effective removal of the biofilm, the flushing

water velocity should be 6 fps or greater (conversation with EPA engineer Gary Carlson; March 30, 2005). The analysis for flushing (above) indicated that the system could provide flushing at a maximum velocity of 5 fps. The head loss would increase by about 17%, pressures in the outer reaches would drop to or below 0 psi, and the system would not be cleaned at the outer reaches of the 8-inch pipeline. Therefore, this is not considered a viable alternative for removal of the biofilm for this system without bringing in a contractor to create the necessary velocities at significant costs.

Alternative 2: Mechanical Removal

Introduction. Pipelines 4 inches in diameter and larger are typically cleaned by at least one or two methods – pigging and/or jetting. Each method requires points of entry into the pipeline (launch points). The number of launch point locations will be a function of the physical features of the pipeline and will need to be ascertained at the time the work starts. The biofilm is removed from the pipeline wall, removed from the pipeline, and then transported to a point for handling and disposing of the waste—which might be considered to be hazardous.

Pigging. Pigs typically have wire brush straps or silicone carbide incorporated in the coating on a medium density foam. The pig is normally forced through the pipeline using water pressure between 60 and 100 psi. Pigs are of such construction they are typically forced through bends and full-throated valves (such as completely open gate valves). Runs as long as 8,000 feet have been successfully cleaned by this method.

The launch location can be into a section of the pipeline below a closed valve that is opened to use the water pressure to move the pig; through a fire hydrant, or a point specifically constructed for this purpose.

The section of line will probably be pigged twice to assure good removal of the biofilm. A private construction crew can clean approximately 2 miles of pipeline per day, depending upon the number of launch sites required. Cost of cleaning will be on the order or $4.25 per foot plus waste disposal and per diem for the crew. This assumes the launch points will be available. The crew could clean the 8-inch and 6-inch Alternate Water Supply System in an estimated 5 working days. It may be necessary to install additional valves and launching/receiving stations for this alternative.

Denver Water Board personnel have conducted some pigging operations and believe it is the best method for removal of the biofilm. They typically introduce the pig into the pipeline at the discharge of a pump, which provides the necessary head. The Alternate Water Supply Line starts almost at the highest point in the system and, therefore, there would be insufficient head for the pig. The line is almost level from station 0+00 to about 19+50; and then slopes steeply to about station 28+00. A pig could be inserted in the pipeline at this location where the static pressure would be approximately 100 psi. Thus there is sufficient pressure at station 28+00 to pig over 90% of the Alternate Water Supply pipeline.

Jetting. Jetting involves directing 40 to 60 gpm of water at a pressure between 1,000 and 6,000 psi at the pipe walls. The jetting equipment can pass through 45^0 bends but not 90^0 fittings such as bends and tee outlets. The distance between launch points is limited to about 700 feet. Typical production for a crew is to clean 3,000 to 4,000 feet per day. Cost is expected to be at least competitive with pigging.

Alternative 3: Use chlorine or other oxidant to destroy the biofilm. The article by Camper[20] indicates that chlorine may not be effective in removal of a biofilm. However, complete removal may not be necessary if a significant percentage of the biofilm were removed. The AWWA standard for disinfecting a water line is to add sufficient chlorine to assure a 10mg/l residual of free chlorine after a 24-hour period[14]. Protocols are given for cleaning and flushing out the pipeline before disinfection, feeding the chlorine, and discharging and disposing of the heavily chlorinated water. The procedure would be time consuming, requiring shutdown of the system during the program, and redoing the test if the residual does not achieve to the specified minimum chlorine concentration.

The major drawbacks of chlorination are the amount of time the system will not be able to provide service to customers, disposing the high concentration of chlorinated water with a high concentration of chlorine, and the ineffectiveness of the chlorination removal of the biofilm.

CONCLUSIONS AND RECOMMENDATIONS

ASCG recommends utilizing the Option1 method of flushing to reduce radionuclides in the system. The approach, frequency and monitoring suggestions were previously outlined. If unacceptable results are obtained after instituting option 1, ASCG suggest implementing alternative 2 of option 2 outlined previously.

To: Doug Meurer, ASCG, Inc
From: Daniel Reeder, Summit Technical Resources, Inc.
Date: July 8, 2005

Subject: *Riverton UMTRA Water Line Evaluation Technical Memorandum*

INTRODUCTION

The Riverton UMTRA Site is located four kilometers (2.5 miles) southwest of the center of Riverton on the north side of State Highway 789 in Fremont County, Wyoming (Figure 1). Before remedial action, the tailings pile occupied about 29 hectares (72 acres) at an average depth of 1.2 meters (4 feet). The site is located within the boundaries of the Wind River Indian Reservation, which is occupied by the Shoshone and Arapaho Tribes.

Contamination at the Site resulted from milling of uranium ores. At the start of the UMTRA clean up project, radioactively contaminated materials at the site included uranium and vanadium mill tailings, radium, thorium, and uranium residues mixed locally with soil, and debris remaining from the prior mill demolition work. Prior to site remediation, the mill site and tailings pile were acquired in 1987 by the State of Wyoming.

Remediation began in May 1988 and was completed in September 1990. After decontamination of the former mill site, the cleaned-up areas were backfilled with clean soil and graded to elevations compatible with the surrounding land and drainage. The areas were then revegetated with native species. Ownership of the remediated site will eventually revert from the State of Wyoming to industrial/commercial use. The U.S. Department of Energy (DOE), in order to fulfill requirements of the UMTRA program for groundwater restoration, will retain control of the property until all phases of the UMTRA Riverton Project are complete (USDOE, 2004).

In 1998, DOE funded the construction of the alternate water supply line by the Indian Health Service as an institutional control to prevent human consumption of contaminated groundwater. The water source originates from two municipal water wells (Arapahoe Water Wells #1 and #2), which were drilled approximately 3 miles west of the Site. Water is pumped from the confined aquifer to a 1-million gallon tank and then routed to individual residences via a gravity fed water supply line. The water supply system serves 25 local residences. Sampling and analyses of this system from hydrants and resident taps were performed between November 2002 and January 2003. Results indicated elevated levels of Ra-226, Ra-228, gross alpha, and

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gross beta above maximum concentration limits (MCLs).

This Technical Memorandum addresses the water quality observed in the alternate water supply line. The purpose of this evaluation is to review applicable Site documents and to evaluate the available water quality data collected from the Riverton UMTRA Site. The primary objective of this evaluation is to determine the source of contamination by comparing and contrasting the water chemistry of the shallow groundwater, the deeper groundwater data from the two municipal water wells, and the water collected from the water supply line.

HISTORICAL DOCUMENT REVIEW

Three applicable Site reports were reviewed for this evaluation: (1) *UMTRA Program-Phase II Groundwater/Drinking Water Final Report* (Phase II UMTRA Report [Babits, 2003]); *Data Validation Report for the Riverton Wyoming Processing Site* (USDOE, 2004); and *Verification Monitoring Report for the Riverton, Wyoming, UMTRA Project Site* (Verification Monitoring Report [UDDOE, 2003]).

The Data Validation Report (USDOE, 2004) and Verification Monitoring Report (USDOE, 2003) summarize water quality data collected from wells, hydrants, taps, and surface water at the Riverton UMTRA Site. Findings from these reports include the following:

- Uranium and molybdenum concentrations in the surficial unconfined aquifer were observed above the MCL. The contaminant plume appears to be migrating from the former processing site to the southeast toward the Little Wind River. Concentrations of uranium appeared to increase slightly in the center of the plume, at monitor wells 0707 and 0722. This is likely attributed to natural flushing of the surficial materials caused by seasonal fluctuations in water levels (USDOE 2003).

- Uranium concentrations were elevated in the oxbow lake, located along the north shore of the Little Wind River (Figure 1). Data indicates that this lake is recharged by contaminated (unconfined surficial) groundwater. However, tissue samples of resident fish indicated minimal impact to aquatic life because the sampling results were significantly less than human health benchmark levels (USDOE, 2004).

- Radionuclide samples collected from hydrant locations were elevated relative to the samples collected from the municipal water supply wells (Arapaho Water Wells #1 and #2). Samples collected from hydrant sample location 0820 exceeded MCLs for gross alpha (15 pCi/L) and Ra-226 + Ra-228 (5 pCi/L). Elevated activities of gross alpha were also observed at hydrant locations 0818 and 0919 (USDOE, 2004).

The Phase II UMTRA Report (Babits, 2003) outlines the following four hypotheses for the elevated radionuclides observed in samples collected from water line hydrants:

1. Elevated levels of radionuclides may have been caused by an unregulated cross connection from a potentially contaminated domestic well. This cross connection has since been detached from the main water supply line, however there is a possibility that other cross connections may exist.

2. Contamination may enter the water line via line breaks or leaking gaskets. This scenario is unlikely due to the high pipe pressures within the water lines. The water supply line is gravity fed by a 1-million gallon storage tank, resulting in an estimated downgradient pipe pressure of 100 psi. A severe pressure drop from line breaks or gasket leaks would be required before groundwater could enter the line. The water line is of relatively new construction and breaks have not been reported to date.

3. Contamination may occur via permeation through the water line material. This is unlikely, because gross alpha radiation cannot penetrate the water line, which is constructed of PVC material.

4. The EPA has proposed that radionuclides may accumulate on biofilm material, which may build along the interior piping. The release of radionuclides may occur during turbulent flushing events. For example, sampling and analyses indicate that radionuclide activities were initially low immediately after the hydrants were opened. Radionuclides significantly increased after several minutes of flushing, but then decreased to background levels after 20 minutes of flushing.

It is uncertain as to whether this phenomenon was caused by biofilm adsorption and subsequent desorption of radionuclides during flushing or simply represents a slug of contaminated water within the pipeline, which was introduced by a cross connection from a contaminated well.

DATA LIMITATIONS

The water quality evaluation of the wells, taps and hydrants at the Riverton UMTRA Site was significantly limited by data gaps and inconsistent data sets. These data gaps and deficiencies are summarized in Table 1. A significant limitation is that target analytes were inconsistent between sampling locations. For example, major ion chemistry was not available for the majority of the sampling locations, including several of the water line taps and hydrants. This made it difficult to compare and contrast the hydrochemistry between sampling locations. Note that analyses of major ion chemistry makes it possible to evaluate changes in hydrochemistry along given flowpaths (e.g., water supply line). This also makes it possible to determine the origin and genesis of water. In addition, several sampling locations did not include radionuclide analyses, which is a significant deficiency considering that the site once contained 72 acres of uranium mill tailings.

The spatial coordinates of several sampling locations could not be identified. This essentially renders these data useless for this evaluation. Of importance is the unknown

identity and location of the cross connection between one of the domestic wells to the water supply line. This feature needs to be identified because it is a potential cause of the elevated radionuclides observed in the water supply line.

In addition, only a single sampling event was performed at the majority of the sampling locations. A few locations were sampled twice. The lack of multiple observations at given sampling locations prevented the use of ANOVA statistical comparisons between sampling locations. A minimum of four observations per location should be available for ANOVA comparisons. For dynamic systems such as groundwater, most statistical applications require quarterly sampling to account for seasonal fluctuations in water quality.

HYDROCHEMISTRY

Despite the obvious data gaps and inconsistencies discussed previously, major ion data were available from several wells and hydrant locations. These data are presented in Table 2. Note that only two of these locations, Arapaho Wells #1 and #2, had complete sets of major ion data (i.e., Ca, Mg, Na, K, HCO_3 or CO_3, SO_4, and Cl). The remaining locations were missing HCO_3, CO_3, or alkalinity data.

However, the missing HCO_3 + CO_3 can be estimated based on the fact that natural water is an electrically neutral system (Fishman and Friedman, 1989). Given that the quantities of the major cations (Ca, Mg, Na, K) and majority of the major anions (SO_4, and Cl) are known and assuming electrical neutrality between the major cations and anions, the unknown quantity of HCO_3 + CO_3 can be estimated by balancing the milliequivalents per liter (meq/L) between cations and anions. This is a valid estimate considering that the major ions typically account for nearly the entire composition of natural waters. However, it should be noted that the calculated HCO_3 + CO_3 quantity is slightly overestimated because other minor constituents such as Br and NO_3 may also contribute to the overall composition of the water (typically < 1%). Overall, this estimate will suffice for characterizing the ionic signatures of sampled water at the Riverton UMTRA Site.

The relative concentrations of the major cations and anions are plotted on the trilinear-diagrams presented in Figures 2 and 3. Figure 2 shows the ionic compositions of the municipal water supply wells, samples from hydrants and/or taps from the municipal water line, and samples from wells completed in the confined (#441) and semiconfined (#445) aquifers. The chemical signatures of the samples obtained from the municipal wells and water line have almost identical compositions and can generally be classified as a Na − HCO_3 + CO_3 water. However the similar composition between the two waters should be qualified due to the lack of data at multiple tap locations along the municipal water line. This makes it difficult to differentiate subtle changes in water chemistry and/or zones of mixing, which may occur at different points along the water supply line. Also of note is the sample from the Arapaho Well #2, which has a much higher sulfate content and is classified as Na − SO_4 water. This sample, which was collected in November 2002 differs significantly from the sample (Na − HCO_3 + CO_3) collected in

July 2000 from the same location. The change in water chemistry between July 2000 and November 2002 may be due to changes in the groundwater flow path, seasonal water level fluctuations, error in analytical and/or sampling, or a change in chemical composition due to well contamination.

The chemical compositions of samples obtained from Wells #441 (Ca + SO_4) and #445 (Ca − HCO_3 + CO_3) also differ significantly from the other samples. This is not unexpected because these samples were collected from different hydrogeological zones than the samples collected from the municipal wells. The diagram does indicate some degree of mixing between the confined and semiconfined aquifer at these locations. Given that these two wells are located adjacent to one another, it's possible that there may be some degree of hydraulic connection between the completion zones of these wells.

Figure 3 shows the ionic composition of samples collected from the confined aquifer beneath the Site. With the exception of the sample obtained from Well #417 (which has a slightly higher calcium content), the majority of the samples can be classified as a Na − HCO_3 + CO_3 or Na − SO_4 water. Note that these samples plot along the same axis on the diamond shaped diagram and anion triangle. This suggests that the chemistry of these samples are very similar, with only variations in SO4 and HCO_3 + CO_3 content. A spatial pattern emerges that may explain these variations. For example, the wells with the higher sulfate content are generally downgradient of the Former Mill Site, whereas the wells with the higher bicarbonate + carbonate content are either upgradient or side gradient of the Former Mill Site. Note that Well #17, which is classified as a Na + Ca − HCO_3 + CO_3 water is also upgradient of the Former Mill Site. One explanation is that the sulfuric acid leaching process, which occurred at the Former Mill Site likely contributed to the increased amount of sulfate content downgradient of the facility.

Figure 4 shows the spatial configuration of radionuclides that exceed MCLs in wells and hydrants at the Site. As shown, uranium, Ra-226, Ra-228, gross alpha, and gross beta exceed MCLs at nine locations. Note that MCL exceedances were also observed at four other locations (Red Crow Ln. #2, Rendezvous Rd., Rendezvous Rd. #2, Rendezvous Rd. #3), but could not be plotted because the exact or approximate locations could not be determined. The highest activities of Ra-226, Ra-228, and gross alpha are present at hydrants 0820 and 0819, and the service line at 865 Rendezvous Lane. Radionuclide results for all locations are presented in Table 3.

RECOMMENDATIONS

Additional data are needed to adequately assess the water quality of the water supply line and groundwater beneath the Site. Standard monitoring protocol is required before any definitive assessments can be determined regarding the nature and source of contamination of the water supply line. A systematic approach such as the EPA Data Quality Objectives (DQO) Process (EPA, 2000) should be adopted prior to initiating the next round of sampling and analyses. Data Quality Objectives need to be clearly defined

so that a monitoring program can be designed to satisfy regulatory and stakeholder requirements. The DQO process is a planning tool for data collection activities. It provides a basis for balancing decision uncertainty with available resources. Note that the DQO process is required for all significant data collection projects within DOE's Office of Environmental Management.

The following are some basic monitoring components that should be considered for future sampling events:

- Sampling locations should be surveyed and defined with spatial coordinates and clearly sited on a map;
- Seasonality should be considered. Four quarterly sampling rounds should be considered to determine seasonal effects on groundwater quality;
- Target analytes need to be consistent at each sampling location;
- The sampling suite should include the major ions (Ca, Mg, Ca, Mg, Na, K, HCO_3 + CO_3, SO_4, and Cl), radionuclides (Ra-226, Ra-228, U-238, gross alpha, and gross beta), pH, and metals; and
- Multiple sampling points should be established along the municipal water supply line to measure subtle changes in water chemistry and determine potential mixing zones.

The data indicate that sulfate concentrations in groundwater are elevated downgradient of the former mill site. The reports reviewed do not adequately address the nature of sulfer and how it may impact the hydrological system at the site. Processes that may impact the uranium and radionuclide concentrations include the potential generation of sulfuric acid as the residual sulfer material is leached through the soil horizon. Changes in soil pH to the more acidic phase may cause uranium and radionuclides that are normally adsorbed to soil and geologic material to be released into solution. This may explain the increase in uranium concentrations observed in the center of the plume, at monitor wells 0707 and 0722. In addition, the sulfuric acid plant, located within the former mill tailings site may also be a potential source of sulfate contamination. Continued monitoring is necessary to evaluate temporal trends changes groundwater quality and potential sources of contamination.

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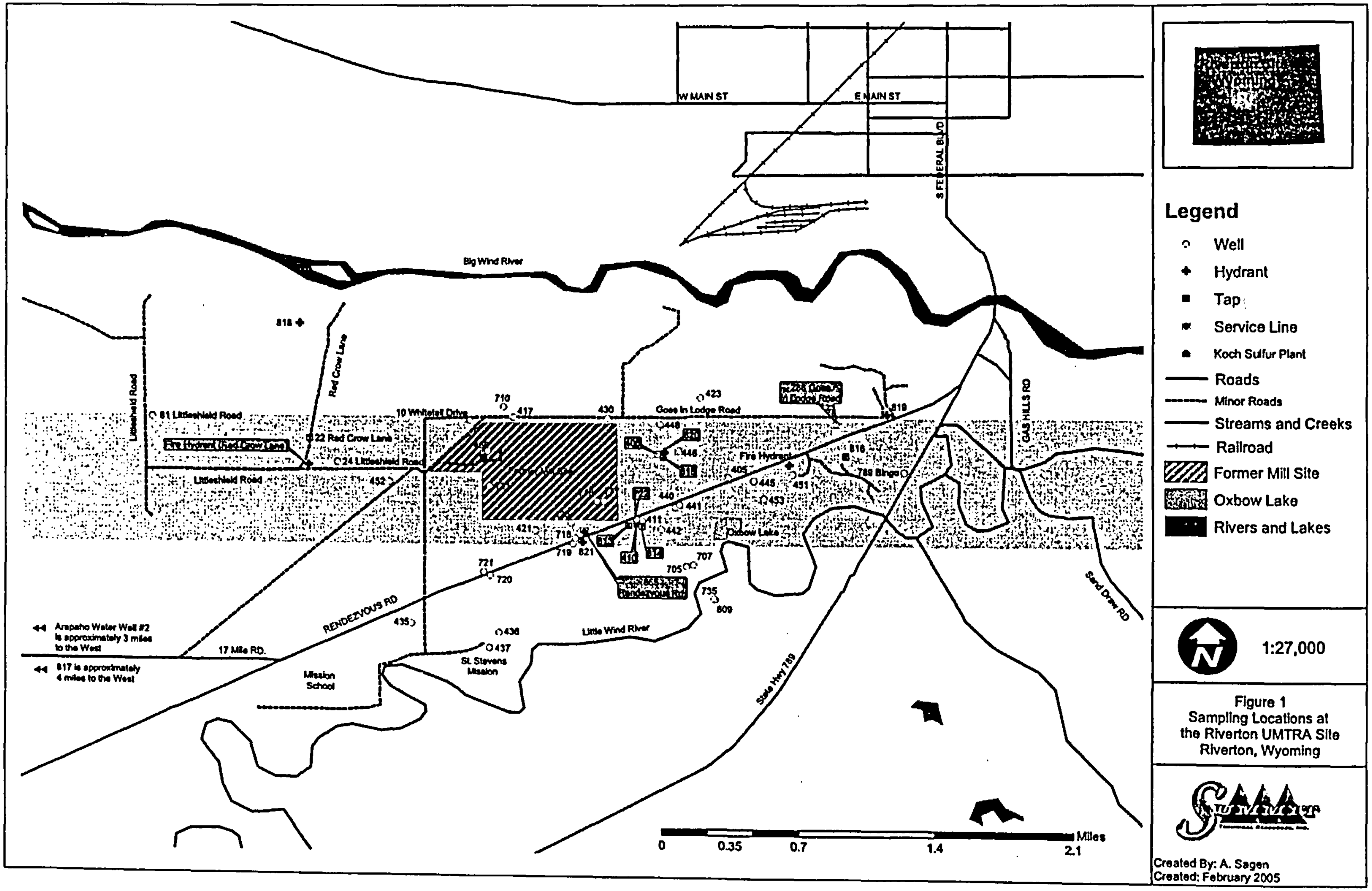


Figure 1
Sampling Locations at the Riverton UMTRA Site
Riverton, Wyoming

Figure 2. Ionic Composition of Riverton UMTRA Site Samples

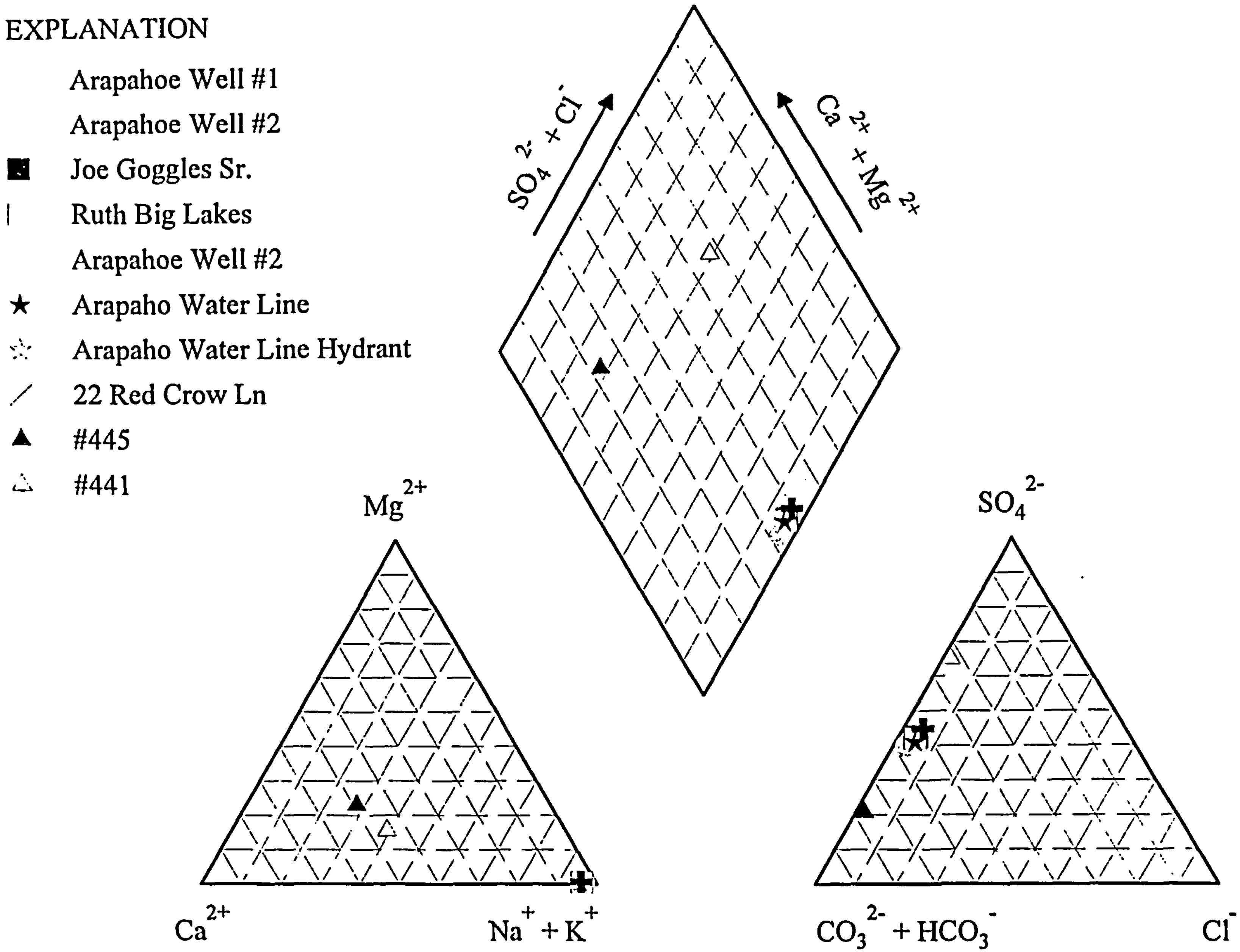
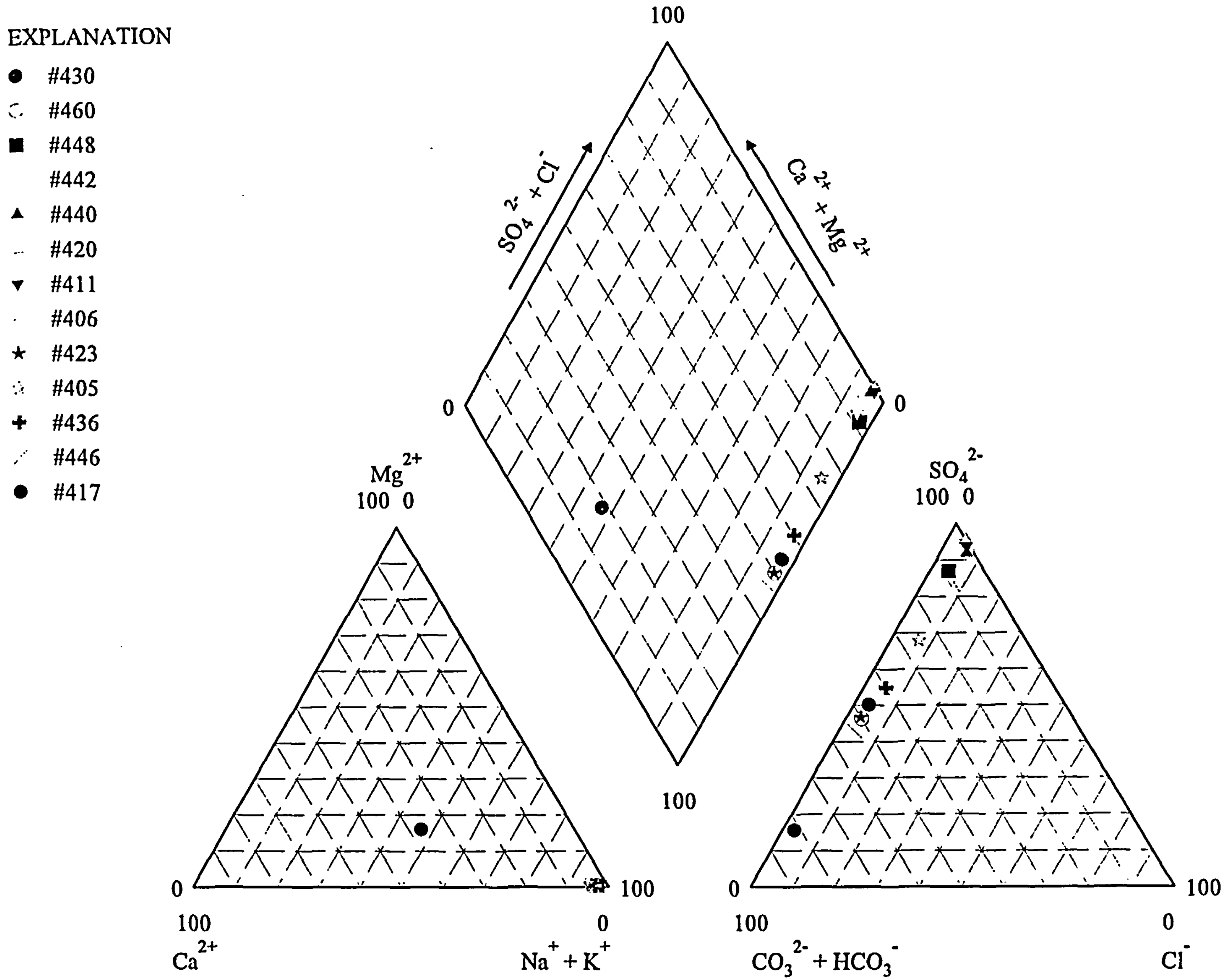
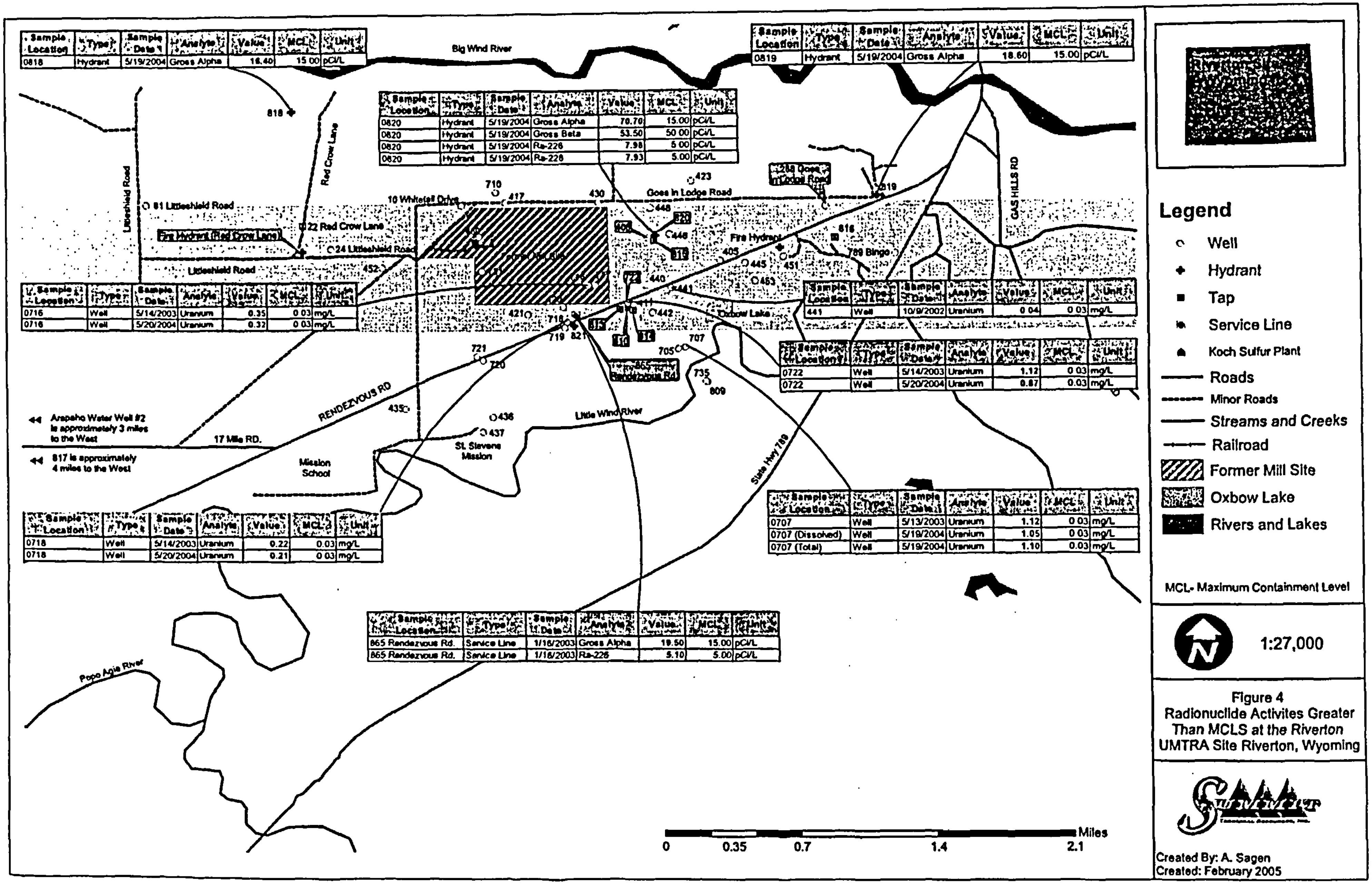


Figure 3. Ionic Composition of Groundwater Samples at the Riverton UMTRA Site





Sample Location	Type	Sample Date	Analyte	Value	MCL	Unit
0818	Hydrant	5/19/2004	Gross Alpha	16.40	15.00	pCi/L

Sample Location	Type	Sample Date	Analyte	Value	MCL	Unit
0819	Hydrant	5/19/2004	Gross Alpha	18.60	15.00	pCi/L

Sample Location	Type	Sample Date	Analyte	Value	MCL	Unit
0820	Hydrant	5/19/2004	Gross Alpha	70.70	15.00	pCi/L
0820	Hydrant	5/19/2004	Gross Beta	53.50	50 00	pCi/L
0820	Hydrant	5/19/2004	Ra-226	7.98	5 00	pCi/L
0820	Hydrant	5/19/2004	Ra-228	7.93	5.00	pCi/L

Sample Location	Type	Sample Date	Analyte	Value	MCL	Unit
0716	Well	5/14/2003	Uranium	0.35	0 03	mg/L
0716	Well	5/20/2004	Uranium	0.32	0 03	mg/L

Sample Location	Type	Sample Date	Analyte	Value	MCL	Unit
441	Well	10/9/2002	Uranium	0 04	0 03	mg/L

Sample Location	Type	Sample Date	Analyte	Value	MCL	Unit
0722	Well	5/14/2003	Uranium	1.12	0 03	mg/L
0722	Well	5/20/2004	Uranium	0.87	0.03	mg/L

Sample Location	Type	Sample Date	Analyte	Value	MCL	Unit
0707	Well	5/13/2003	Uranium	1.12	0 03	mg/L
0707 (Dissolved)	Well	5/19/2004	Uranium	1.05	0 03	mg/L
0707 (Total)	Well	5/19/2004	Uranium	1.10	0.03	mg/L

Sample Location	Type	Sample Date	Analyte	Value	MCL	Unit
0718	Well	5/14/2003	Uranium	0.22	0.03	mg/L
0718	Well	5/20/2004	Uranium	0.21	0 03	mg/L

Sample Location	Type	Sample Date	Analyte	Value	MCL	Unit
865 Rendezvous Rd.	Service Line	1/16/2003	Gross Alpha	19.50	15.00	pCi/L
865 Rendezvous Rd.	Service Line	1/16/2003	Ra-226	5.10	5.00	pCi/L

Figure 4
Radionuclide Activites Greater Than MCLS at the Riverton UMTRA Site Riverton, Wyoming

Created By: A. Sagen
Created: February 2005

Table 1. Data Gaps and Deficiencies

Sampling Locations Without Major Ion Analyses	Sampling Locations Without Radionuclides Analyses	Sampling Locations Without Spatial Coordinates
81 Littleshield Rd	Oxbow Lake 747	Great Plains #2 (Arapaho Water Supply Well #2?)[c]
865 Rendezvous Rd	0705	Red Crow Ln #1 (0818?)[c]
Red Crow Lane Hydrant #3	0707	Red Crow Ln #2 (0818?)[c]
Red Crow Lane Hydrant #2	0710	Red Crow Ln #3 (0818?)[c]
Red Crow Lane Hydrant #1	0716	Rendezvous Rd (0821?)[c]
865 Rendezvous Rd Hydrant #3	0717	Rendezvous Rd #1 (0821?)[c]
865 Rendezvous Rd Hydrant #2	0718	Rendezvous Rd #2 (0821?)[c]
865 Rendezvous Rd Hydrant #1	0719	Rendezvous Rd #3 (0821?)[c]
Oxbow Lake 747	0722	
0705[b]	0723	
0707[b]	0731	
0710[b]	0735	
0716[b]		
0717[b]		
0718[b]		
0719[b]		
0722[b]		
0723[b]		
0731[b]		
0735[b]		
0813[a]		
0814[a]		
0815[a]		
0816[a]		
0817[a]		
0818[a]		
0819[a]		
0820[a]		
0821[a]		

[a] Samples analyzed for total alkalinity and sulfate only.
[b] Samples analyzed for sulfate only.
c Potential alias. Not verified by coordinate data.

Table 2. Major Ions

Location ID	Sample Date	Parameter	Ion mg/L	Ion meq/L
Arapaho Well #1	7/26/2000	Mg	0.5	0.04
Arapaho Well #1	7/26/2000	Ca	3.8	0.19
Arapaho Well #1	7/26/2000	Na	141	6.13
Arapaho Well #1	7/26/2000	K	0.3	0.01
Arapaho Well #1	7/26/2000	SO4	118	2.46
Arapaho Well #1	7/26/2000	HCO3	215	3.52
Arapaho Well #1	7/26/2000	Cl	6.7	0.19
Arapaho Well #2	7/26/2000	Mg	0.5	0.04
Arapaho Well #2	7/26/2000	Ca	3.4	0.17
Arapaho Well #2	7/26/2000	Na	137	5.96
Arapaho Well #2	7/26/2000	K	0.4	0.01
Arapaho Well #2	7/26/2000	SO4	123	2.56
Arapaho Well #2	7/26/2000	HCO3	195	3.20
Arapaho Well #2	7/26/2000	Cl	9.9	0.28
Joe Goggles Sr.	12/4/2002	Mg	0.5	0.04
Joe Goggles Sr.	12/4/2002	Ca	4.8	0.24
Joe Goggles Sr.	12/4/2002	Na	152	6.61
Joe Goggles Sr.	12/4/2002	K	0.5	0.01
Joe Goggles Sr.	12/4/2002	SO4	141	2.94
Joe Goggles Sr.	12/4/2002	HCO3[1]	223	3.66
Joe Goggles Sr.	12/4/2002	Cl	10.9	0.31
Ruth Big Lakes	12/4/2002	Mg	0.5	0.04
Ruth Big Lakes	12/4/2002	Ca	4.8	0.24
Ruth Big Lakes	12/4/2002	Na	151	6.57
Ruth Big Lakes	12/4/2002	K	0.5	0.01
Ruth Big Lakes	12/4/2002	SO4	139	2.89
Ruth Big Lakes	12/4/2002	HCO3[1]	224	3.67
Ruth Big Lakes	12/4/2002	Cl	10.7	0.30
Arapahoe Well #2	11/8/2002	Mg	0.5	0.04
Arapahoe Well #2	11/8/2002	Ca	7.1	0.35
Arapahoe Well #2	11/8/2002	Na	197	8.57
Arapahoe Well #2	11/8/2002	K	1.1	0.03
Arapahoe Well #2	11/8/2002	SO4	260	5.41
Arapahoe Well #2	11/8/2002	HCO3[1]	187	3.06
Arapahoe Well #2	11/8/2002	Cl	18.4	0.52
Arapahoe Water Line	11/8/2002	Mg	0.5	0.04
Arapahoe Water Line	11/8/2002	Ca	5.4	0.27
Arapahoe Water Line	11/8/2002	Na	155	6.74
Arapahoe Water Line	11/8/2002	K	0.5	0.01
Arapahoe Water Line	11/8/2002	SO4	139	2.89
Arapahoe Water Line	11/8/2002	HCO3[1]	233	3.82
Arapahoe Water Line	11/8/2002	Cl	12.3	0.35
Arapahoe Water Line Hydrant	12/10/2002	Mg	0.5	0.04
Arapahoe Water Line Hydrant	12/10/2002	Ca	5.5	0.27
Arapahoe Water Line Hydrant	12/10/2002	Na	142	6.18
Arapahoe Water Line Hydrant	12/10/2002	K	2	0.05
Arapahoe Water Line Hydrant	12/10/2002	SO4	139	2.89

Table 2. Major Ions

Location ID	Sample Date	Parameter	Ion mg/L	Ion meq/L
Arapahoe Water Line Hydrant	12/10/2002	HCO3[1]	204	3.34
Arapahoe Water Line Hydrant	12/10/2002	Cl	10.9	0.31
22 Red Crow Ln	12/13/2002	Mg	0.5	0.04
22 Red Crow Ln	12/13/2002	Ca	4.9	0.24
22 Red Crow Ln	12/13/2002	Na	143	6.22
22 Red Crow Ln	12/13/2002	K	2.2	0.06
22 Red Crow Ln	12/13/2002	SO4	141	2.94
22 Red Crow Ln	12/13/2002	HCO3[1]	201	3.30
22 Red Crow Ln	12/13/2002	Cl	11.6	0.33
#445	11/5/2002	Mg	28.3	2.33
#445	11/5/2002	Ca	99.1	4.95
#445	11/5/2002	Na	60.7	2.64
#445	11/5/2002	K	6.9	0.18
#445	11/5/2002	SO4	101	2.10
#445	11/5/2002	HCO3[1]	474	7.77
#445	11/5/2002	Cl	7.8	0.22
#441	10/9/2002	Mg	20.5	1.69
#441	10/9/2002	Ca	97.8	4.88
#441	10/9/2002	Na	93.4	4.06
#441	10/9/2002	K	6.9	0.18
#441	10/9/2002	SO4	338	7.04
#441	10/9/2002	HCO3[1]	217	3.56
#441	10/9/2002	Cl	7.5	0.21
#430	11/21/2002	Mg	0.5	0.04
#430	11/21/2002	Ca	4.7	0.23
#430	11/21/2002	Na	184	8.00
#430	11/21/2002	K	0.5	0.01
#430	11/21/2002	SO4	200	4.16
#430	11/21/2002	HCO3[1]	234	3.84
#430	11/21/2002	Cl	10.2	0.29
#460	11/12/2002	Mg	0.5	0.04
#460	11/12/2002	Ca	3.6	0.18
#460	11/12/2002	Na	163	7.09
#460	11/12/2002	K	0.5	0.01
#460	11/12/2002	SO4	163	3.39
#460	11/12/2002	HCO3[1]	222	3.65
#460	11/12/2002	Cl	10.1	0.28
#448	10/9/2002	Mg	0.5	0.04
#448	10/9/2002	Ca	4.3	0.21
#448	10/9/2002	Na	190	8.27
#448	10/9/2002	K	1.4	0.04
#448	10/9/2002	SO4	358	7.45
#448	10/9/2002	HCO3[1]	44	0.73
#448	10/9/2002	Cl	13.3	0.38
#442	10/8/2002	Mg	0.5	0.04
#442	10/8/2002	Ca	7.2	0.36

Table 2. Major Ions

Location ID	Sample Date	Parameter	Ion mg/L	Ion meq/L
#442	10/8/2002	Na	209	9.09
#442	10/8/2002	K	0.5	0.01
#442	10/8/2002	SO4	428	8.91
#442	10/8/2002	HCO3[1]	5	0.07
#442	10/8/2002	Cl	18.4	0.52
#440	10/9/2002	Mg	0.5	0.04
#440	10/9/2002	Ca	7.3	0.36
#440	10/9/2002	Na	209	9.09
#440	10/9/2002	K	0.5	0.01
#440	10/9/2002	SO4	434	9.04
#440	10/9/2002	HCO3[1]	10	0.16
#440	10/9/2002	Cl	22.5	0.63
#420	10/8/2002	Mg	0.5	0.04
#420	10/8/2002	Ca	6.2	0.31
#420	10/8/2002	Na	194	8.44
#420	10/8/2002	K	0.5	0.01
#420	10/8/2002	SO4	405	8.43
#420	10/8/2002	HCO3[1]	0.30	0.005
#420	10/8/2002	Cl	13.3	0.38
#411	10/8/2002	Mg	0.5	0.04
#411	10/8/2002	Ca	6.1	0.30
#411	10/8/2002	Na	212	9.22
#411	10/8/2002	K	0.5	0.01
#411	10/8/2002	SO4	438	9.12
#411	10/8/2002	HCO3[1]	4	0.07
#411	10/8/2002	Cl	18.8	0.53
#406	10/9/2002	Mg	0.5	0.04
#406	10/9/2002	Ca	8.5	0.42
#406	10/9/2002	Na	213	9.27
#406	10/9/2002	K	0.5	0.01
#406	10/9/2002	SO4	390	8.12
#406	10/9/2002	HCO3[1]	47	0.77
#406	10/9/2002	Cl	30.4	0.86
#423	10/17/2002	Mg	0.5	0.04
#423	10/17/2002	Ca	4.3	0.21
#423	10/17/2002	Na	174	7.57
#423	10/17/2002	K	0.5	0.01
#423	10/17/2002	SO4	176	3.66
#423	10/17/2002	HCO3[1]	239	3.91
#423	10/17/2002	Cl	9.2	0.26
#405	10/17/2002	Mg	0.5	0.04
#405	10/17/2002	Ca	7.8	0.39
#405	10/17/2002	Na	211	9.18
#405	10/17/2002	K	0.5	0.01
#405	10/17/2002	SO4	314	6.54
#405	10/17/2002	HCO3[1]	149	2.44

Table 2. Major Ions

Location ID	Sample Date	Parameter	Ion mg/L	Ion meq/L
#405	10/17/2002	Cl	22.9	0.65
#436	10/17/2002	Mg	0.5	0.04
#436	10/17/2002	Ca	5.2	0.26
#436	10/17/2002	Na	193	8.40
#436	10/17/2002	K	1.2	0.03
#436	10/17/2002	SO4	230	4.79
#436	10/17/2002	HCO3[1]	212	3.48
#436	10/17/2002	Cl	16.4	0.46
#446	12/11/2002	Mg	0.5	0.04
#446	12/11/2002	Ca	3	0.15
#446	12/11/2002	Na	154	6.70
#446	12/11/2002	K	2	0.05
#446	12/11/2002	SO4	143	2.98
#446	12/11/2002	HCO3[1]	226	3.70
#446	12/11/2002	Cl	9.2	0.26
#417	12/10/2002	Mg	9.8	0.81
#417	12/10/2002	Ca	37.4	1.87
#417	12/10/2002	Na	51.4	2.24
#417	12/10/2002	K	5.2	0.13
#417	12/10/2002	SO4	37.9	0.79
#417	12/10/2002	HCO3[1]	251	4.11
#417	12/10/2002	Cl	5.1	0.14

[1] HCO3 is an estimated quantity based on the assumption of electrical neutrality

Table 3. Radionuclide Data

Well No.	Type	Aquifer Unit	Sample Date	Uranium (mg/L)	U Qualifier	Ra-226 (pCi/L)	Ra-226 Qualifier	Ra-228 (pCi/L)	Ra-228 Qualifier	Gross Alpha (pCi/L)	Gross Alpha Qualifier	Gross Beta (pCi/L)	Gross Beta Qualifier	Ra-226 + Ra-228 (pCi/L)
405	Domestic Well	Confined	10/17/2002	0.0003	U	0.2	U	1	U	1	U	5.3		1.2
406	Domestic Well	Confined	10/9/2002	0.0003	U	0.2	U	1	U	1.4		2	U	1.2
411	Domestic Well	Confined	10/8/2002	0.0003	U	0.2	U	1	U	1.4		2	U	1.2
417	Domestic Well	Confined	12/10/2002	0.0016		0.6				2.7				0.6
420	Domestic Well	Confined	10/8/2002	0.0003	U	0.2	U	1	U	1	U	2	U	1.2
423	Domestic Well	Confined	10/17/2002	0.0003	U	0.6		1	U	1.5		2	U	1.6
430	Domestic Well	Confined	11/21/2002	0.0003	U	0.2	U			1.8				0.2
435	Domestic Well	Unknown	10/17/2002	0.0003	U	0.2	U	3.6		1.6				3.8
436	Domestic Well	Confined	10/17/2002	0.0003	U	0.8		1	U	1	U	2	U	1.8
437	Domestic Well	Unknown	10/17/2002	0.0003	U	0.2	U	1	U	1.8		2	U	1.2
440	Domestic Well	Confined	10/9/2002	0.0003	U	0.2	U	1	U	1	U	2	U	1.2
441	Domestic Well	Confined	10/9/2002	0.037		0.2	U	1	U	6.4		6.8		1.2
442	Domestic Well	Confined	10/8/2002	0.0003	U	0.2	U	1	U	1	U	2	U	1.2
445	Domestic Well	Semiconfined	11/5/2002	0.0108		0.2	U	1	U	2.5		9.6		1.2
446	Domestic Well	Confined	12/11/2002	0.0003	U	0.8				1.7				0.8
448	Domestic Well	Confined	10/9/2002	0.0003	U	0.2	U	1	U	1	U	2	U	1.2
460	Domestic Well	Confined	11/12/2002	0.0003	U	0.2	U			2.3				0.2
705	Well	Semiconfined	5/19/2004	0.0002	U									0
705	Well	Semiconfined	5/13/2003	0.00041										0
707	Well	Surficial	5/19/2004	0.97										0
707	Well	Surficial	5/13/2003	1.12										0
710	Well	Surficial	5/18/2004	0.005										0
710	Well	Surficial	5/14/2003	0.0075										0
716	Well	Surficial	5/20/2004	0.32										0
716	Well	Surficial	5/14/2003	0.352										0
717	Well	Semiconfined	5/20/2004	0.00013	U									0
717	Well	Semiconfined	5/14/2003	0.0001	U									0
718	Well	Surficial	5/20/2004	0.21										0
718	Well	Surficial	5/14/2003	0.217										0
719	Well	Semiconfined	5/20/2004	0.00049										0
719	Well	Semiconfined	5/14/2003	0.00056										0
720	Well		5/18/2004	0.011										0
721	Well		5/18/2004	0.00007	U									0
722	Well	Surficial	5/20/2004	0.87										0
722	Well	Surficial	5/14/2003	1.12										0
723	Well	Semiconfined	5/20/2004	0.00006	U									0
723	Well	Semiconfined	5/14/2003	0.0001	U									0
729	Well		5/19/2004	0.017										0
730	Well		5/19/2004	0.00039										0
731	Well	Surficial	5/19/2004	0.014										0
731	Well	Surficial	5/14/2003	0.0075										0
735	Well	Semiconfined	5/18/2004	0.00035										0
735	Well	Semiconfined	5/14/2003	0.00046										0
809	Well	Unknown	5/18/2004	0.0041										0

Table 3. Radionuclide Data

Well No.	Type	Aquifer Unit	Sample Date	Uranium (mg/L)	U Qualifier	Ra-226 (pCi/L)	Ra-226 Qualifier	Ra-228 (pCi/L)	Ra-228 Qualifier	Gross Alpha (pCi/L)	Gross Alpha Qualifier	Gross Beta (pCi/L)	Gross Beta Qualifier	Ra-226 + Ra-228 (pCi/L)
813	Tap	Unknown	5/18/2004	0.00009	U	0.405	U	0.72	U	1.72		1.98	U	1.125
814	Tap	Unknown	5/18/2004	0.00018		0.263		0.789	U	1.26		2.39	U	1.052
815	Tap	Unknown	5/18/2004	0.00012	U	0.736	U	0.759	U	0.991	U	2.95		1.495
816	Tap	Unknown	5/18/2004	0.00011	U	0.718	U	0.666	U	1.31	U	3.73		1.384
817	Extraction Well	Unknown	5/19/2004	0.0001	U	0.783	U	0.865	U	1.35		2.3		1.648
818	Hydrant	Unknown	5/19/2004	0.00009	U	1.58		2.31		16.4		24.3		3.89
819	Hydrant	Unknown	5/19/2004	0.00011	U	1.64		2.33		18.6		24.1		3.97
820	Hydrant	Unknown	5/19/2004	0.00012	U	7.98		7.93		70.7		53.5		15.91
821	Hydrant	Unknown	5/19/2004	0.0001	U	1.64		1.73		12		18.4		3.37
10 Whitetail Dr.	Domestic Well	Unknown	12/11/2002	0.0038		0.9				2.6				0.9
22 Red Crow Ln.	Tap	WS	12/10/2002	0.0003	U	1.1				2.3				1.1
24 Littleshied Rd.	Domestic Well	Unknown	12/11/2002	0.0003	U	0.6				2.4				0.6
288 Goes in Lodge	Domestic Well	Unknown	11/21/2002	0.0005		1.2				1.6				1.2
445 (Blind Dup.)	Domestic Well	Semiconfined	11/5/2002	0.0106		0.2	U	1	U					1.2
707 (FILTERED)	Well	Surficial	5/19/2004	1.05										0
707 (UNFILTERED)	Well	Surficial	5/19/2004	1.1										0
789 Bingo	Domestic Well		10/8/2002	0.0003	U	0.2	U	1	U	1	U	10.4		1.2
81 Littleshield Rd.	Domestic Well	Unknown	2/14/2002	0.0003	U	0.2	U	1	U	1	U	2	U	1.2
865 Rendezvous Rd.	Service Line	WS	1/16/2003	0.0003	U	5.1		2.2		19.5		24.1		7.3
972 Rendezvous Rd.	Tap	WS	12/18/2002	0.0003	U	0.2	U			2.5				0.2
Arapahoe Water Well #2	Well	Confined	11/27/2002	0.0003	U	0.8		3.5						4.3
Great plains #2	Wellhead	Confined	11/7/2002	0.0003	U	0.8		3.5		1	U	2	U	4.3
Joe Goggles Sr.	Tap	WS	12/4/2002	0.0003	U	1.9				2.6				1.9
Red Crow Ln.	Hydrant	WS	5/19/2004	0.0003	U	1.6		1	U					2.6
Red Crow Ln. #1	Hydrant	WS	1/16/2003	0.0003	U	1.1		1	U	3.7		2	U	2.1
Red Crow Ln. #2	Hydrant	WS	1/16/2003	0.0003	U	15.8		11.9		48.2		49.4		1
Red Crow Ln. #3	Hydrant	WS	1/16/2003	0.0003	U	1.3		1	U	4.2		12.3		2.3
Rendezvous Rd.	Hydrant	WS	11/7/2002	0.0003	U	1.2		1	U	5.8		10.8		2.2
Rendezvous Rd.	Hydrant	WS	12/10/2002	0.0003	U	12.5				47.8				12.5
Rendezvous Rd. #1	Hydrant	WS	1/16/2003	0.0003	U	0.6		1	U	4.6		9.6		1.6
Rendezvous Rd. #2	Hydrant	WS	1/16/2003	0.0003	U	12.2		5.7		57.1		57.1		17.9
Rendezvous Rd. #3	Hydrant	WS	1/16/2003	0.0003	U	11.1		5		49.8		63.1		16.1
Rendezvous Rd. (10 min)	Hydrant	WS	5/19/2004	0.0003	U	1.40		4.80						6.2
Rendezvous Rd. (30 min)	Hydrant	WS	5/19/2004	0.0003	U	3.1		1	U					4.1
Ruth Big Lake	Tap	WS	12/4/2002	0.0003	U	1.1				2.2				1.1
Ruth Big Lake (Dup)	Tap	WS	12/4/2002	0.0003	U	0.2	U			2.7				0.2
Arapahoe Entry Point	Service Line	WS	12/31/2002							1.7				0

Bold Type denotes MCL Exceedance

SECTION III

LONGEVITY OF WATER DISTRIBUTION SYSTEM

BACKGROUND

The Alternate Water Supply system that provides water to the area within the ICB was installed during the period from October 1997 to September 1998. The primary line was installed from the 1.0 MG tank northerly to across the Wind River B Ditch; and then southeasterly and easterly to the intersection of Goes in Lodge and Rendezvous Roads as shown on Figure I-A. This map was taken from a report by HKM Engineering[1].

The transmission and distribution pipelines were constructed of PVC with DIP fittings. The system included a conventional assortment of air release valves, concrete thrust blocks, fire hydrants, yard hydrants, gate valves, and service connections and lines.

DESCRIPTION OF SYSTEM

Documents Provided ASCG

The following documents were provided ASCG by the NAUO:

1. Set of plans titled SUSQUEHANA/DOE WATER LINE; ARAPAHOE, WYOMING; WIND RIVER INDIAN RESERVATION. The approval signature block on the cover sheet for the *Sanitation Facilities Construction Officer* had not been signed. There was no indication on the drawings that they represented the constructed condition. A note added to Sheet No. 18 indicated the "suspected end of line" at approximate station 421+00 whereas the line was shown to end at station 449+51.
    a. The main line from the tank was to consist of approximately 34,300 feet of 8-inch and 10,650 feet of 6-inch pipe. Two 6-inch laterals totaling almost 11,000 feet were also installed.
    b. Fittings and gate valves were shown to be anchored to concrete thrust blocks with #4 reinforcing steel; the anchors for the valves were to be coated with Koppers Bitumastic

#50.

c. Required depth of bury is not indicated. Depth can be inferred from the scaled profiles to be between 6 to 7 feet.

2. A set of catalog cuts for water pipeline materials "submitted by Northwest Pipe Fittings, Inc." There is no indication of review and approval of the documents. The following comments apply to these catalog cuts:

   a. PVC pipe was shown to conform to ASTM D-2241 with gaskets conforming to ASTM F-477 and to be of SDR 26 with a rated capacity of 160 psi.

   b. Pipeline fittings are shown to be of DIP conforming to AWWA standards with special transition gaskets to mate to the PVC pipeline. Specification for these gaskets was not provided.

   c. Stainless steel, or other corrosion resistant, bolts, nuts, washers, and fasteners were not called for in the materials supplied. ASCG's standard practice is to require such components to be of stainless steel.

   d. Gate valves are shown to be Mueller A-2360 resilient wedge with MJ ends and a fusion epoxy coating on exterior and interior iron. The coating conformed to AWWA C550.

   e. Fire hydrants were shown to be Mueller Super Centurion 250 conforming to AWWA C502. These are cast iron units with bronze and stainless steel trim.

   f. Service line taps were shown to be made with a Rockwell 370 series service saddle with dual studs. All metal components would be of stainless steel and washers are of nylon. Rockwell products are now sold under the name of Smith-Blair. The older Rockwell catalog does not list gasket material; the current Smith-Blair catalog lists the standard gasket to be of Buna-N.

   g. Corporation stops and curb valves were shown to be Mueller of bronze construction.

   h. Curb boxes were shown to be Mueller extension type and of cast iron.

   i. Service lines were shown to be of Drisco HDPE conforming to either ASTM D2239 or D2737.

3. A copy of pages of a standard diary with minimal entries covering work accomplished.

   a. Some entries may have been for another project. For example the entry dated 12/20/97 included a boring and hot tap to a line on 17 Mile Road. However, the plans do not show

any work extending to 17 Mile Road.

b. The entries were not signed.

c. Stationing of pipeline installed was not listed.

A soils report for the project was not provided.

ENVIRONMENTAL CONDITIONS

Sulfuric Acid

The presence of sulfuric acid has not been proven; rather it is inferred that it may be there now or even within the 100-year analysis period. Summit[11] technicians indicated that sulfuric acid is often found in locales impacted by a sulfur processing facility. It is noted that Summit's report[11] did not find evidence indicating the presence of sulfuric acid within the area of concern

Sulfuric acid, even in small concentrations, will adversely affect pipeline gaskets. The most common materials used for pipeline gaskets are SBR and EPDM. According to the Handbook of PVC Pipe[8], SBR is not resistant to sulfuric acid at low concentrations and EPDM is less suitable than other materials but is considered satisfactory for some applications. According to Smith-Blair engineers (verbal contact on February 18, 2005) EPDM or VITON should have been used if sulfuric acid is present. VITON will better resist the acid than EPDM and, therefore, should be considered for future installation.

The acid will also corrode carbon steel nuts and bolts of mechanical joint fittings, carbon steel fasteners on the gate valves, and rebar anchors on fittings and valves (unless the coated rebar for the valves had no holidays).

PVC is considered to be excellent in its ability to resist corrosion from low concentrations of sulfuric acid.

Bronze is considered to be fair to poor in a sulfuric acid environment. The thinner sections will corrode rather quickly whereas the heavy bodied valves probably will provide adequate service for an extended period of time (per verbal contact with Mueller Corp. representative, February 18, 2005). The bodies can be expected to pit and discolor but the valve should remain in good service.

Radiation

ASCG contacted the Ductile Iron Pipe Research Association in regard to the effect of exposure of DIP to radiation. The association replied stating that they had no knowledge of such research and did not think low-level radiation would impact their pipe and fittings.

The Handbook of PVC Pipe[8] does not address the impact of radiation on PVC pipe. However, it does address the effect on gaskets. Gasket materials of SBR, BR, EPM, EPDM, NBR, and CR are not considered resistant to radiation but"...still suitable for some conditions[8]. No other information was given in the handbook.

Soils

Description of the soils was not presented. A generalized *Depth to Frost Penetration* map indicates frost depth could be expected to be in the neighborhood of 5½ to 6 feet. Thus frost heave could create a problem at the apparent depth of bury of about 6 feet.

One groundwater well was tested within a range that bracketed the depth of bury of the water pipelines- site 0731 identified in the DOE report of July 2003[3]. The sampling/testing range was from 2 to 11.4 feet below the ground surface; the groundwater pH was found to be 8.51.

The DOE Data Validation report[4] listed sampling of 17 monitoring wells wherein ground water was from 5.5 to 9.6 feet below the ground surface. Two wells were outside the area of interest and, therefore, our analysis considered the results of the other 15 wells. Those results were used to estimate soil characteristics that impact corrosion of, primarily, piping components of ductile iron. According to AWWA Manual of Practice M41[9] five soil characteristics are evaluated to determine the soil's contribution to corrosion. Points are assigned for each characteristic and totaled. If the

total equals 10 or more, "...corrosive to gray or ductile cast-iron pipe, protection is indicated." The results of our review of the data awards 10 or more points to seven of the wells and 8 points to another three wells. Since there is only one set of data provided, it is prudent to conclude that protection of DIP components is required. Typical protection of ductile pipe in such soil conditions would be to wrap the pipe and fittings with a polyethylene film.

Summary

Given the possibility, even remotely, of sulfuric acid within the ICB area, and its effect in small concentrations on the gaskets, there is potential for eventual breakdown of gasketing materials. Sulfuric acid, if present, will have a negative effect on carbon steel components that are buried with the pipeline. Although such components may have been painted, holidays will allow the acid to reach the metal and start the corrosion process. The heavy-duty brass components of service lines should not be a problem unless a high concentration of acid should come into contact with these components.

Carbon steel has been buried throughout the project in the form of valve fasteners, anchors to thrust blocks, and mechanical joint nuts and bolts. These components will probably also have a short life span in the environment in which they have been placed.

Radioactivity is not expected to adversely affect the life of the pipelines, including the gaskets, at the levels indicated by the data provided to ASCG.

There are indications of high pH in some groundwaters sampled. A high pH could have a negative impact on the pipeline system - especially components of ductile iron such as water pipeline fittings.

Aggressive soil conditions will affect longevity of a pipeline system. The characteristics of the soils within the ICB area have not been determined. It is recommended that the soils be tested for resistivity, pH, redox potential, and sulfides in accordance with AWWA M41[9] to assure maximum life is received from future installations.

Development of Alternate Water Supply Longevity

"A properly designed, installed and operated system will last in excess of 100 years."[10]. This statement was made specifically in support of installation of polyvinyl chloride (PVC) pipe. The system description and analysis of the pipeline environment indicates that the lifetime of the system components will vary.

ASCG used the *Asset Management: A Handbook for Small Water Systems*[24] that provides estimates of life of the various components of a water system. The components and their expected life is given in the table found in Appendix D.

The various components of the Alternate Water Supply System are listed in the table found in Appendix D. Useful life was determined from the EPA Handbook. Whenever a range of years of life was listed, the longest life was chosen. The direct cost of replacement for any item was taken from costs derived in the cost estimates found in Appendices B and C. The direct cost of $4,074,000 was increased by a multiplier to get the total cost in 2005 dollars. The multiplier for projects that lend themselves to force account work or that do not require extensive design was 1.25. Such projects include the cost of cleaning wells, replacement of well pumps, and similar work. The multiplier for the large projects such as replacement or installation of new pipelines was 1.4. The overall multiplier for some of the projects given in Appendices B and C was computed and found to be right at 1.4.

Service Fees

Introduction

The majority of the pipeline within the ICB area would not be affected by the subsurface conditions particular to the area influenced by the uranium plume; about one-third to one-half of the 6-inch pipeline and appurtenances thereto are in the that area. If the source of the radionuclides is as premised – the water supply wells – then the entire Arapaho system could have the same problem – not just that portion within the ICB area. Cost of eliminating that problem would be allocated to all users which resulting in less unit cost to all, including those within the ICB area. It follows that the

cost particular to the area within the ICB would be replacement of components of the distribution system.

Comparison to Other Tribal Communities

NAUO charges each residential water customer $17.00 per month. The use is not metered. According to Jerry Redman, the utility is presently reviewing the fee because it is felt that the existing fee does not provide sufficient income to operate and maintain the water and sewer utilities satisfactorily. NAUO has approximately 800 customers on the water utility which would indicate a population served of between 2,500 and 3,000 people. ASCG researched water use fees with three other tribal communities in the Rocky Mountain region for the purpose of comparison. The following are the results and comparisons.

- The Navaho Tribal Utility Authority charges $5.50 per month as the service charge. They then charge $2.20 per 1000 gallons for the first 3,000 gallons used and $3.35 per 1,000 gallons for any additional usage above that level. Using the averages for the NAUO service area, the comparable charge would be $25.50 based on an average use of approximately 7,000 gallons per month. Absence of metering at individual units would make this impossible to implement.
- The Blackfeet Tribe in Montana charge a single monthly rate of $10.45 with no metered usage fees.
- The Confederated Salish and Kootenai Tribe (CSKT) charge a single monthly amount of $19.50 per month with no metered water fees.

The three communities use the money from monthly charges for operations and maintenance and find the charges fall below needs for capital improvements. Efforts to identify and use State and Federal funding sources are used for capital improvements. All three communities indicated they are currently reviewing fees and will possibly implement an increase soon. The Blackfeet and CSKT also indicated strong consideration to add meters to the system and begin imposing charges based on water consumption in the future as well.

It is difficult to establish a monthly fee per customer based on traditional methods. There are normally three components to finances regarding operation of a public system. They are:

1. Connection fees charged to new customers which are traditionally used to fund capital projects made necessary by growth and regulatory change.
2. Loans or bond money which is typically used for large capital improvements and the debt is then retired from a portion of monthly users fees.
3. Monthly customer charges are normally collected to cover the annual maintenance, operations and debt reduction expenses. It is not uncommon for water use to also be metered and charges for actual water use to also be included.

Given the projected costs for both upgrades necessary to meet the systems 100-year longevity requirements and capital projects necessary to fund growth, it is apparent the monthly use charges alone will not cover these costs. Therefore, we have simply looked at comparable community systems to determine reasonable levels of monthly charges to fund operations, maintenance and debt reduction costs.

Based on the analysis, it would appear that the current fee of $17.00 per customer with unlimited usage is within the range of other tribal communities. A complete analysis of the current fee structure is beyond the scope of this project. As with the other communities, a review of future needs and an increase of the monthly usage fee would be reasonable.

ADDITIONAL MAINTENANCE REQUIREMENTS

Cost of routine maintenance has been covered previously. Requirements included herein are for the recommended periodic flushing of the Alternate Water Supply System. It is assumed that this flushing program will be accomplished by NAUO because it will be an ongoing program. The cost of the effort described herein would have to be integrated into the normal operating budget of the NAUO.

NAUO does not normally flush or otherwise clean their system and, therefore, a method for estimating the cost for radionuclide reduction is needed. The Denver Water Board typically uses as many as five 2-man crews to conduct a scheduled flushing program. A rough estimate of the effort needed to flush the Alternate Water Supply system was one 2-man crew could conduct the recommended program in about one week. The work would involve equipment setup, monitoring the flushing program as it proceeded, sampling and record keeping. Miscellaneous costs would include testing and reporting of samples; and costs associated with disposal of the flush water.

The crew would be equipped with a pickup; assorted tools for working with pipeline valves and fire hydrants; and flow metering equipment.

If the periodic flushing program does not produce satisfactory results, implementation of a more aggressive program has been recommended. ASCG contacted contractors that have equipment specifically for pigging and/or flushing. Launching sites are required for either method. Equipment can be launched through fire hydrants, flushing hydrants, or similar facilities. The required number of launch sites will depend upon the method utilized; runs can be from 700 feet for jetting to 2,500 feet for high velocity flushing. The first time cost of one of these programs includes engineering and planning of the program which is not included in subsequent cleanings at $199,000. Since the biofilm is being removed by these methods, the period between cleanings will be longer than the recommended flushing program. Estimates of the time between cleanings vary for 2 to 5 years.

A preliminary review of the construction plans for the Alternate Water Supply indicated that eight or ten launch sites would have to be constructed. This would be a one-time cost.

Estimates of cost were based on telephone contact with contractors and, therefore, did not include preparation of a specific listing of the work expected of the contractors. The estimates of cost appear to be about the same for any of the alternates. Therefore, final selection of a removal method will be made at a later date when more specific details of the requirements of the various options are known.

Cost of removal of radionuclides by any of the Option 2 alternatives is estimated to be as follows:

Engineering and planning:	$ 23,000
Installation of new launch sites:	21,000
Cleaning operation:	199,000
Total first time cost:	**$243,000**

The cost of subsequent periodic cleanings is estimated to be $199,000.

All costs are in 2005 dollars.

SECTION IV

FUTURE GROWTH AND ASSOCIATED COSTS

INTRODUCTION

A water system is normally planned to meet the needs of the community as a whole. Such planning makes allowance for variances in growth rates and changes with time. Development of the infrastructure, if not tied to whole community will be inefficient and generally costly. If the infrastructure is designed for the whole community, changes and variances in growth rates can be accommodated; facilities can be constructed on an as needed basis; and the costs can be allocated on an as needed basis. However, this project is to be considered as a stand-alone. The following presentation will include both concepts of planning.

PLANNING AREA

The planning area for this report has been established as the area encompassed by the Institutional Control Boundaries. ASCG superimposed the ICB on Figure 4 of the HKM Preliminary Engineering Report[1]; the resulting map is found at the end of Section I. The area of that site is shown to be 1,533 acres[4]. The total area served by the NAUO has been estimated at approximately 5,133 acres, excluding the "Possible Growth Area" (edge of Gas Hills area to east). The area within the ICB is then approximately 25% of the total area, which includes some allowance of the excluded area.

The planning period for this report has been established at 100 years which is the projected time required for the ground water in the area impacted by the mill and other facilities to be flushed clean.

Water demand and required water providing facilities are schematically designed for the NAUO area in total. The share of facilities common to the ICB to all of the serviced area is assumed to be 25% according to the above discussion. Facilities are also designed for the Planning Area.

PREVIOUS POPULATION PROJECTIONS

Growth projections from local, state, and national organizations have been previously summarized[1]. The report presented very divergent existing and projected populations. The total customers of the NAUO in the Arapaho area are 274. The divergence in population was due, in part, to the estimated number of people living in the homes served.

The HKM report[1] stated "...historical population growth is the best method of predicting future population....". However, because of the divergent existing, and historical counts, any projection would be suspect. It was concluded in that report[1] that the U.S. Census/Wyoming State Data Center provided the most reliable information for low range projections and the Indian Health Service the most reliable for high range projections. Those projections are given in Table IV-A.

TABLE IV-A
PREVIOUS POPULATION PROJECTIONS

Range	Assumed growth rate	2000	2010	2020	2030	2040
High Value	IHS short term historical growth rate at 3.28% *	2,278	3,146	4,344	5,988	8,283
Low Value	US Census/Wyo Short term projected growth rate at 0.43% **	1,766	1,843	1,924	2,009	5,998

* IHS population of 1992

** U.S. Census & Wyoming State Data Center estimates of 2000.

PREVIOUS WATER CONSUMPTION PROJECTIONS

HKM presented a summary of historical water demands for the years 1991, 1994, 1998, 1999, and 2000. The annual per capita per day demand ranged from 94 to 108 gpdpc with an average of 99 gpdpc based on a population of 1,766 in the year 2000. The average daily use was 171,640 gpd in 2000.

ASCG was provided water delivery records from the well house for the Great Plains Water Well for the months of October and November 2004. An analysis of those records indicates the average daily flow for October was 1.1 times the 2000 average daily flow and for November was 1.4 times the

2000 average daily flow. The annual increase in daily flow from 2000, based on these two months of record, would be 6.8%, which exceed the IHS short-term historical population growth rate given in the HKM report (3.28%). According to the HKM report the annual average daily flow increased at a rate of about 0.97% (Table 6)[1].

Individual water users are not metered. HKM reported the U.S. Geological Survey estimated total demand in Fremont County as being 261 gpdpc. This figure includes not only domestic customers but also that of commercial, industrial, and public customers. However, according to the information provided ASCG, only domestic customers (not industrial) are served by the Arapaho system. Therefore, it appears that design of the system should be based on only domestic demand. Typically, ASCG's experience is that such demand is in the range of 80 to 100 gpdpc.

EXISTING WATER SUPPLY SYSTEM

Introduction

The following description of the existing system was taken from the report by HKM[1].

The first public water supply system was constructed in 1967; it included one well, one 10,000 gallon storage tank, and approximately 15,000 feet of 4-inch asbestos cement (AC) pipe. Housing areas were added to the system in 1969, 1971, 1973, 1977, 1984, and 1997. Apparently all of the new pipelines were of AC before 1977; almost all of it was of 4- and 6-inch diameter.

Water Supply

The first well was constructed in 1967 and later abandoned. Well No. 1 was drilled in 1973, and Well No. 2 in 1980.

Babits described the wells in an assessment report[2]. It was stated therein that both wells were rehabilitated and upgraded in August of 2001. New 65-hp pumps were installed with a capacity of 450 gpm. It was also stated "The Arapaho wells have been test pumped at 240 gpm." The report

does not indicate if this was a long-term draw-down test or a test at 240 gpm only. ASCG assumes the long-term capacity of each well is 240 gpm.

Storage

Reservoirs were added as follows:

1) 1973: 100,000 gallon welded-steel above the West Great Plains housing area; this reservoir is out of service.
2) 1980: 200,000 gallon welded-steel above Great Plains housing area; this reservoir is out of service.
3) 1984: 60,000 gallon welded-steel south of Beaver Creek; this reservoir is out of service.
4) 2002: 1,000,000 gallon glass-lined bolted steel about 37 feet above the other tanks; this tank is still in use.

Thus the effective capacity of the storage system is 1,000,000 gallons but there is no firm storage capacity if the 1-million gallon tank is out of service.

Transmission

The transmission system consists of 4-inch, 6-inch, and 8-inch pipelines, some of which are not looped[1]. The system was modeled in the HKM Report[1] and the results show that system pressures are adequate when operating at average day and peak day demands except for the areas in the immediate vicinity of the storage tanks. Fire flows of 500 to 1,500 gpm are required, depending on spacing of housing. The analysis showed that the system will deliver about 600 gpm of fire flow to the ICB with a residual pressure of 20 psi.

APPROACH 1: STAND ALONE DEVELOPMENT WITHIN THE INSTITUTIONAL CONTROL BOUNDARY AREA

Projected Water Demands

There are 19 homes in this area currently connected to the Alternate Water Supply System and 6 others that are not connected. ASCG assumed that the annual water consumption of those homes

would 350 gpd. Since this use is expected to be consistent throughout the planning period, the consumption within the ICB area was projected at a growth rate of 2.11% -- the rate used by IHS for population projections.

Fire flows for the Arapaho area were indicated by HKM[1] as being from 500 to 1,500 gpm for "...residential areas, depending on house spacing." Approach 1 projects growth of the ICB to be 5% of that projected in Approach 2. It was assumed that house spacing would be significantly less in the ICB for Approach 1 and the fire flow would be 500 gpm.

Facilities would be designed for the following rates of water consumption at the end of the 100-year planning period:

1. Annual average daily flow: 54,000 gpd
2. Peak day design flow: 162,000 gpd
3. Peak day design flow: 112 gpm
4. Consumer peak hour design flow: 170 gpm
5. Fire flow: 500 gpm for two hours
6. Total Peak hour design flow: 670 gpm
7. Total storage requirement: 220,000 gal

The HKM report[1] recommended that the average annual use be increased by a factor of 3.0 to estimate the peak day use.

<u>Evaluation of Capacity of Existing Facilities</u>

Transmission: It is the understanding of ASCG that the entire Alternate Water Supply Line was funded by DOE. The transmission system must be able of delivering the peak hour flow (170 gpm) plus the fire flow (500 gpm) to the ICB area, ASCG's computations indicate the Alternate Water Supply pipeline will not provide the required flow with a residual pressure at the end of the 6-inch PVC pipeline of more than 20 psi unless some flow is carried by other components of the NAUO transmission system.

Storage: Storage volume should equal the peak day flow (162,000 gal) plus fire flow (60,000 gal). It is ASCG's understanding that DOE funded a steel storage tank in 1998; no details of the tank were given. According to the chronology given in the HKM report, no storage tanks were constructed during the 1997 to 2000 period. The only tank currently in service was constructed in 2002, and it is assumed this is the tank DOE partially funded. ASCG was informed that DOE's participation was 25% of the cost. This tank has a capacity of 1.0 MG and, subject to other factors; it is presumed DOE paid for 250,000 gallons of storage in the tank. This exceeds the minimum recommended volume of 220,000 gallons and it is concluded that additional storage is not needed.

Wells: The water supply system should have a firm capacity equal to the peak day flow of 112 gpm. Two wells each having a capacity of 112 gpm dedicated to serving the ICB area would meet this requirement. DOE funded installation of larger motors and pumps in both of the NAUO wells. The capacity of each well is rated at 240 gpm and the capacity allotted to the ICB area is 60 gpm. Thus both wells are required to meet the projected peak day demand.

Capital Cost Requirements

Transmission: A preliminary review indicates the 6-inch line in Rendezvous Road should be extended southwest to Mission Road and then southerly to the existing line in Seventeen Mile Road. This connection will then complete the loop around the ICB. Some strengthening of other components of the NAUO transmission lines may also be required.

Storage. The existing storage capacity for the ICB area is sufficient for the planning period. Therefore, capital expenditures are not required.

Water supply wells: One well of minimum capacity of 112 gpm is required.

Opinion of probable project cost: The cost of new facilities during the planning period is given in Table IV-B. A detailed breakdown of the cost estimates is found in Appendix B. All costs are in 2005 dollars. The costs presented in Table IV-B includes construction, engineering, project administration, and contingencies all of which is detailed in the Appendix.

TABLE IV – B APPROACH NO 1: CAPITAL COSTS	
Alternate Water Supply Component	**Cost**
Construct transmission improvements to complete loop around the ICB area.	$298,000
Construct additional storage	$ - 0 -
Install one new well to include metering facilities and connections to the piping network(s).	$392,000
Opinion of Project Cost: Total	**$690,000**

APPROACH 2: PLAN SYSTEM FOR GROWTH INTEGRATED WITH NAUO SERVICE AREA

Growth

The serviced population in 2000 was approximately 1,776 and the estimated annual water consumption was 99 gpdpc[1].

The increase in water use from 1991 to 2000 was computed to be at an annual rate of 0.97%. The Indian Health Service (IHS) uses a long-term historical population growth of 2.11% and the U.S. Bureau of Reclamation (USBR) uses 1.76%[1]. It is then prudent that long-term growth be considered at both the IHS and USBR rates. Since the water system does not provide service to non-domestic customers, the growth rates of population and water use will be, for all practical purposes, equal. Therefore, growth of water demand can be based on an annual average use of 172,000 gpd in the year 2000.

Projected increases in water demand for the 100-year planning period are presented on the graph in Appendix A. One curve is based on the USBR projected rate of 1.76% and one on the IHS projected rate of 2.11%. Facilities would be designed for the rates of water consumption at the end of the 100-year planning period shown in Table IV-C.

TABLE IV - C APPROACH 2: WATER USE RATES			
Projected rate of growth		1.76 %	2.11 %
Annual average daily flow	gpd	1,072,000	1,153,000
Peak day design flow	gpd	3,216,000	3,618,000
Peak day design flow	gpm	2,230	2,510
Consumer peak hour design flow	gpm	3,350	3,760
Fire flow (duration of 2 hours)	gpm	1,500	1,500
Total storage requirement	gal	3,400,000	4,200,000

Facilities for the Future

Design Criteria: The existing demand within the ICB is believed to be less than 25% of the total demand served by the Arapaho Utility Organization. The water delivery system will provide 600 gpm for fire protection to the northeastern area at the present time. However, as demand grows in other areas, delivery of water to the area under study will decrease, even to less than the desired value of 500 gpm. Based on long-term growth projections, the system within the ICB will not provide satisfactory service throughout the planning period.

There is no storage of water in the area under study, and it appears that the existing ground surface is not high enough in elevation for a tank. Therefore, it is concluded that water must be provided from outside the ICB area.

Facilities for an adequate water supply, storage, and transmission are expensive and their costs are subject to economies of scale. Therefore, our analysis is based on the need of the entire Arapaho area for these facilities. It is then assumed that the area within the ICB control will require 25 percent of the total needs of the entire area.

The HKM report[1] recommended that the average annual use be increased by a factor of 3.0 to estimate the peak day use.

Water Supply. Investigation of the legal and physical availability of water is beyond the scope of this project.

The projected demand as a function of time is found on the graph in Appendix A. Development of a master plan for expansion of the water delivery system is beyond the scope of this report. However, a basic approach to such a plan is needed to develop costs.

The existing wells take water from the Wind River Formation at depths of approximately 600 feet. The availability of surface water will probably not meet the requirements of communities served by the Little Wind River. River flows of less than 1.6 MGD have occurred in the past 25 years. That amount of water would not meet the demands of Northern Arapaho for the planning period let alone the demands of the three communities.

Therefore, our preliminary design is based on drilling wells into the Wind River formation that will have a long term capacity of 210 gpm (0.3 MGD) each. A total of 12 wells would be required for growth at the USBR growth rate and 17 at the IHS growth rate. The wells would be clustered at sufficient distance from the other wells, so not to adversely influence production. It was also assumed that three additional wells would be required for either growth scenario for backup capability.

Storage. Sufficient storage is required for the peak day use plus fire flows. Since the projected development densities are fairly low, fire flows have been estimated to be 1,500 gpm for a period of 2 hours. This fire flow is at the upper end of the design range for providing service to residential communities. It may be that the eventual community will not require this flow but it is just as likely that some locales within the system may require the 1,500 gpm fire flow. The impact of the fire flow reduces as the total demand in the community increase, and the resulting cost estimates are probably not affected at this level of planning. Total storage requirements based on the USBR growth rate will be 3.7 MG by the end of the planning period and 5.3 MG based on the IHS growth rate. It was assumed that three tanks of equal capacity would be required for either growth rate.

Transmission. The transmission system will need considerable upgrading to provide satisfactory service for the projected growths. ASCG has also assumed that fire protection will be provided. This is an important component of the maximum daily flows at the outset and its

importance diminishes as the area grows.

OPINIONS OF PROBABLE COST

Estimates of probable cost are given in four tables found in Appendix C. Those estimates are of total project costs over the entire NAUO system for the 100-year planning period. Therefore, the costs to provide adequate service to the area within the ICB are 25% of the costs given in the tables for water supply, transmission and storage capacity and are as follow:

- $ 1,190,000 to provide an adequate water supply (25%);
- $ 1,526,000 to provide adequate transmission (25%);
- $ 804,000 to provide adequate storage capacity (25%);
- **$ 3,520,000 Total to provide an adequate water supply to the area within the ICB.**

These costs include the estimated construction cost, a construction cost contingency of 25%, engineering estimated at 15% of construction cost, an adder for project administration, and a project contingency of 10%. Unit costs for systems were based on bid prices for similar work. If such costs were not available, costs were developed from Means Construction Cost Guides. All such costs were escalated from the appropriate date to 2005. Thus all total project costs are in 2005 dollars.

SECTION V

SITE VISIT, INTERVIEWS, AND FIELD OBSERVATION

BACKGROUND

A site visit was conducted on December 14, 2004 by Jim Ford and Jerry Fragua of ASCG Incorporated. The site visit was conducted to observe the site and interview the NAUO regarding the construction of the Alternative Water Supply System, review the construction documents as well as evaluate the operation and maintenance of the system.

CONSTRUCTION RECORDS

The construction records for the installation of the water system were very incomplete. A specification book or project manual was not available for review. Copies of cut sheets for the waterline materials were furnished. These appear to be shop drawing quality but no review by the designers or engineers was recorded. The materials are standard quality for the water system, however no literature or cut sheet for poly wrap insulation for the ductile fittings was furnished or its use was indicated. Daily inspection reports were not found, but were delivered to ASCG's office at a later date.

Prior to the site visit, a meeting was held at the NAUO with the Utility, Wind River Water Quality Commission, and S.M. Stoller. The main thrust of the meeting was to obtain records of the water line construction, as well as review the operation and maintenance of the system. The review of the waterline construction included the means and methods of construction, and materials used for the waterline.

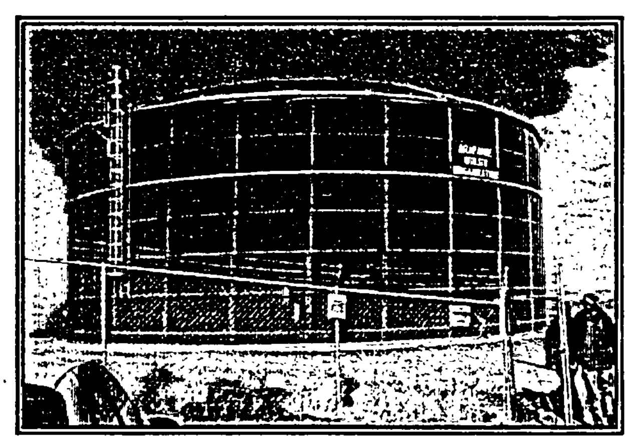
At the NAUO meeting, photographs of the pipeline installation were reviewed. The photographs clearly showed the pipe being installed with groundwater entering the potable water pipe. Also observed was soil inside the pipe during installation. Documentation of flushing the lines or bacteriological tests was not found in the NAUO project files. Hand written notes of two failed pressure tests of the water system were also observed. However, no indication of repair or

retests could be located. In general, the records of construction were very incomplete which indicates the indifference of the agency supervising the construction of the Alternate Water Supply system.

Site Visit

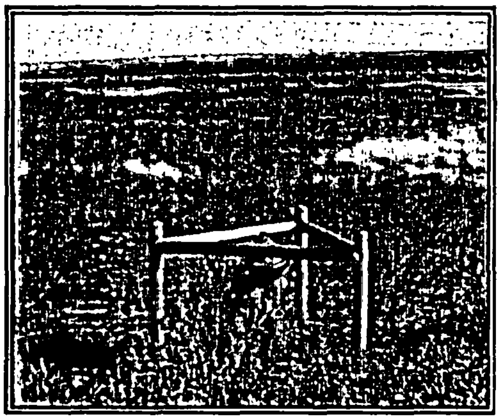
After the NAUO meeting, the attendees visited the well pump house, the water tank and portions of the distribution system.

The well pump house was examined to determine the disinfection process and integrity of the well. The wells was observed to be in good condition, the wells are sealed and protected either fenced (Well #1) or within the well building (Well #2). Records for the well pumps were requested. The well records, received on January 14, 2005, indicate the time and duration of pumping, the water tank level and the amount of sodium hypochlorite injected into the system. This information shows pump amounts and tank levels but not how the system is operated. During the site visit, it was described by the NAUO operators that the tank is visually checked by climbing to the top hatch of the tank and measuring the tank level by hand. If the tank reaches a low level, the operator returns to the well pump house and fills the tank by manually turning on the pumps. This is not an efficient or safe operational procedure.



The one million gallon water tank is located between the water supply wells and the distribution system. The bolted steel glass lined tank was put in service in 2002 so it is relatively new and in fairly good condition. There are a number of areas on the exterior of the tank where the tank coating has been damaged, possibly from vandals throwing rocks. The

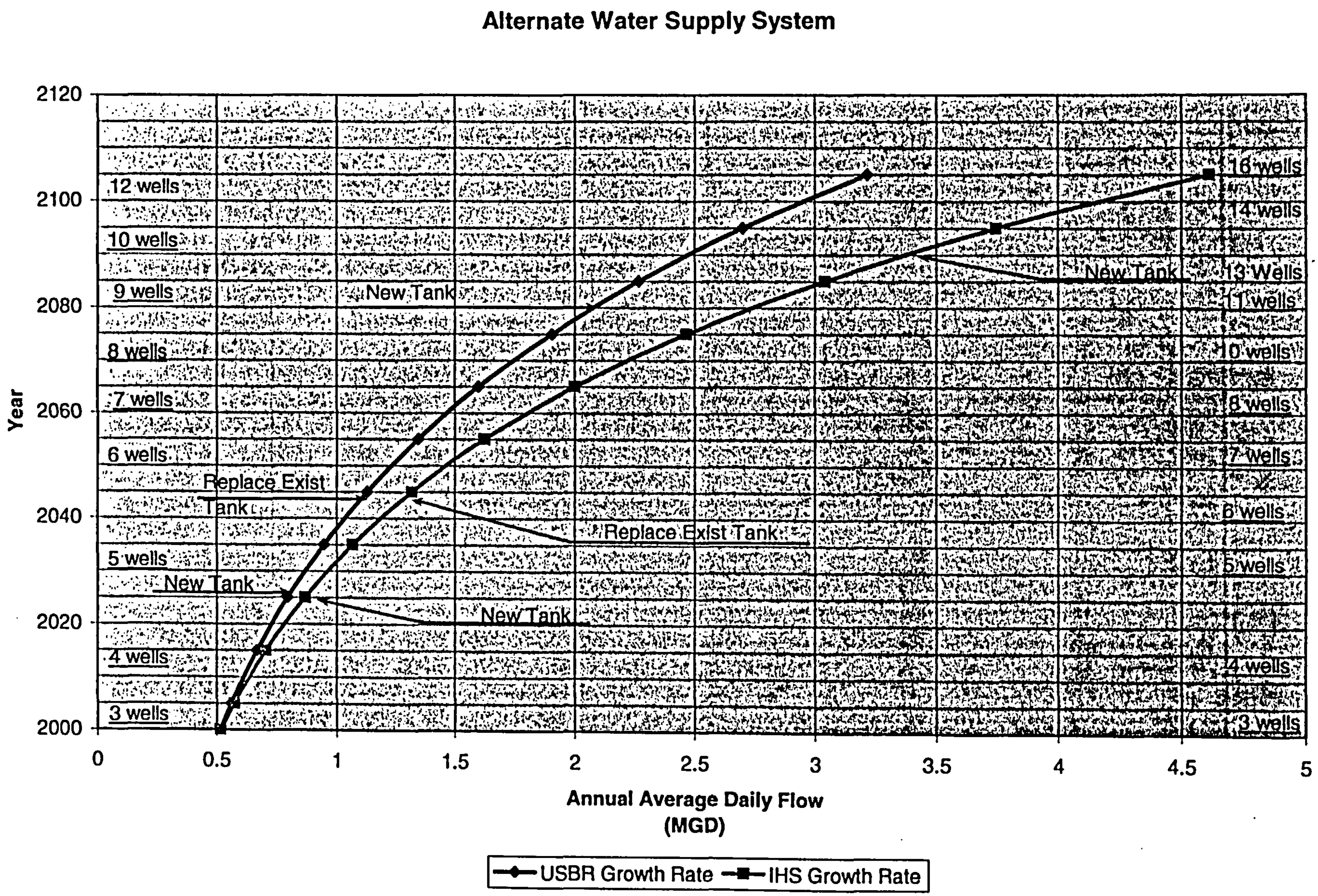
damage was pointed out to the NAUO personnel and advised that the damage may affect the tank interior glass lining as well. The tank is set at an elevation to provide adequate pressure for the distribution system.



The distribution system site visit reviewed hydrant locations and the extent of the underground piping. Two hydrants were observed at Rendezvous Road and Red Crow Lane. The hydrants are located at the end of dead end lines and will be effective for flushing the system.

The site visit did not reveal any obvious deficiencies in the system, however tank level sensors and pump controls will aid in the operation and safety for the NAUO personnel.

Appendix A



500723

S. M. STOLLER
ALTERNATE WATER SUPPLY: ARAPAHO WIND RIVER TRANSMISSION SYSTEM

OPINION OF PROBABLE CONSTRUCTION COST $ 198,000

ASCG Job No: 500723 — OPINION OF PROBABLE PROJECT BUDGET $ 298,000

Date of latest revision

ALTERNATE: Transmission system for Approach No. 1- Stand alone development

Comments:

Cost Index Data

For date of origination, the index =	ENR Construction Cost Index	7,298	
For the date of the revision index =	ENR Construction Cost Index	7298	1.00

Narrative			Quantity	Units	Unit cost	Extension	Major Item Subtotal
TRANSMISSION PIPELINES							
8" PIPELINE			2,200	lf			$ 141,000
	Cost source:	Green Mountain Water & San Distr					
		2002 Water System Improvements					
ENR CCI=	6462	ENR correction =	1.13				
Low bid price:	$53.00	Adjusted:	59.86				
Pipeline:							
Total footage			2,200	lf	$ 60	$ 132,000	
Fittings- assume all tees			4	ea	$ 700.00	$ 3,162	
Water pipeline valves @ 600 ft spacing			2	ea	$ 1,175.00	$ 2,654	
Connections to other transmission system			2	ea	$ 1,500.00	$ 3,388	
6" PIPELINE			0	lf			$ -
	Cost source:	Green Mountain Water & San Distr					
		2002 Water System Improvements					
ENR CCI=	6462	ENR correction =	1.13				
Low bid price:	$52.00	Adjusted:	58.73				
Pipeline:			-	lf	$ 59.00	$ -	
Fittings- assume all tees			0	ea	$ 575	$ -	
Water pipeline valves @ 600 ft spacing			-	ea	$ 875	$ -	
Connections to other transmission system			-	ea	$ 1,500	$ -	

Narrative	Quantity	Units	Unit cost	Extension	Major Item Subtotal
Fire hydrants					$ 8,000
Fire hydrant	2	ea	$ 1,600	$ 3,614	
10ft of 6-in lateral @ ea	20	lf	$ 50	$ 1,129	
tees and valves	2	ea	$ 1,450	$ 3,275	

CONTRACTOR'S DIRECT COST				$ 149,000
CONTRACTOR'S OVERHEAD	rate:	included in line items	0%	$ -
CONSTRUCTION COST - ESTIMATED				$ 149,000
CONSTRUCTION COST CONTINGENCY		rate	33%	$ 49,000
SUBTOTAL:				$ 198,000
ENGINEERING		rate	15.0%	$ 30,000
LEGAL, FINANCING, CONTRACT ADMINISTRATION		rate		$ 10,000
SUBTOTAL:				$ 238,000
PROJECT CONTINGENCY		rate	25.0%	$ 60,000
TOTAL ESTIMATED PIPELINES PROJECTS BUDGET				$ 298,000

S. M. STOLLER
ALTERNATE WATER SUPPLY: ARAPAHO WIND RIVER
WATER SUPPLY SYSTEM (WELLS) INTO WIND RIVER FORMATION

OPINION OF PROBABLE CONSTRUCTION COST $ 276,000

MWE job no: 500723 — OPINION OF PROBABLE PROJECT BUDGET $ 392,000

Date of latest revision

ALTERNATE: Wells for Approach No. 1- Stand alone development

Comments:

Year Cost Index Data

For date of origination, the index =	ENR Construction Cost Index	7,298	
For the date of the revision index =	ENR Construction Cost Index	7298	1.00

Correction to unit prices for area of project

Means City Cost Index: Denver	107.9	Riverton	97.9	City Cost correction	0.91

	Narrative	Quantity	Units	Unit cost	Extension	Major Item Subtotal
WELLS						
Well Equipment	Furnish and install	1	LS	$ 168,000		$ 168,000
Equipment:	AmWest Inc estimate & includes lump sum for					
	Pump& motor					
	Wiring					
	Piping					
	Pitless adapter					
	Controller in panel, local					
	Miscellaneous					
	Equipment total by AmWest			$ 60,000		
	correction to Riverton	1	LS	$ 54,439	$ 54,439	
Installation	Per estimate from Hinkle drilling					
	100 ft (+/-) wire wrapped ss cε	1	LS			
	casing, gravel pack					
	pitless adapter, sealing well					
	pitless adapter					
	geophysical logging of hole					
	Pumping tests: 8 & 24 hours	1	LS			
	subtotal			$ 125,000		

Narrative	Quantity	Units	Unit cost	Extension	Major Item Subtotal
correction to Riverton	1	LS	$ 113,415	$ 113,415	
Meter Vault:	1	LS	$ 37,000		$ 37,000
Connection to transmission/distribution system	1	LS	$ 16,000		$ 16,000
Water Supply Wells					
Install wells completely equipped	1	EA	$ 168,000		$ 168,000
Meter Vault	1	EA	$ 37,000		$ 37,000
Connect to piping system	1	EA	$ 16,000		$ 16,000

CONTRACTOR'S DIRECT COST				$ 221,000
CONTRACTOR'S OVERHEAD	rate:	included in line items	0%	$ -
CONSTRUCTION COST - ESTIMATED				$ 221,000
CONSTRUCTION COST CONTINGENCY		rate	25%	$ 55,000
SUBTOTAL:				$ 276,000
ENGINEERING		rate	15.0%	$ 41,000
LEGAL, FINANCING, CONTRACT ADMINISTRATION		rate		$ 10,000
SUBTOTAL:				$ 327,000
PROJECT CONTINGENCY		rate	20.0%	$ 65,000
TOTAL ESTIMATED PROJECT BUDGET				$ 392,000

S. M. STOLLER
ALTERNATE WATER SUPPLY: ARAPAHO WIND RIVER
WATER SUPPLY SYSTEM (WELLS)

OPINION OF PROBABLE CONSTRUCTION COST $ 3,591,000
ASCG Job No: 500723 OPINION OF PROBABLE PROJECT BUDGET $ 4,761,000
Date of latest revision

ALTERNATE: Wells for Approch No. 2 – integrated system
Comments:

Year Cost Index Data

For date of origination, the index =	ENR Construction Cost Index	7,298	
For the date of the revision index =	ENR Construction Cost Index	7298	1.00

Correction to unit prices for area of project
Means City Cost Index: Denver 107.9 Riverton 97.9 City Cost correction 0.91

Narrative			Quantity	Units	Unit cost	Extension	Major Item Subtotal
WELLS							
Refer to: Appendix B-1 for derivation of unit cost of wells							
Wells			1	LS	$ 168,000		$ 168,000
Well Equipment	Furnish and install						
Equipment:	Pump& motor	AmWest estimate					
	Wiring						
	Piping						
	Pitless adapter						
	Controller in panel, local						
	Miscellaneous						
	Equipment total by AmWest				$ 60,000		
	correction to Riverton		1	LS	$ 54,439	$ 54,439	
Installation	Per estimate from AmWell		1	LS	$ 20,000		
	Per estimate from Hinkle drilling						
	100 ft (+/-) wire wrapped ss ca		1	LS			
	casing, gravel pack						
	pitless adapter, sealing well						
	pitless adapter						
	geophysical logging of hole						
	Pumping tests: 24 to 72 hours		1	LS			

Narrative	Quantity	Units	Unit cost	Extension	Major Item Subtotal
subtotal			$ 125,000		
correction to Riverton	1	LS	$ 113,415	$ 113,415	
Meter Vault:	1	LS	$ 37,000		$ 37,000
Connection to transmission/distribution system	1	LS	$ 16,000		$ 16,000
Water Supply Wells					
Install and equip 13 new wells	13	EA	$ 168,000		$ 2,184,000
Meter Vault	13	EA	$ 37,000		$ 481,000
Connect to piping system	13	LS	$ 16,000		$ 208,000

CONTRACTOR'S DIRECT COST				$ 2,873,000
CONTRACTOR'S OVERHEAD	rate:	included in line items	0%	$ -
CONSTRUCTION COST - ESTIMATED				$ 2,873,000
CONSTRUCTION COST CONTINGENCY		rate	25%	$ 718,000
SUBTOTAL:				$ 3,591,000
ENGINEERING		rate	15.0%	$ 539,000
LEGAL, FINANCING, CONTRACT ADMINISTRATION		rate		$ 10,000
SUBTOTAL:				$ 4,140,000
PROJECT CONTINGENCY		rate	15.0%	$ 621,000
TOTAL ESTIMATED PROJECT BUDGET				$ 4,761,000

S. M. STOLLER
ALTERNATE WATER SUPPLY: ARAPAHO WIND RIVER
TRANSMISSION SYSTEM

OPINION OF PROBABLE CONSTRUCTION COST $ 4,816,000
ASCG Job No: 500723 OPINION OF PROBABLE PROJECT BUDGET $ 6,103,000
Date of latest revision

ALTERNATE: Transmission system for Approch No. 2 – integrated system
Comments:

Cost Index Data

For date of origination, the index =	ENR Construction Cost Index	7,298	
For the date of the revision index =	ENR Construction Cost Index	7,298	1.00

Narrative	Quantity	Units	Unit cost	Extension	Major Item Subtotal
TRANSMISSION PIPELINES					
12" PIPELINE	67,600	lf	$ 44.00		$ 2,974,000
Cost source: Cooley Raw Water & Potable Water					
Transmission Pipelines for Town of Morrison. Bid August 2000					
ENR CCI= 6233 ENR correction =	1.17				
Low bid price: $34.00 Adjusted:	39.81				
Pipeline:					
From existing tank site northward	2,900	lf			
Easterly to Pronghorn Drive	15,700	lf			
To Whitetail Dr to Rendv. Rd	10,300	lf			
Total footage along northen route:	28,900		$ 40	$ 1,156,000	
From new tank to Mission Rd	12,900	lf			
Mission Rd to Chair Ln	12,900	lf		$ -	
Chair Ln to existing Tank	12,900	lf		$ -	
Along Renduv Rd	-				
Total footage along southern route:	38,700	lf	$ 40.00	$ 1,548,000	
				$ -	
Fittings- total cost a Cooley $6,970					
unit price per ft of pipe $ 1.30				$ -	
corrected $ 1.52	67,600	lf	$ 2.00	$ 135,200	
Thrust blocks- total @ Cooley $5,700		lf			
unit price per tb @ cooley $ 475					
unit price per ft of pipe $ 0.09					
Valves: Lafayette Water System Improvements: Nov 1991					

Narrative	Quantity	Units	Unit cost	Extension	Major Item Subtotal
ENR CCI= 6127 ENR correction =	1.19				
Low bid price: $1,700 Adjusted:	$2,025				
Install valves @ say every 1,200 ft	56	each	$ 2,000	$ 112,000	
SUBTOTALS FOR 12" PIPELINE:	38,700	LF	$ 46.39	$ 1,795,200	
Total price to use for final estimate			$ 44		
10" PIPELINE	22,300	lf	$ 38.00		$ 847,000
Cost source: Cooley Raw Water & Potable Water					
Transmission Pipelines for Town of Morrison. Bid August 2000					
ENR CCI= 6233 ENR correction =	1.17			$ -	
Low bid price: $29.80 Adjusted:	34.89				
Pipeline:					
Along Renduv. Rd.	10,600	lf			
Along Mission Rd	4,700	lf			
Elsewhere	7,000	lf			
		lf			
Total footage of 10" pipeline:	22,300	lf	$ 35.00	$ 780,500	
Fittings & thrust blocks- use price from above	22,300	lf	$ 2.00	$ 44,600	
Valves: Cooley					
ENR CCI= 6233 ENR correction =	1.17				
Low bid price: $1,100 Adjusted:	$1,288				
Install valves @ say every 1,200 ft	20	each	$ 1,300	$ 26,000	
SUBTOTALS FOR 10" PIPELINE:	22,300	LF	$ 38.17	$ 851,100	
Total price to use for final estimate			$ 38.00		
AIR RELEASE VALVES	6	EA	$ 5,300		$ 32,000
Cost source: Cooley Raw Water & Potable Water					
Transmission Pipelines for Town of Morrison. Bid August 2000				$ -	
ENR CCI= 6233 ENR correction =	1.17				
Low bid price: $4,500 Adjusted:	$5,269			$ -	

Narrative			Quantity	Units	Unit cost	Extension	Major Item Subtotal
CONTRACTOR'S DIRECT COST							$ 3,853,000
CONTRACTOR'S OVERHEAD	rate:	included in line items			0%		$ -
CONSTRUCTION COST - ESTIMATED							$ 3,853,000
CONSTRUCTION COST CONTINGENCY				rate	25%		$ 963,000
SUBTOTAL:							$ 4,816,000
ENGINEERING				rate	15.0%		$ 722,000
LEGAL, FINANCING, CONTRACT ADMINISTRATION				rate			$ 10,000
SUBTOTAL:							$ 5,548,000
PROJECT CONTINGENCY				rate	10.0%		$ 555,000
TOTAL ESTIMATED PIPELINES PROJECTS BUDGET							$ 6,103,000

S. M. STOLLER
ALTERNATE WATER SUPPLY: ARAPAHO WIND RIVER STORAGE

OPINION OF PROBABLE CONSTRUCTION COST $ 2,323,000
OPINION OF PROBABLE PROJECT BUDGET $ 3,217,000

ASCG Job No: 500723
Date of latest revision

ALTERNATE: Storage for Approch No. 2 – integrated system
Comments:

Cost Index Data

For date of origination, the index =	ENR Construction Cost Index	7,298	
For the date of the revision index =	ENR Construction Cost Index	7,298	1.00

Narrative	Quantity	Units	Unit cost	Extension	Major Item Subtotal
STORAGE TANKS	2	EACH	$ 929,000		$ 1,858,000
Then for a 1.75 MG tank based on Means					
Basic tank cost (2001) $ 747,000					
Correction to 2005	1	LS	$ 851,281	$ 851,281	
Add for site work	851,281	%	9.2%	$ 78,166	

CONTRACTOR'S DIRECT COST				$ 1,858,000
CONTRACTOR'S OVERHEAD	rate:	included in line items	0%	$ -
CONSTRUCTION COST - ESTIMATED				$ 1,858,000
CONSTRUCTION COST CONTINGENCY		rate	25%	$ 465,000
SUBTOTAL:				$ 2,323,000
ENGINEERING		rate	15.0%	$ 348,000
LEGAL, FINANCING, CONTRACT ADMINISTRATION		rate		$ 10,000
SUBTOTAL:				$ 2,681,000
PROJECT CONTINGENCY		rate	20.0%	$ 536,000
TOTAL ESTIMATED STORAGE PROJECTS BUDGET				$ 3,217,000

APPENDIX D

S. M. STOLLER
ALTERNATE WATER SUPPLY: ARAPAHO WIND RIVER
REPLACEMENT COSTS FOR 100 YEAR PLANNING PERIOD.

Water system component	Quan.	Date installed	Use. Life yrs	Age yrs	Add'l life yrs	First Repl. year	Cost to replace: Unit Cost	Cost to replace: Extension	Cost to replace: Total
Water Supply									
Wells									
No 1 well, screen, casing, gravel pack		1973	35	32	10				
Replacement well, complete	2		50			2018	$ 113,000	$ 226,000	$ 314,000
Well cleaning, improvements	2				20		$ 30,000	$ 60,000	$ 75,000
pump & motor upgrade		2001	10	4					
Replace pump and motor	10		10			2011	$ 30,000	$ 300,000	$ 375,000
No 2 well, screen, casing, gravel pack		1980	35	25	10				
Replacement well, complete	2		50		10	2025	$ 113,000	$ 226,000	$ 316,000
pump & motor upgrade		2001	10	4					
Replace pump and motor	10		10				$ 30,000	$ 300,000	$ 375,000
Pipeline(s) to storage tank 4" & 6" ACP									
4" & 6" ACP		1973	35	32					
Replacement	5280		100			2008	$ 60	$ 316,800	$ 444,000
4" & 6" ACP		1980	35	25					
Replacement	5280		100			2015	$ 60	$ 316,800	$ 444,000
Storage: 1.0 MG steel ground level tank		2001	40	4					
Replace tank	2					2041	$ 445,000	$ 890,000	$ 1,246,000
Alternate Water Supply System									
8" PVC pipeline 34,300 lf		1997	100	8					
pipeline fittings of ductile iron		1997	40	8					

500723

APPENDIX D

Water system component	Quan.	Date installed	Use. Life yrs	Age yrs	Add'l life yrs	First Repl. year	Cost to replace Unit Cost	Extension	Total
air release valves		1997	40	8					
gate valves		1997	40	8					
Replace fittings, valves, etc	2					2037	$ 102,900	$ 205,800	$ 288,000
6" PVC pipeline 10,650 lf		1997	100	8					
pipeline fittings of ductile iron		1997	40	8					
air release valves		1997	40	8					
gate valves		1997	40	8					
ductile iron pipelines to fire hydrants		1997	40	8					
Replacement	2					2037	$ 31,418	$ 62,835	$ 88,000
fire hydrants		1997	60	8					
Replacement	25					2057	$ 3,100	$ 77,500	$ 109,000

Total Cost to Develop 100 year useful life: $ 4,074,000

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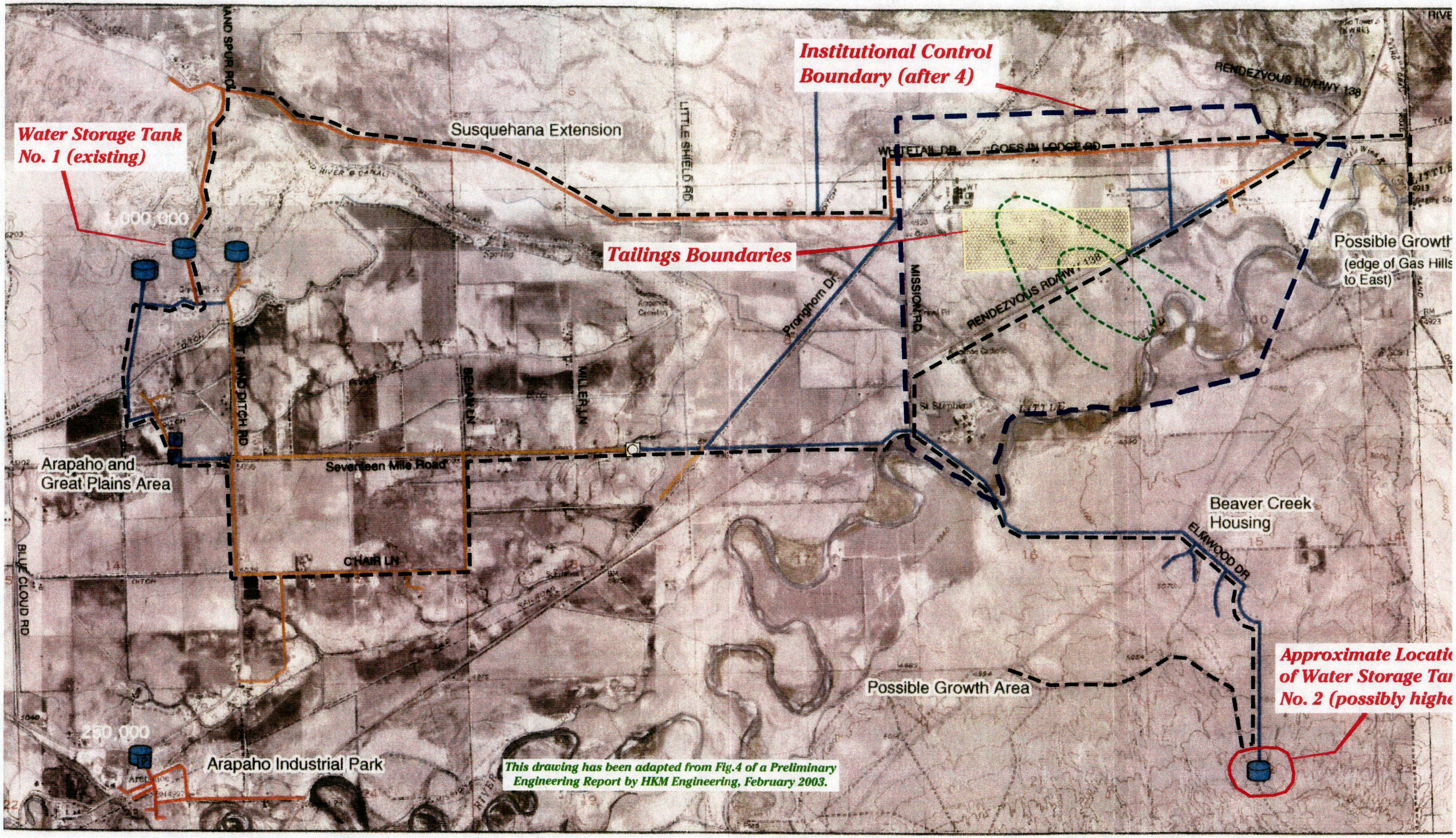

0 2000

1 inch = 2000 feet

Legend

Wells Tanks Pumps **Pipe Diameter** 6, 8, 2, 4, 12

Proposed New 12" Line

FIG III-A: ARAPAHO WATER SYSTEM

Contours of Uranium Concentration

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