UMTRA GROUND WATER PROJECT

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Final Site Observational Work Plan for the UMTRA Projects Site at Grand Junction, Colorado

February 1999

Prepared by the
U.S. Department of Energy
Grand Junction Office

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UMTRA Ground Water

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Acronyms and Abbreviations

ACL	alternate concentration limit
BAF	bioaccumulation factor
BLRA	baseline risk assessment
BOR	U.S. Bureau of Reclamation
CDPHE	Colorado Department of Public Health and Environment
cm	centimeter(s)
COPC	chemical of potential concern
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
ERA	ecological risk assessment
ft	foot (feet)
GJO	Grand Junction Office
gpm	gallons per minute
HI	hazard index
HQ	hazard quotient
in.	inch(es)
Kd	distribution coefficient
km	kilometer(s)
lb	pounds
m	meter(s)
µg/L	micrograms per liter
µm	micrometers
MCL	maximum concentration limit
mg/L	milligrams per liter
mi	mile
mL	milliliter
mL/g	milliliters per gram
NEPA	National Environmental Policy Act
ORNL	Oak Ridge National Laboratory
pCi/g	picocuries per gram
pCi/L	picocuries per liter
PEIS	Programmatic Environmental Impact Statement
PVC	polyvinyl chloride
RBC	risk-based concentration
RRM	residual radioactive materials
SEE	Site Environmental Evaluation
SOWP	Site Observational Work Plan
TAGR	Technical Approach to Groundwater Restoration
TDS	total dissolved solids
UMTRA	Uranium Mill Tailings Remedial Action (Project)
UMTRCA	Uranium Mill Tailings Radiation Control Act
USGS	U.S. Geological Survey

Executive Summary

This document is the Site Observational Work Plan (SOWP) for the Grand Junction, Colorado, Uranium Mill Tailings Remedial Action (UMTRA) Project site. The purpose of this report is to provide a strategy for achieving compliance with requirements established in the Uranium Mill Tailings Radiation Control Act (42 *United States Code* 7901 *et seq.*) and the U.S. Environmental Protection Agency's (EPA's) "Health and Environmental Protection standards for Uranium and Thorium Mill Tailings" (Title 40, *Code of Federal Regulations*, Part 192).

The compliance strategy proposed for the Grand Junction, Colorado, site is no remediation and the application of supplemental standards based on the criterion of limited use ground water. Ground water in the alluvial aquifer is not a current or potential source of drinking water because the quality of the water is naturally poor. Average uranium and selenium concentrations in background ground water of the alluvial aquifer exceed UMTRA Project maximum concentration limits. Existing institutional controls imposed by the U.S. Department of Energy, the Colorado Department of Public Health and Environment, or the City of Grand Junction prevent use of the alluvial aquifer for drinking water on site and downgradient of the site. A feasibility study indicates that treatment of the ambient ground water for municipal use would be unreasonably expensive.

The Grand Junction millsite, also known as the Climax uranium mill, began as a sugar beet mill and was operated as a uranium/vanadium mill from 1950 to 1970. During that time the mill processed more than 2 million tons of ore, which produced about 12 million pounds of uranium oxide (U_3O_8) and 46 million pounds of vanadium oxide (V_2O_5). Ore was crushed, ground, salt roasted and water leached to remove vanadium; uranium was extracted with a sulfuric acid leach. The Climax Corporation demolished most of the mill buildings and seeded the tailings piles before leaving the site in 1976. From the late 1980s to 1994 the site was used as an interim repository for mill tailings removed from Grand Junction vicinity properties as part of the UMTRA Surface Project. By the end of 1994 all tailings and the remaining buildings, except the old sugar beet warehouse, were demolished and hauled to the Cheney Repository about 18 miles southeast of Grand Junction.

The original Site Observational Work Plan (DOE 1996d) indicated that applying the criterion of widespread ambient contamination of the alluvial aquifer might be justified on the basis of high concentrations of total dissolved solids and naturally high concentrations of molybdenum, selenium, and uranium in background alluvial ground water. The Baseline Risk Assessment (BLRA)(DOE 1995) concluded that ground water quality in the alluvial aquifer in the area is naturally poor, the aquifer is not being used as a source of drinking water, and that institutional controls were in place in the vicinity of the site to prevent its future use as drinking water. A list of chemicals of potential concern (COPCs) was developed and consisted of arsenic, cadmium, cobalt, fluoride, iron, manganese, molybdenum, nickel, ^{226}Ra, sulfate, uranium, vanadium, and zinc. Risks to human health and the environment were considered minimal, but the BLRA recommended collection of additional information to further evaluate these risks and to further characterize the ground water.

For this 1999 Site Observational Work Plan, additional information was collected to evaluate the ground water and surface water quality and movement, determine any contribution of contamination from sediments, refine the hydrogeologic model, and provide updated information about risks to human health and the environment. Background ground water quality was determined to be poor because average concentrations of uranium and selenium were above UMTRA Project maximum concentration limits, and average concentrations of chloride, iron, manganese, sulfate, and total dissolved solids were above secondary standards established in the Safe Drinking Water Act. Analytical results of samples of Colorado River water upgradient, at, and downgradient of the millsite indicated that ground water was not measurably contaminating the river.

Hydraulic conductivity in the alluvial aquifer was predicted in earlier studies to be about 70 feet per day. The latest study found more heterogeneity in flow rates beneath the site; estimated flow rates ranged from several feet per day to more than 200 feet per day. The alluvial aquifer consists of fill covering sandy to silty sediments and a lower cobbly zone that overlies bedrock of Dakota Sandstone shales. The description of the alluvial aquifer is similar to descriptions in previous studies, but the bedrock is redefined as dark gray shales of the Dakota Sandstone instead of dark shales of the Mancos Shale. This change in identification of bedrock formation does not change the description of the hydraulic properties of the material. Shales of both the Dakota Sandstone and the Mancos Shale are described as aquitards. Ground water in the underlying Dakota Sandstone shales does not have mill-related contaminants and was not considered susceptible to downward migration of contaminants.

The evaluations of human health and ecological risks were updated using data collected in 1998. For human health risk, only the potential drinking water ingestion pathway was evaluated, as the initial BLRA indicated that risks from all other pathways were negligible. Results from the BLRA update indicated that regular human consumption of plume and background ground water could produce adverse health effects, though risks associated with ingestion of plume ground water were considerably higher. Uranium was the largest risk component in plume ground water, followed by ammonia, arsenic, fluoride, iron, manganese, molybdenum, and vanadium. Greatest risk contributors to background ground water were manganese, selenium, fluoride, molybdenum, and uranium. The final COPC list for risks to human health consisted of ammonia, arsenic, iron, manganese, molybdenum, sulfate (because toxicity data are currently being evaluated by EPA), uranium, and vanadium. However, because alluvial ground water in the area of the Grand Junction site is not used for drinking, and because city zoning and development code prohibits its use as drinking water, this exposure pathway is incomplete. It was concluded that site water does not present a risk to human health in the present or the foreseeable future.

An ecological risk assessment compared surface water, sediment, and plant tissues from the millsite area with similar samples collected from a reference area about three miles upstream along the Colorado River. That evaluation did not find a statistically significant difference in contaminant concentrations in abiotic and biotic samples between the two areas, although slightly elevated concentrations of some contaminants (ammonia and some metals) were detected sporadically in samples from the millsite. Therefore, it is recommended that ammonia, uranium, vanadium, manganese, and molybdenum are retained as ecological COPCs for the Grand Junction site. The study found no unacceptable risks to the ecology.

1.0 Introduction

The U.S. Department of Energy (DOE) Grand Junction Office (GJO) in Grand Junction, Colorado, produced this Site Observational Work Plan (SOWP). Its purpose is to determine a site-specific approach to comply with the U.S. Environmental Protection Agency (EPA) ground water standards for the Grand Junction Uranium Mill Tailings Remedial Action (UMTRA) Project site (also called the Climax site). The Grand Junction SOWP presents a comprehensive summary of the site hydrogeologic data, delineates a conceptual model for the aquifer system, and discusses the origins of milling-related ground water contamination. It also defines the magnitude of ground water contamination, potential human health and ecological risks associated with ground water contamination, and proposes a compliance strategy.

Section 2.0 describes the requirements for meeting standards at UMTRA Project sites. Section 3.0 provides new information gathered in 1997 and 1998 about the site, Sections 4.0 and 5.0 provide site-specific data that support the proposed ground water compliance strategy, and Sections 6.0 and 7.0 present justification for the proposed compliance strategy.

1.1 Ground Water Compliance Strategy

The proposed ground water strategy for the Grand Junction site is no remediation and the application of supplemental standards based on the criterion of limited use ground water. Limited use ground water is ground water that is not a current or potential source of drinking water because of widespread ambient contamination that cannot be cleaned up with treatment methods reasonably employed by public water supply systems (Title 40, *Code of Federal Regulations* [CFR], Part 192.11). The shallow ground water in the alluvial aquifer is considered limited use ground water. However, EPA standards require DOE to consider the effect of milling contamination on current or future beneficial uses of the ground water. Because the quality of ground water in the site area is naturally poor and because the City of Grand Junction prevents the use of ground water for domestic consumption, potential beneficial uses would be limited to watering livestock and plants.

1.2 UMTRA Project Programmatic Documents

Programmatic documents that guide the SOWP include the *UMTRA Ground Water Management Action Process* (DOE 1998), the *Final Programmatic Environmental Impact Statement for the Uranium Mill Tailings Remedial Action Groundwater Project* (PEIS) (DOE 1996c), and the *Technical Approach to Ground Water Restoration* (TAGR) (DOE 1993a). The Ground Water Management Action Process document states the mission needs and objectives for the UMTRA Ground Water Compliance Program and provides an overall technical and managerial approach for conducting the program. The PEIS provides an objective programmatic decision-making framework for conducting the UMTRA Ground Water Project, assesses the potential programmatic effects of conducting the project, provides a method for determining the site-specific ground water compliance strategies, and provides data and information that can be used to prepare site-specific National Environmental Policy Act (NEPA) documents (10 CFR 1021). The TAGR provides technical guidance for conducting the ground water program.

1.3 Relationship to Site-Specific Documents

The remedial action plan prepared for the cleanup of tailings, soils, and buildings provides site characterization information (DOE 1991). This information was updated in developing the SOWP to formulate the site conceptual model. If a ground water compliance strategy requiring remedial action was selected for this site, a ground water remedial action plan would be prepared; otherwise, a modification to the surface remedial action plan would suffice.

The *Baseline Risk Assessment of Ground Water Contamination at the Uranium Mill Tailings Site at Grand Junction, Colorado* (BLRA) (DOE 1995) was prepared in 1995. Potential risks identified at the site are considered in this SOWP to ensure that the proposed compliance strategy is protective of human health and the environment.

After a proposed compliance strategy is identified in the SOWP and described in the Ground Water Compliance Action Plan, a site-specific NEPA document (e.g., an environmental assessment) will be prepared to evaluate the potential effects of implementing the proposed compliance strategy. DOE will implement the proposed compliance strategy after receiving concurrence from the U.S. Nuclear Regulatory Commission (NRC) and the Colorado Department of Public Health and Environment (CDPHE).

1.4 SOWP Revisions

This SOWP presents a summary of existing data, a conceptual model, and a recommended compliance strategy based on this conceptual model. Additional data were collected in 1997 and 1998. An additional 23 monitoring wells were drilled, and two rounds of ground water samples were collected and analyzed. An ecological reference area chosen to represent site conditions before milling operations began was studied and sampled; results were compared to analytical results of ecological samples collected at the Grand Junction site. This document presents the additional data, correlates the data to previous information, and updates the BLRA and the site conceptual model.

DOE will provide copies of the final SOWP (Revision 1) to the NRC, CDPHE, and to the public for comment. Public meetings were conducted during preparation of the Baseline Risk Assessment for the Grand Junction site to ensure close coordination and consultation with potentially affected stakeholders.

1.5 Sources of Historical Data

An early engineering assessment of the site was conducted by Ford, Bacon, and Davis Utah Inc. in 1977 (Ford, Bacon, and Davis 1977). Surface remedial action data concerning the removal of tailings and final site conditions is in the *Remedial Action Plan and Site Design for Stabilization of the Inactive Uranium Mill Tailings Site at Grand Junction, Colorado* (DOE 1991), and the *Grand Junction, Colorado, Process Site Draft Completion Report,* Volumes 1 and 2, January 1995 from MK Ferguson (no final report was produced). Information about the chemicals used during the mill operations and a description of the milling process were taken from *The Extractive Metallurgy of Uranium* (Merritt 1971).

Ground water information is presented in the TAGR (DOE 1993); the *Site Observational Work Plan for the UMTRA Project Site at Grand Junction, Colorado* (DOE 1996d); *Potential Groundwater Contamination at Grand Junction UMTRAP Vicinity Properties* (Cahn and others 1988); and 45 boxes of field notes, internal reports, and other information archived in the DOE–GJO vault. Information in these boxes was generated by various contractors performing assessment and construction work at the site.

Other publications dedicated to local ground water or associated studies include *Geology and Artesian Water Supply, Grand Junction Area, Colorado*, a U.S. Geological Survey Professional Paper by Lohman (1965); the *Cobble Aquifer Investigation,* U.S. Bureau of Reclamation (U.S. Bureau of Reclamation 1986); and U.S. Geological Survey Open-File Report 94-110 entitled *Physical, Chemical and Biological Data for Detailed Study of Irrigation Drainage in the Uncompahgre Project Area and in the Grand Valley, West-Central Colorado, 1991–92* (Butler and others 1994).

Human health and ecological risk information is described in the Environmental Impact Statement for the millsite (DOE 1986) and in the BLRA (DOE 1995).

An important source of information and one used extensively for this report is the Site Environmental Evaluation (SEE) UMTRA database maintained at the DOE GJO facility. The database produces reports, tables, and graphs of surface and ground water and sediment chemistry, monitoring well information, lithologic and well completion data, and map coordinate information. Data for Grand Junction start in the mid-1980s. All new data generated for this report reside in SEE UMTRA. Maps that display analytical data are generated using SEE UMTRA information merged with an ArcView GIS package.

End of current text

2.0 Regulatory Framework

A ground water compliance strategy is proposed for the Grand Junction site to achieve compliance with EPA ground water standards applicable to Title I UMTRA Project sites. This section identifies the requirements of the Uranium Mill Tailings Radiation Control Act (UMTRCA), the EPA ground water protection standards (40 CFR Part 192), NEPA, and other regulations that are applicable to the UMTRA Ground Water Project.

2.1 Federal Regulations

2.1.1 Uranium Mill Tailings Radiation Control Act

The U.S. Congress passed UMTRCA (42 U.S.C. §7901 *et seq.*) in 1978 in response to public concerns about the potential health hazards from long-term exposure to uranium mill tailings. UMTRCA authorized DOE to stabilize, dispose of, and control uranium mill tailings and other contaminated materials at uranium-ore processing sites.

UMTRCA has three titles that apply to uranium-ore processing sites. Title I designates 24 inactive processing sites to undergo remediation, directs EPA to promulgate standards, mandates remedial action in accordance with standards prescribed by EPA, directs remedial action to be selected and performed with the concurrence of the NRC in consultation with states and Indian tribes, directs NRC to license the disposal sites for long-term care, and directs DOE to enter into cooperative agreements with the affected states and Indian tribes. Title II applies to active uranium mills, and Title III applies to certain uranium mills in New Mexico. The UMTRA Ground Water Project has responsibility for administering only Title I of UMTRCA.

In 1988, Congress passed the Uranium Mill Tailings Remedial Action Amendments Act (42 U.S.C. §7923 *et seq.*) authorizing DOE to extend without limitation the time needed to complete ground water remediation at the processing sites.

EPA Ground Water Standards

UMTRCA requires that EPA promulgate standards for protecting public health and the environment from hazardous constituents associated with processing uranium ore and with the resulting residual radioactive materials (RRM). On January 5, 1983, EPA published standards in 40 CFR 192 for the disposal and cleanup of RRM. The standards for ground water compliance were revised, and a final rule was published on January 11, 1995, and codified at 40 CFR 192.

The standards in 40 CFR 192.02 (c)(1) require that the Secretary of Energy determine which constituents listed in Appendix I of 40 CFR 192 are present in, or reasonably derived from, RRM. Those standards also require the Secretary to determine the areal extent of ground water contamination by listed constituent. Section 4.0 of this document, "Field Investigation Work," complies with these requirements and identifies the constituents of concern at the Grand Junction site.

The standards for cleanup address two ground water contamination scenarios in 40 CFR 192.02 (c)(2). The first scenario addresses ground water contaminated as a result of RRM associated with disposal cells. Future protection of ground water at the disposal sites is being addressed as part of the UMTRA Surface Project. The second scenario addresses ground water contaminated as a result of RRM in the uppermost aquifer at the processing site. The regulations allow the option of complying with four general standards. Three are numerical standards and are set forth in 40 CFR 192.02 (c)(3) as follows:

- Background level—Concentrations of constituents in the uppermost aquifer in an area that were not affected by milling activities.
- Maximum concentration limit (MCL)—EPA's maximum concentration limits for certain hazardous constituents in ground water, as proposed for the UMTRA Project. The MCLs for inorganic constituents that apply to the UMTRA Project sites are given in Table 1 to Subpart A, 40 CFR 192.04.
- Alternate concentration limit (ACL)—An alternate concentration limit for a hazardous constituent that does not pose a substantial present or potential hazard to human health or the environment, as long as the limit is not exceeded. An ACL may be applied after considering options to achieve background levels and MCLs.

DOE may, with NRC concurrence, apply a fourth option to contaminated ground water. Supplemental standards may be applied if any one of the following conditions is met as set forth in 40 CFR 192.21:

- Remedial action would pose a significant risk to workers or members of the public.
- Remedial action to meet the standards would directly produce harm to human health and the environment that is clearly excessive compared to the health and environmental benefits, now or in the future.
- The estimated cost of remedial action is unreasonably high relative to the long-term benefits, and the RRM does not pose a clear present or future hazard.
- There is no known remedial action.
- The remediation of ground water quality at any processing site is technically impracticable from an engineering standpoint.
- The ground water is considered limited use ground water if it is not a current or potential source of drinking water because:
  —Concentrations of total dissolved solids (TDS) exceed 10,000 milligrams per liter (mg/L).
  —Widespread ambient contamination is present that cannot be cleaned up using treatment methods reasonably employed in public water supply systems.
  —The quantity of water available for sustained continuous use is less than 150 gallons per day.

  When the criteria for limited use ground water apply, "supplemental standards shall ensure that current and reasonably projected uses of the affected ground water are preserved" [40 CFR 192.22 (d)].

- Radiation from radionuclides other than ^{226}Ra and its decay products is present in sufficient quantity and concentration to constitute a significant radiation hazard from RRM.

One of the four cleanup standards (i.e., clean up to background, MCLs, or ACLs, or apply supplemental standards) is selected on the basis of risk to human health and the environment. The methods available to achieve compliance include active remediation, natural flushing, and no remediation. Section 5.0, "Site Conceptual Model," presents a summary of the geology, hydrology, geochemistry, and ecology of the site. That discussion provides the information relevant to selecting a ground water compliance strategy. Section 7.0, "Ground Water Compliance Strategy," presents a discussion of the proposed compliance strategy for the Grand Junction site and includes a justification for selection of the no-remediation compliance strategy.

The regulations in 40 CFR 192.22(c) also require DOE to inform landowners and occupants of the locations affected by hazardous constituents and to solicit their comments if supplemental standards are applied.

2.1.2 National Environmental Policy Act

DOE NEPA regulations are in 10 CFR part 1021, "National Environmental Policy Act Implementing Procedures." Pursuant to NEPA, DOE finalized a PEIS for the UMTRA Ground Water Project to analyze potential effects of implementing the alternatives for conducting ground water compliance at the UMTRA Project processing sites.

A Record of Decision was published in April 1997 in which DOE's preferred alternative was selected based on the information available at the time. The decision gave DOE the option of implementing one or a combination of the following compliance strategies:

- Active ground water remediation
- Natural flushing
- No ground water remediation

2.1.3 Other Regulations

In addition to EPA ground water standards and requirements of NEPA, DOE must also comply with presidential executive orders, such as those related to pollution prevention and environmental justice, that may be relevant to the work being performed. Other Federal regulations include those that require protection of wetlands and floodplains, threatened and endangered species, and cultural resources.

2.2 State and Tribal Regulations

DOE must also comply with state and tribal regulations where federal authority has been delegated to the state. These include compliance with state permits required for drilling, completing, and abandoning monitoring wells; water discharge; and waste management.

2.3 DOE Orders

A number of environmental, health and safety, and administrative DOE orders apply to the work being conducted under the UMTRA Ground Water Project. DOE orders prescribe the manner in which DOE will comply with federal and state laws, regulations, and guidance, and the manner in which DOE will conduct operations that are not prescribed by law. DOE guidance for complying with federal, state, and tribal environmental regulations is given in the DOE Order 5400.1 series, which is partially superseded by DOE Order 231.1. DOE Order 5400.5 requires protection of the public from radiation hazards. DOE guidance pertaining to NEPA is given in DOE Order 451.1, and specific guidance pertaining to environmental assessments is provided in *Recommendations for the Preparation of Environmental Assessments and Environmental Impact Statements* (DOE 1993c).

2.4 Agreements

UMTRCA requires that compliance with the ground water standards be accomplished with the full participation of the states and Indian tribes on whose lands uranium mill tailings (RRM) are located. UMTRCA also directed DOE to enter into cooperative agreements with the states and Indian tribes.

3.0 Site Conditions

3.1 Physical Setting and Climate

The Grand Junction site is at an elevation of approximately 4,600 feet (ft) (1,400 meters [m]) in the broad, arid Grand Valley and has historically been referred to as the Climax site. It is located in Mesa County, Colorado (Figure 3–1), along the southern side of Grand Junction in an industrial area (Plate 1). The site is bounded on the south by the west-flowing Colorado River, which joins the Gunnison River about 0.75 mile (1.2 kilometers [km]) to the west. The Grand Valley is bounded by the Book Cliffs to the northeast, about 9 miles (15 km) from the site; the Grand Mesa to the east, about 16 miles (26 km) from the site; and the Uncompahgre Plateau to the west, about 5 miles (8 km) from the site. The Grand Junction site encompasses approximately 114 acres (46 hectares) that underwent surface remedial action from 1989 to 1994.

Annual precipitation in Grand Junction is approximately 9.1 inches (in.) (23.0 centimeters [cm]), and the mean annual temperature is 52.1°F (Lohman 1965). August and September are the wettest months; summer thunderstorms can produce more than an inch of rain. Potential evapotransporation for the area is approximately 71 in. (180 cm) per year, making the potential evapotransporation to precipitation ratio about 8:1.

3.2 Land and Ground Water Use

The original millsite was covered with 6 in. of clean soil and revegetated by 1994. Part of the original remedial action involved constructing wetlands, including eight ponds along the southern boundary of the property adjacent to the Colorado River (see Figure 3–10). River flooding in 1995 eroded the ponds and reconfigured the southern boundary of the site.

The area encompassing the former millsite is administered by the City of Grand Junction Parks and Recreation Department. In 1997 a pedestrian bridge was built across the Colorado River at the southeast corner of the site. In 1995 and 1996 the Army Corps of Engineers constructed a flood control levee through the southern part of the site. A concrete sidewalk built in 1997 on top of the levee is part of the city's riverfront trail corridor connecting the north side of the Colorado River to the south side at Orchard Mesa Middle School via the foot bridge. West of the site, the Western Colorado Botanical Society, in coordination with the city, constructed the Western Colorado Botanical Gardens, which contain a variety of indoor plants, butterflies, and an outdoor reconstruction of the valley's geomorphology with associated flora. The gardens are located at the south end of 7th Street at the access to the Watson Island section of the Colorado River Trail.

No ground water is being used from the site. The deed transferring the site to the City of Grand Junction from the Colorado Department of Public Health and Environment (CDPHE) specifies ground water use restrictions that are controlled by the state and DOE (see Section 7.2 for details). According to information from the State Engineer's Office, no wells are recorded for properties downgradient of the site. The Botanical Gardens uses a sump near the Colorado River to pump water into a lined pond for irrigating the gardens.

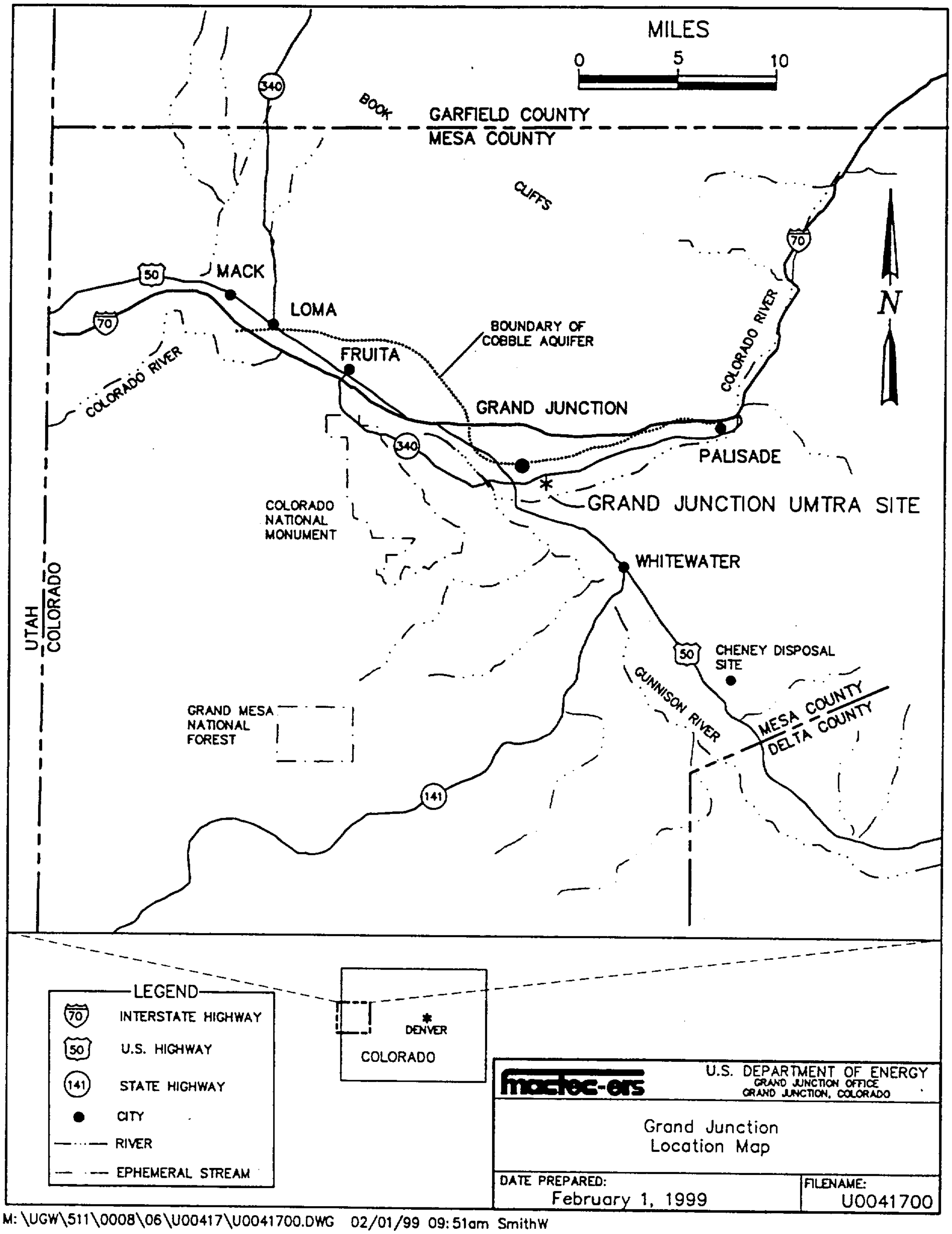

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Figure 3–1. Location of the Grand Junction Site

3.3 Site History

3.3.1 Milling History

The millsite and the remaining brick mill building were originally part of the Colorado Sugar Manufacturing Company; the building was constructed in 1899. Later it became the Holly Sugar Corporation and processed sugar from sugar beets; the plant closed before the pre-1947 photograph shown in Figure 3–2. The site of four ponds used during the sugar processing era, located directly south of the mill, were used later for settling ponds during the uranium milling operation.

The site was reconfigured for uranium-ore processing and opened as the Climax mill in late 1950 (Mastrovich 1985). The mill was constructed and operated by the Climax Uranium Company, a subsidiary of Climax Molybdenum Corporation. The Climax mill had an initial production rate of 330 tons per day until 1955; modifications increased capacity to 500 tons per day, which was maintained until closure (Merritt 1971; Orr 1954). Figure 3–3 is an oblique aerial photograph taken about 1956 looking northwest. The photograph shows the old sugar beet mill warehouse extending from the right side of the picture up to about the stack. Various other buildings, blending vats, labs, and ponds are visible in this photograph. Ore was brought by rail and truck and stored in the area shown in the upper left portion of the photograph. Figure 3–4 is a 1954 aerial photograph that shows the size of the tailings area, the ore storage area, and the settling ponds. In 1960, Climax was incorporated into American Metals Climax, Inc., which operated the mill until closure in March 1970. Figure 3–5 is an aerial photograph from 1961 showing the two solids disposal areas in the eastern and western sections of the property, where tailings in the form of sands and slimes were pumped (Merritt 1971). Figure 3–6 from 1966 shows the three large evaporation ponds totaling 35 acres on the eastern part of the property, where effluent was pumped from the settling ponds just south of the mill.

This mill was the first in the United States that was designed for uranium production with vanadium as a byproduct. Ores were predominantly sandstones from the Morrison and Chinle Formations that contained primary uranium/vanadium oxide and silicate minerals, as well as oxidized ores containing predominantly carnotite (potassium uranium vanadate) and tyuyamunite (calcium uranium vanadate). Most of the mill feed came from about 20 company-owned mines in the Uravan Mineral Belt; the remainder came from independent producers (Merritt 1971).

The ore was crushed and ground; uranium was initially acid leached and neutralized before sands and slimes were separated. Sands were acid leached again. After separation, the slime fraction was salt roasted and water leached to remove vanadium, and finally acid leached again to remove uranium and water-insoluble vanadium. A solvent extraction process separated uranium from vanadium. The solvent extraction raffinate solution and other intermediate products were treated with acid again to remove additional uranium and vanadium (Merritt 1971). Tailings from the washing circuit and raffinate from the solvent extraction operation were sent to one or two small holding ponds near the mill, where fines settled out before the waters were sent to one of the three separate holding ponds where liquids were allowed to evaporate. The tailings piles were stabilized with vegetation during the years of operation, and erosion of tailings into the Colorado River was minimized. This complex milling process required a number of different chemicals. Inorganic chemicals included sulfuric acid, hydrochloric acid, sodium chlorate, ammonia, sodium chloride, sodium carbonate, hydrogen peroxide, and powdered iron metal; organic chemicals included Number 2 fuel oil, di(2-ethylhexyl) phosphoric acid, tributyl phosphoric acid, and tertiary amines (DOE 1995).

During 19 years of milling, 2,281,614 tons of ore were processed; the ore averaged 0.28 percent U_3O_8 and 1.41 percent V_2O_5. A total of 11,698,736 pounds (lb) of U_3O_8 and 46,050,877 lb of V_2O_5 were produced. Uranium recovery averaged 93 percent and vanadium recovery averaged 72 percent over the history of the operation (Albrethson and McGinley 1982). An estimated 2.2 million dry tons of tailings in the form of fine sands and slimes were produced during the life of the mill. From 1950 to 1966, tailings were available to private citizens and contractors who used them for fill and other construction activities (e.g., concrete production). The Atomic Energy Commission denied having jurisdiction over the tailings because they contained less than 0.05 percent of the uranium source material, which was the criterion set forth in the *Code of Federal Regulations* (Mastrovich 1971). But in 1966 the tailings were sampled for radon, and preliminary results indicated elevated levels. Although that finding caused Climax to discontinue release of tailings from the site, an estimated 300,000 tons of sands containing uranium daughter products had been removed by that time (Mastrovich 1971).

3.3.2 Surface Remedial Action and Current Status

The mill was closed in March 1971. During 1970 and 1971 Climax demolished 8 of the 12 main mill buildings and sold slimes in the northernmost settling ponds to Union Carbide Corporation as ore. The bottoms of the large evaporation ponds were plowed and dikes surrounding them were leveled. Equipment that could be decontaminated was sold; other equipment that could not be decontaminated was buried in the tailings piles along with building rubble (Merritt 1971). Some building rubble was used as riprap along the river. Figure 3–7 from 1977 shows the remaining mill buildings that Climax left and final reclamation efforts of the tailings piles. Climax personnel experimented with planting different types of grasses directly on the tailings. They found that crested wheat grass grew well if irrigated sufficiently (Merritt 1971). The circular patterns in this photograph (Figure 3–7) and, to a lesser extent, in the previous one (Figure 3–6), are irrigated areas of grasses. Climax deeded 40 acres, where the three evaporation ponds had been located, to the State of Colorado. This was the temporary or interim repository for vicinity property tailings during the next phase of remedial action. Climax sold its remaining property by 1976 (Mastrovich 1985).

After Climax left in 1976, the next and final phase of surface remedial action was the UMTRA effort that began in the mid-1980s. This cleanup was conducted in two phases. Phase I, completed in 1989, consisted of fencing, demolishing remaining buildings except the old sugar mill, constructing lined retention ponds, and preparing the wastewater treatment plant foundation at the Cheney Disposal Cell located about 15 miles southeast of Grand Junction. Phase II began in 1990 and included constructing and filling the Cheney Disposal Cell and assembling the wastewater treatment plant. Figure 3–8, a May 1991 oblique aerial photograph looking west, shows the treatment plant, initial excavation and removal of contaminated materials, and the newly constructed rail car haul system. Figure 3–9, a March 1993 oblique aerial photograph looking west, shows continued excavation of the mill tailings and interim storage of vicinity property materials on the site of the evaporation ponds. By the end of 1994 all contaminated materials from the old processing site and the vicinity property materials temporarily stored at the site had been transported to the Cheney Disposal Cell. Figure 3–10 is a May 1994 oblique aerial photograph looking west that shows the site fully excavated, backfilled, contoured, and seeded. The only building left is the original brick sugar mill warehouse that was cleaned, fitted with a new roof, and sold to the private sector in 1995. It is now located outside of the fenced enclosure of the old Climax site (information from the completion report prepared by M. K. Ferguson, January 1995).

In 1994 eight ponds were constructed along the southern side of the site adjoining the Colorado River as part of a wetlands area. Floods in the spring and early summer of 1995 severely eroded some ponds and filled others with silt. The wetlands area was never reconstructed and today only indistinct traces of the eight ponds are visible. Sampling of the original ponds indicated that higher levels of contamination were present in the two westernmost ponds (DOE 1996d). However, the higher concentrations may have resulted from evaporation.

3.3.3 Sources of Ground Water Contamination

During the sugar beet milling period, excess vegetation and pulp from the sugar beets were used to feed livestock. The apparent remnants of these early stock yards can be seen in a pre-1947 photo (Figure 3–2) along the southeastern portion of the site. Later, an area along the west side of the site was used as corrals (see Plate 1). Both areas, but especially the area in the southeastern part of the site, may have contributed nitrogen to the ground water.

Ground water contamination at the site resulted from processing ore and from subsequent leaching of uranium mill tailings constituents by mill water, rain water, and ground water. During active milling, slimes and water from the operation were sent to four settling ponds located directly south of the mill (see Figure 3–3) and from there to three evaporation ponds located east and north of the mill (Figure 3–6 and Plate 1). The evaporation ponds apparently did not have enough surface area for complete evaporation of the water, and some liquids seeped into the underlying sediments. An estimated 50 million gallons (190,000 cubic meters) per year from 1951 to 1955, and 75 million gallons (285,000 cubic meters) per year from 1956 to 1970 were used to process ore. Based on this estimate, the total amount of process water that was available to seep into the sediments underlying the site over the history of milling operations was approximately 1,900 acre-feet, or 2.3 million cubic meters (DOE 1996d).

3.4 Future Uses of Land and Ground Water

DOE deeded the Climax site to the CDPHE, who inturn, deeded the site to the City of Grand Junction. CDPHE quitclaimed the former Climax millsite to the City of Grand Junction in April 1997. The deed specified that ground water from the site could not be used for any purpose without written approval of DOE and CDPHE. The City is developing a master plan for use of the land as an open park area. Possible uses include a city pedestrian park with trees, sidewalks, and grassy areas; a recreational area including ball fields; and an engineered area for holding ponds and wetlands that temporarily store excess storm flow before it is released to the river. The City has recently named the land occupied by the former millsite “Las Colonias Park,” from an earlier Latino community that existed in that part of town.

The City has also acquired some additional parcels of land downgradient (west) of the millsite. One narrow strip extends from the millsite to about 8th Street along the small northern channel of the Colorado River. Another parcel extends from 7th Street to 5th Street on the south side of Struthers Avenue. That parcel will have botanical gardens and a parking lot in the western section and already contains a building housing other botanical gardens and a butterfly house in the eastern part. Currently, the City does not have plans to obtain other parcels of land in the region east of the millsite and south of Struthers Avenue extending west to 5th Street. Several commercial and private landowners have property in this corridor. On the west side of 5th Street, the City now owns the old American Auto Salvage property and has constructed a dike along its southern perimeter that is connected to the dike farther north protecting the community surrounding Riverside Park. The area inside the old American Auto Salvage property north of the dike and south of Riverside Park Drive (or 4th Avenue) may be offered to light industry; the area south of the dike contains a large pond open to the Colorado/Gunnison River confluence that U.S. Fish and Wildlife hopes to use as a breeding area for fish during times of high water.

No future use of the ground water is planned or anticipated. The City requires persons or businesses inside the city limits to use municipal water hookups. No wells are registered with the State Engineer's Office in this area. The City pumps water from a sump near the Colorado River into a series of ponds along the west side of the botanical gardens property and plans to use this ponded water as irrigation for some of the gardens.

Explanation of aerial photographs (Figures 3–2 through 3–10)

Figure 3–2: Pre-1947 Overhead Aerial Photograph. Sugar beet mill buildings and four ponds are visible. The semirectangular areas southeast of the mill near the Colorado River are interpreted to be remnants of stockyards. An old channel of the Colorado River crosses the southern part of the property.
Figure 3–3: 1956 Oblique Aerial Photograph of the Climax Mill—Looking Northwest. The large building on the right, which was the warehouse for the sugar beet mill (1), is being used in the uranium milling process. The dryer stack (2) is located between the roaster building (3) and the main mill buildings (4), and farther to the left are two thickener tanks (5). Left of the tanks is the ore crusher house (6) and ore piles (7)(mostly hauled in by rail). The tall, light-colored building in the left foreground is the vanadium plant (8). Four slimes ponds (9) are visible in the foreground and light-colored tailings (10) are visible in the left foreground.
Figure 3–4: 1954 Overhead Aerial Photograph. The mill has been in operation for about 4 years and the ponds south of the mill are being used for slimes ponds (sometimes called raffinate ponds). Tailings are being deposited southwest of the ponds.
Figure 3–5: 1961 Overhead Aerial Photograph. Considerably more tailings have been deposited since 1954 and are spread over most of the millsite area.
Figure 3–6: 1966 Overhead Aerial Photograph. Large evaporation ponds (ponds 1, 2, and 3 on Plate 1) are visible to the east of the mill. Circular areas are from American Metals Climax, Inc. irrigation and reseeding attempts on the tailings piles. Smoke can be seen emanating from the stack.
Figure 3–7: 1977 Overhead Aerial Photograph. The mill closed in 1971, and by 1977 American Metals Climax, Inc. had razed most of the buildings and attempted to vegetate the tailings piles.
Figure 3–8: October 1991 Oblique Aerial Photograph—Looking West (from DOE 1995a, Volume 1). This figure shows the removal of tailings and other materials. The wastewater retention basin is visible at the top of the photo and the rail out-load facility is shown on the right. Only the original sugar beet mill warehouse remains.
Figure 3–9: March 1993 Oblique Aerial Photograph—Looking West (from DOE 1995a, Volume 1). This figure depicts the continued removal of vicinity property tailings from the state's interim repository pile in the foreground. The rail out-load facility is seen on the right.
Figure 3–10: May 1994 Oblique Aerial Photograph—Looking West (from DOE 1995a, Volume 1). All facilities for remedial action are removed; the site is contoured, revegetated, and a series of 8 ponds are constructed along the Colorado River. In1995, spring flood water from the Colorado River infilled or eroded the pond system, and little evidence of its existence is visible today.

Figure 3–2. Pre-1947 Photograph

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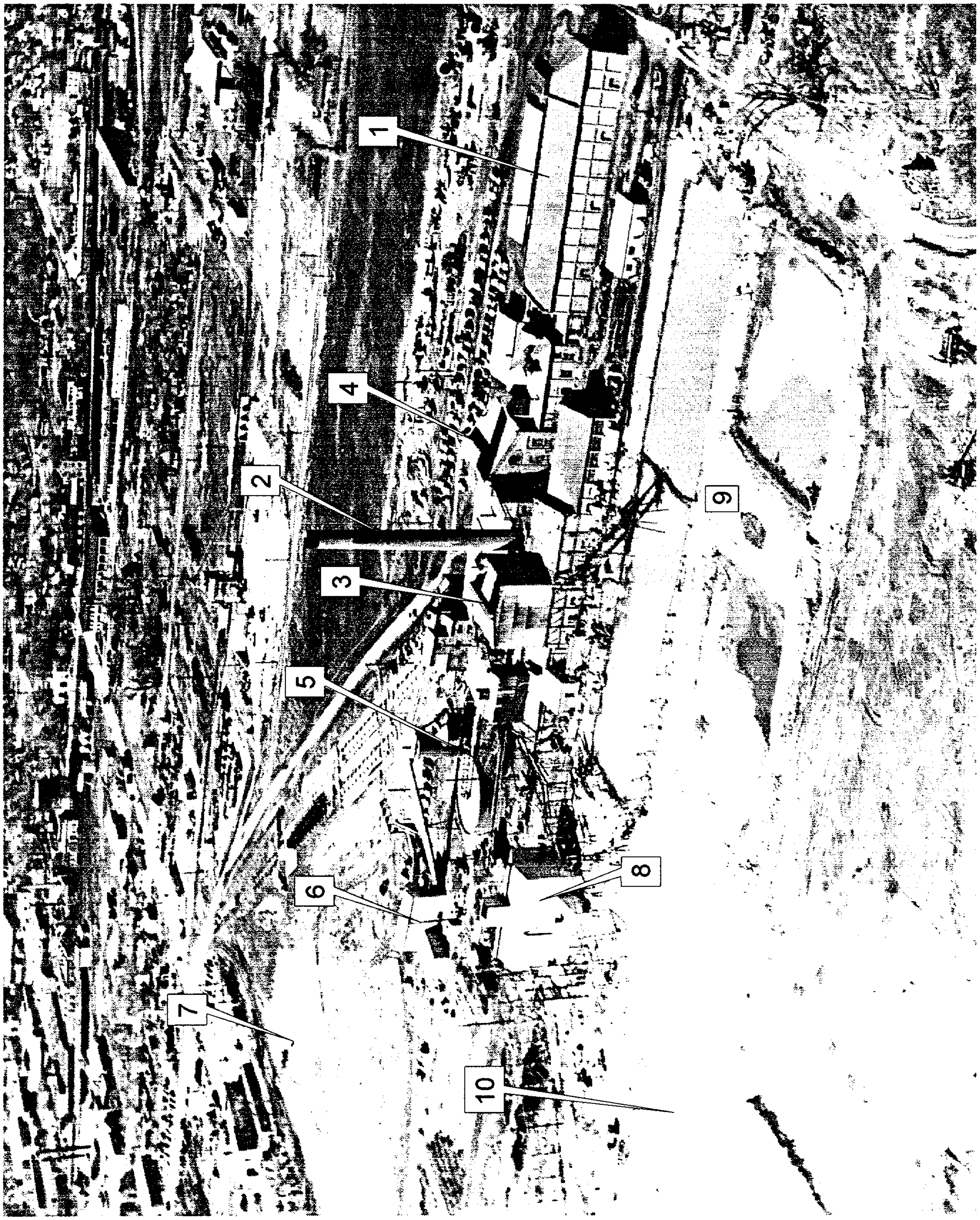

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Figure 3–3. 1956 Photograph of the Mill—Looking Northwest

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Figure 3–4. 1954 Aerial Photograph

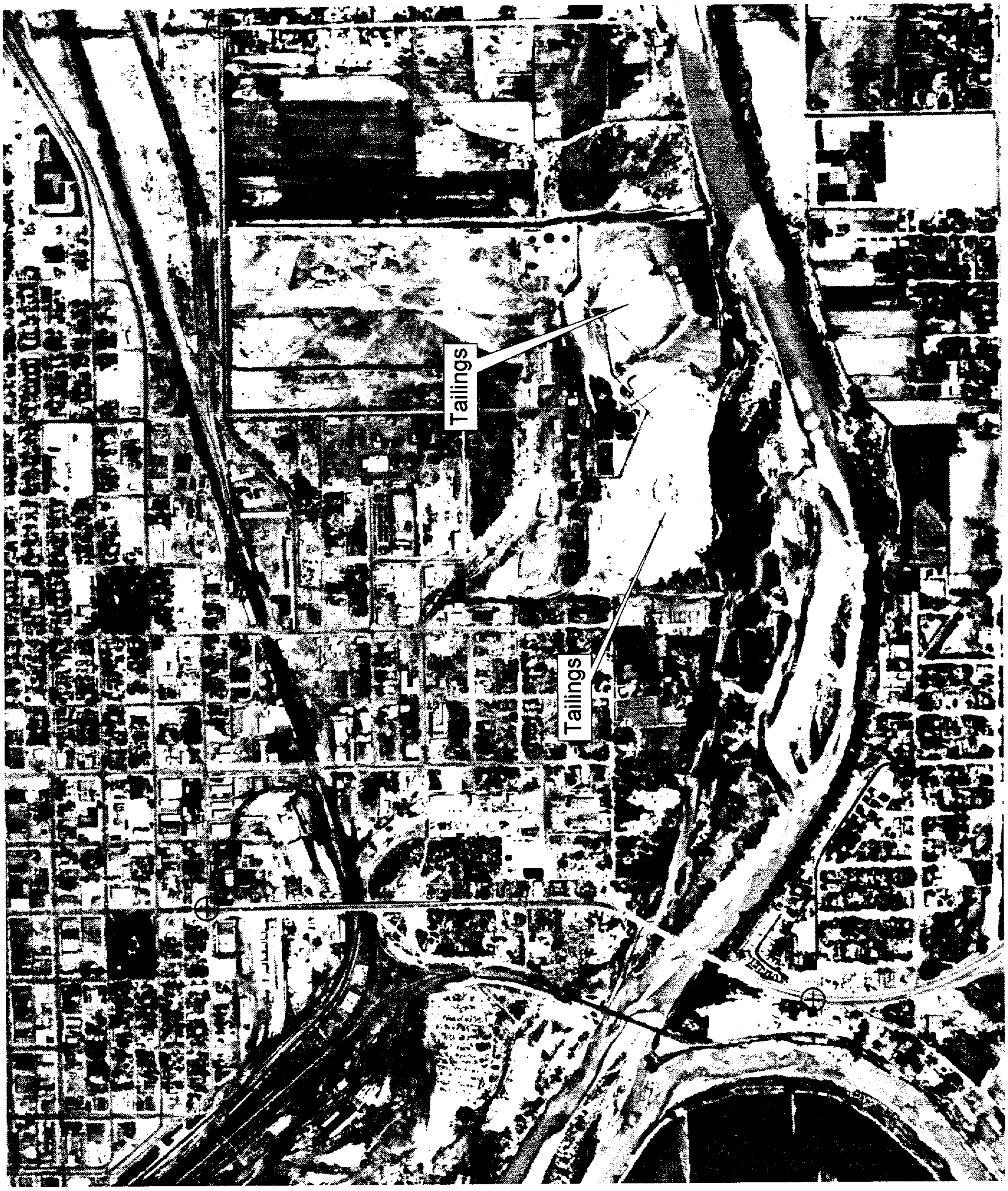

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Figure 3–5. 1961 Aerial Photograph

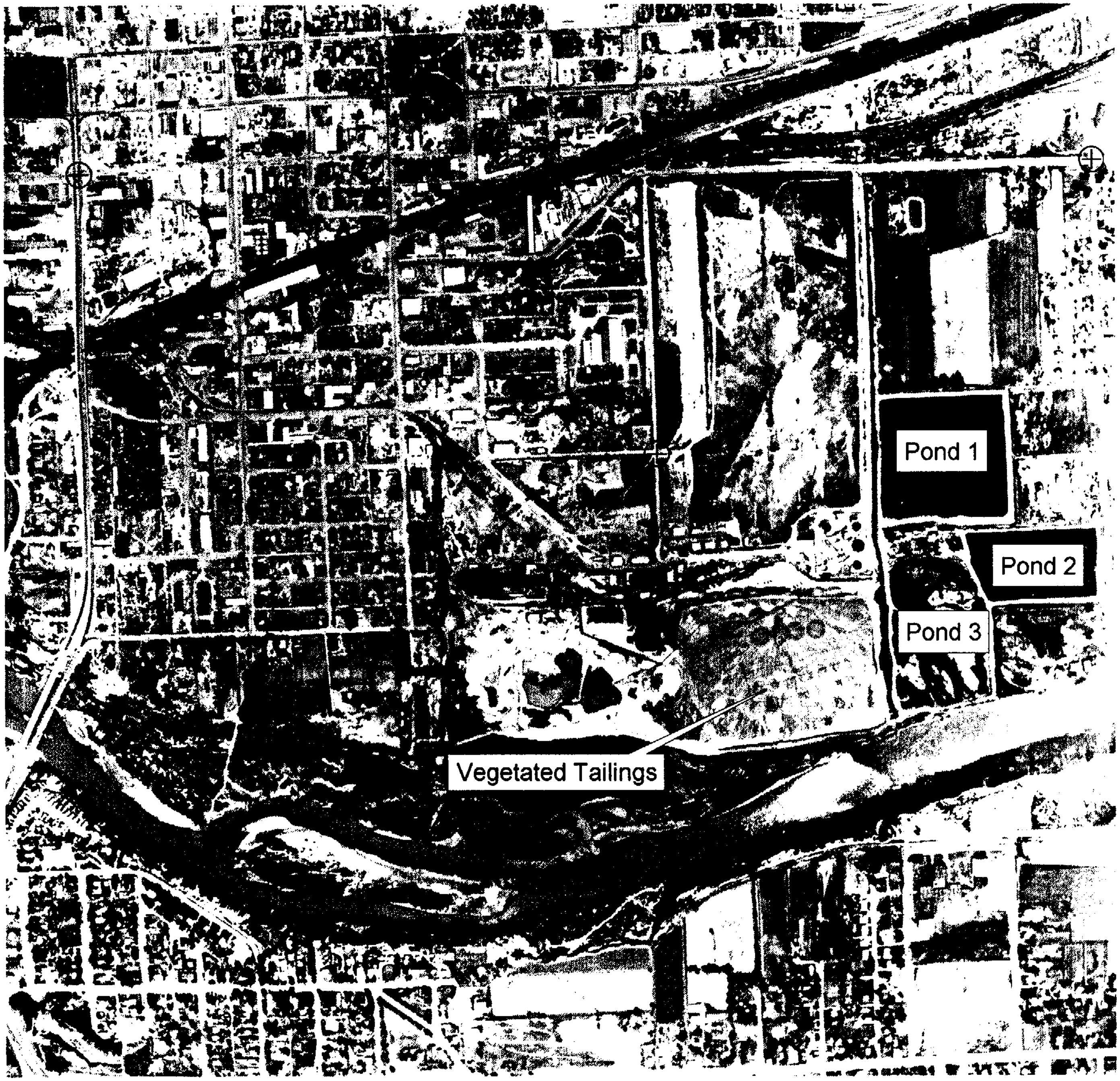

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Figure 3–6. 1966 Aerial Photograph

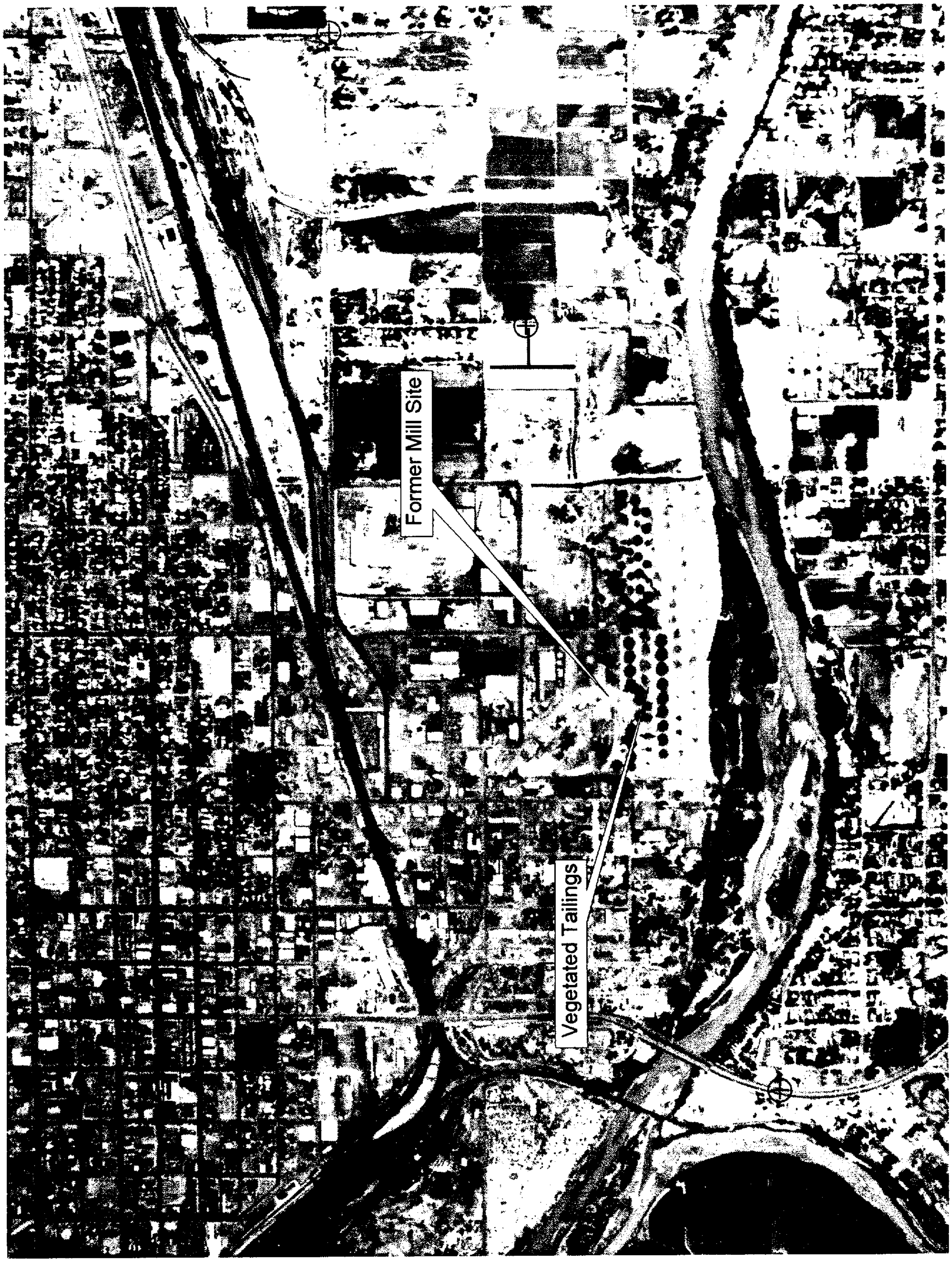

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Figure 3–7. 1977 Photograph of the Climax Mill

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Figure 3–8. 1991 Photograph; Looking West at the Excavation of the Climax Tailings Piles

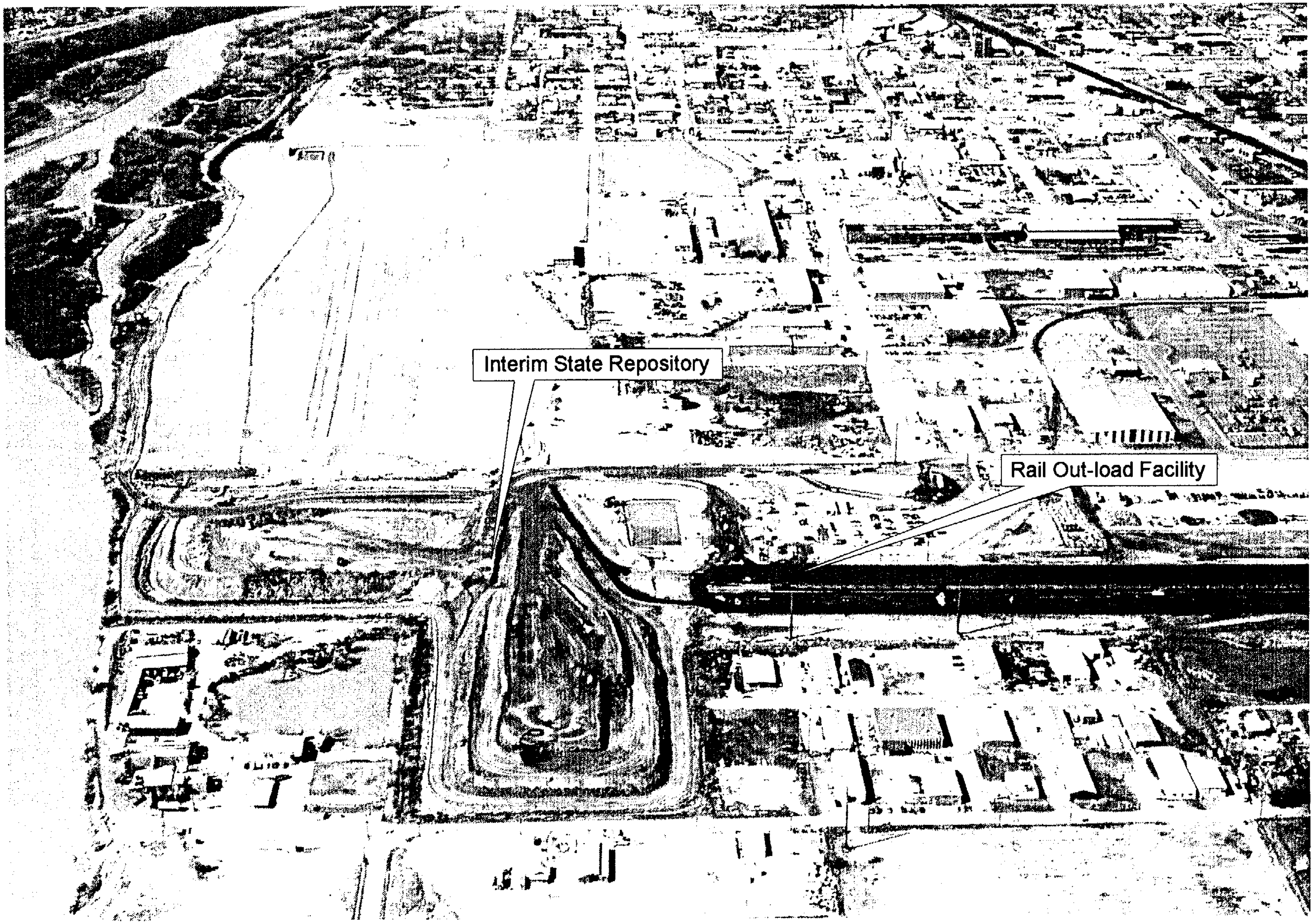

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Figure 3–9. 1993 Photograph; Looking West at the Excavation of the Tailings Piles

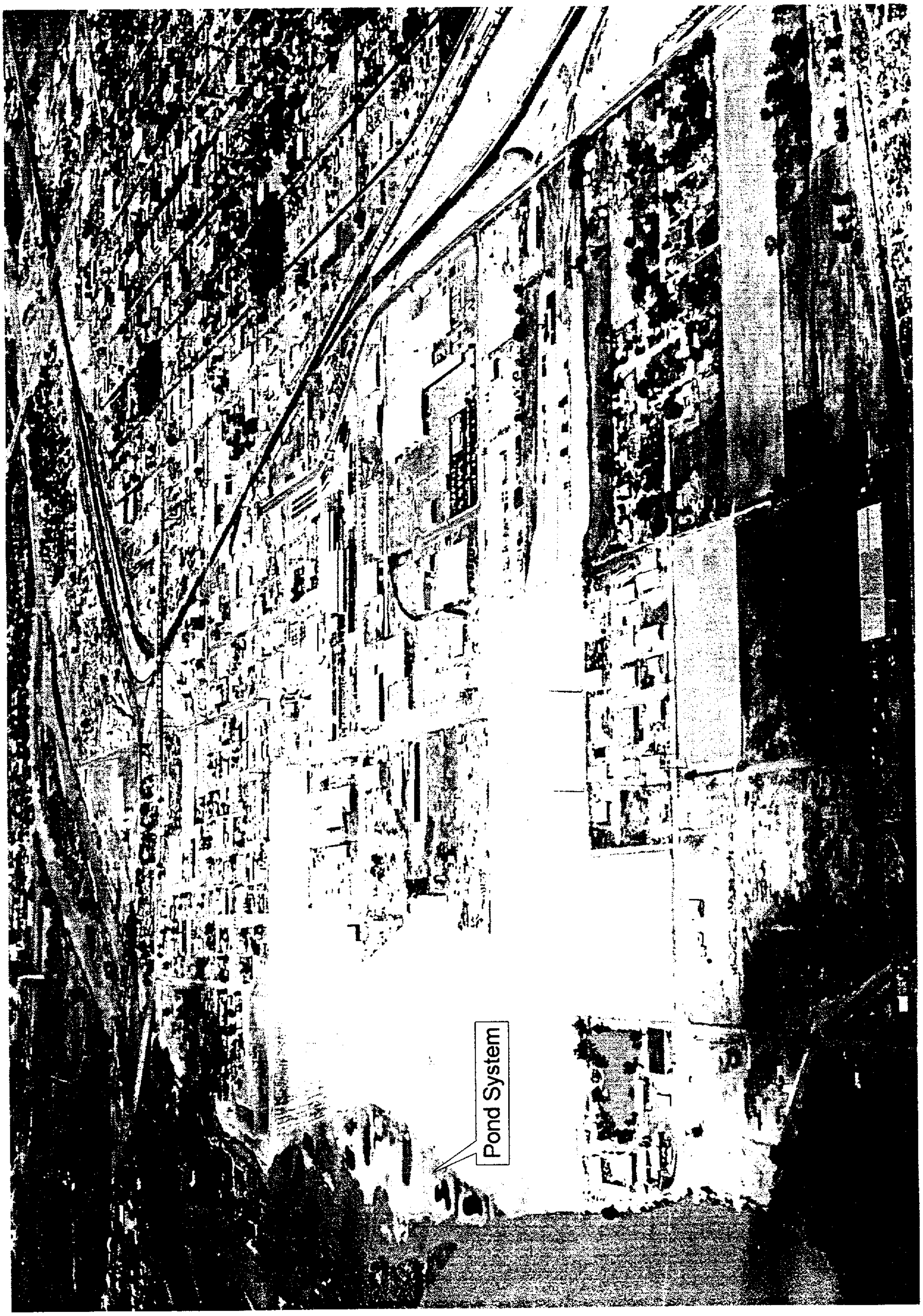

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Figure 3–10. 1994 Photograph; Looking West at the Completed Reclamation of the Millsite

4.0 Field Investigations Results

This section presents results of field studies performed to meet data needs. Application of the results is presented in Section 5, "Conceptual Site Model."

4.1 Geology

The geology near the site is structurally and stratigraphically simple. The Cretaceous marine Mancos Shale and Cretaceous marginal marine Dakota Sandstone Formations dip gently to the northeast away from the Uncompahgre Plateau on the west. Unconsolidated alluvial sediments of Quaternary to Recent age overlie these rocks and form the alluvial aquifer, which contains contaminated ground water associated with the Grand Junction site.

The work plan for characterizing the Grand Junction site (DOE 1997) describes the geological data needs in Quarternary stratigraphy and bedrock identification. Figure 4–1 is the A–A' geologic cross section shown on Plates 1 and 2.

4.1.1 Alluvial Aquifer

The Colorado River has been prograding updip and southward across the Grand Valley, probably as a result of the eroding shales from the north clogging the river channel. Its current channels lie against the bluffs on the south side of the river. Thickness of the river alluvium, which forms the alluvial aquifer, ranges from 8 ft (2.4 m) to more than 78 ft (24 m) in the Grand Valley (U.S. Bureau of Reclamation 1986). The U.S. Bureau of Reclamation report describes the sediments near the site as Colorado River alluvium consisting of sandy to silty sediments underlain by the Cobble aquifer, which consists of unconsolidated sands, gravels, and cobbles.

Well logs developed during installation of 23 new monitoring wells are shown in Appendix B. Surface fill near the millsite is 9 to 10 ft (3 m) thick, so the upper sandy/silty zone in question was not identified with confidence as part of the alluvial aquifer. Cobbly sediments were below this zone, and depth to Dakota shale (i.e., bedrock) ranged from 13 ft (4 m) in well 1017 (nearest the river on the site) to 27 ft (8 m) in well 1019 (the northernmost well on site). Well locations are shown in Plate 2.

An examination of background well lithologic logs indicated an organic-rich soil horizon developed in pastures and fields for the first 1 to 5 ft (0.3 to 1.5 m), with silty sands below this (wells 1024 and 1025). In most background wells and in wells in historically agricultural areas, silty sands extend from near surface to depths of 15 ft (4.6 m) or more (wells 1026 and 1028) and overlie the cobbly gravel zone. These cobbly gravels were drilled to a maximum depth of 32 ft (10 m) in well 1025. The work plan for these monitoring wells required installing 20 ft (6 m) of screened interval below the saturated zone or drilling to bedrock, whichever was less. Consequently, the alluvial aquifer was not fully penetrated in some background wells east of the site.

A pre-1947 aerial photograph of the millsite (Figure 3–2) shows a prominent channel crossing the site from east to west. Milling operations eliminated the trace of this old channel, as can be seen in subsequent photographs (Figures 3–4, 3–5, and 3–6), but its possible effect on hydrologic conditions is discussed in Section 5.1.3.

4.1.2 Bedrock Identification

Previous reports assign the shales underlying the site to the Mancos Shale (Ford, Bacon, and Davis 1977; DOE 1996c; DOE 1996d; and others). An effort was made to differentiate the gray shales of the Dakota Sandstone sequence from the gray shales of the Mancos Shale in the site area. To do this, contractor geologists requested assistance from Dr. Robert G. Young, a local consulting geologist, who had mapped these units for his dissertation. Dr. Young provided criteria for distinguishing the two formations and accompanied the contractor geologists into the field.

The criteria for distinguishing the formations are:

Dakota Sandstone	Mancos Shale
Carbonaceous (to lignitic), not calcareous	Calcareous (reacts to HCl), not carbonaceous
Silty to clayey	Clayey with few silty layers
Contains no marine fossils	Contains marine fossils
Some silty lenses in shales	Thin layer of white bentonite near the bottom of the unit
Some pyrite nodules or iron staining	No pyrite nodules, little or no iron staining

Rocks composing the bluffs on the south side of the Colorado River from the confluence of the Gunnison River about 2,000 ft (610 m) west of the site to approximately 2,000 ft (610 m) east of the site were field examined and evaluated using the criteria listed above. Dakota Sandstone shales crop out from a point about 100 yards (91 m) east of the 5th Street bridge eastward and dip beneath the site at about 1 to 2 degrees. The shales below the site area, which were described as Mancos Shale in earlier reports, actually belong to a middle shale unit of the Dakota Sandstone. The estimated trace of the Mancos subcrop is shown in Plate 1. It follows the estimated contact on the south side of the Colorado River (this section of the bank is overgrown with vegetation), crosses the river at an elevation of about 4,570 ft (1,393 m) where a limy, resistant siltstone bed produces a small area of rapids, extends about 200 ft (61 m) east of the site, and continues to the northwest. Some intertonguing of these formations might be expected at this transitional contact between the marine Mancos Shale and the marginal marine Dakota Sandstone sequence. Ground water traveling from the north toward the south and southwest across the site would contain trace elements leached predominantly from the Mancos Shale as well as from the Dakota shales.

By use of these criteria, the total thickness of the Dakota Sandstone in the area of the site was determined to be about 200 ft (61 m). The same recognition criteria were applied to core from five previously drilled boreholes (724, 725, 735, 741, and 743) located near the site on the north side of the Colorado River. None of the core had these characteristics of Mancos Shale, indicating that the subcrop of Mancos is some distance north or east of the site. To further confirm this, the same criteria were used to evaluate cuttings from the bottom of wells. For all on-site wells, drilling continued through the alluvial aquifer into bedrock. Dakota shales were identified as bedrock in all wells drilled on site.

4.2 Hydrology

Hydrogeologic data needs for ground water and surface water were identified in Section 5.0 of the original SOWP (DOE 1996d) and Section 3.5 of the *Work Plan for Characterization Activities at the UMTRA Grand Junction Project Site* (DOE 1997b). Additional site

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characterization was performed to better define the water table surface, saturated thickness, lithology, and hydraulic parameters of the alluvial aquifer. New monitor wells were installed and developed, and water levels in selected monitor wells have been measured on a continuous basis using downhole dataloggers. Aquifer pumping tests were performed in a number of monitor wells to evaluate hydraulic conductivity beneath the site. Slug tests were also done in monitor wells to estimate hydraulic conductivity throughout the site. The recharge/discharge relationship between the Colorado River and the alluvial aquifer was evaluated by measuring water levels in the river and comparing these with ground water levels in adjacent monitor wells.

4.2.1 Alluvial Aquifer Analysis

Twenty-three new monitor wells (numbered between 1010 and 1035) were installed in the alluvium to provide additional information on lithology, saturated thickness, and hydraulic parameters (lithologic logs are in Appendix B, and well locations are shown on Plate 1).

Twenty-one wells were installed during September 1997 by using a hollow-stem auger. These consisted of eight on-site wells (1012–1019), five upgradient wells (1020, 1021, 1023, 1024, 1025), four downgradient wells (1010, 1011, 1022, and 1029), and four vicinity property wells (1026, 1027, 1028, and 1030). Boreholes 1031 and 1032 were used to obtain water level measurements. A CME-75 truck-mounted auger rig was used to drill 12¼-inch o.d. boreholes; the monitor wells installed were 4-inch schedule 40 PVC casing with 0.02-inch factory-slotted PVC screens and bottom caps. Soil samples were collected with a 2½-inch-diameter, 2-foot split barrel sampler using a 150-pound hydraulic drop hammer. A total of 99 split barrel samples were collected. Drilling protocol required that wells intercept bedrock or extend 20 ft into the saturated zone, whichever was less. All wells intercepted bedrock except wells 1025, 1026, 1027, and 1028 (1025 is an upgradient well, the other three are at the Regional Center). General information and surveyed locations are shown in Appendix A, and lithologic/well completion logs are in Appendix B.

All wells were developed by repeated surging and pumping. However, water production from most of the wells was still considered to be low for a typical fluvial sediment, so seven on-site wells were jetted to improve production and efficiency. Jetting consisted of using a five-horsepower pump to force a jet of potable water outward along the screened interval of the wells. Water was constricted from a 2-inch line to a 1-inch T-nozzle jetting tool. Approximately 425 gallons of water could be expelled into the well in five minutes. This process can remove smeared clays or other debris from the slotted screen. After this procedure, production was improved by 32 percent overall, but some wells were still only producing 2 to 3 gallons (7.6 to 11.4 liters) per minute. This prompted drilling two new wells (1034 and 1035) in September 1998 by a different method to improve well efficiency and to obtain more realistic hydraulic parameters of the aquifer. Monitor wells 1034 and 1035 were drilled using a casing-advance drilling method that resulted in less disturbance to the adjacent formation materials. A factory-slotted screen was installed in monitor well 1034, and a continuous-wrapped vee-wire screen was installed in monitor well 1035. Aquifer pumping tests in these two wells indicated significantly improved well efficiencies and higher hydraulic conductivity values for the alluvial aquifer than values obtained from the wells installed by the hollow-stem auger (see Appendix D).

Aquifer pumping and recovery tests were performed in selected monitor wells at the site to provide an estimate of the hydraulic conductivity in the alluvial aquifer. Single-well pumping tests were run in monitor wells 1013, 1015, 1017, 1019, and 746 during January and February

1998. Additional single well pumping tests were conducted in wells 590, 1001, and 1018 during August 1998. Multiple-well pumping tests were run in monitor wells 1034 and 1035 during September 1998; drawdown response and recovery of water levels were measured in three adjacent observation wells (1002, 1013, and 1034/1035). The calculation of hydraulic parameters (see Appendix D) focused on the multiple-well pumping tests in wells 1034 and 1035 because the most reliable data are obtained from drawdown and recovery in observation wells. Recovery data collected from the single-well tests in wells 590 and 1018 appeared reasonable, so results of those tests are also included.

Results of selected aquifer pumping test calculations (estimations) of hydraulic parameters are summarized in Table 4–1. Data collected from aquifer pumping tests in alluvial aquifer wells in the west (0590), central (1034/1035), and east (1018) portions of the site indicate that transmissivity ranges from 161 to 2,434 ft^2/day (15 to 226 m^2/day). Hydraulic conductivity ranges from 18 to 304 ft/day (5.5 to 93 m/day) based on saturated thickness in the alluvial aquifer ranging from 6 to 9 ft (1.8 to 2.7 m) in the wells. As expected, the values of hydraulic conductivity are variable across the site, even in the relative proximity of wells 1034 and 1035. Variation in these values is a result of several factors: (1) lateral and vertical lithologic changes typical of alluvial deposits, including the possible effect of old channels in the alluvium, (2) the Colorado River as a boundary condition, especially near well 0590 (about 60 ft [18 m] from the river), and (3) well construction and screen type that may cause variable well efficiency and response to pumping stress (e.g., screen type in well 1035 has greater area of exposure to the aquifer than in well 1034). The average linear ground water velocity beneath the millsite is about 2.0 ft/day (0.6 m/day) based on an average estimated hydraulic conductivity of 100 ft/day (30 m/day), a hydraulic gradient of 0.004, and an effective porosity of 20 percent. Many variables affect hydraulic parameter values in an aquifer system, so the results are an approximation that provides a general idea of the characteristics of the alluvial aquifer.

Slug tests were performed in 13 monitor wells, and hydraulic conductivity was estimated where possible (water levels in some wells recovered too rapidly for meaningful estimation). Slug tests provide only a rough approximation of hydraulic conductivity, and the values should be considered as order-of magnitude estimates. Also, the area of influence of a slug test extends only a short distance from the borehole, and results should not be inferred to be valid at any distance from the area of influence. Consequently, slug test estimates are not used in the evaluation because of their limited extent and also because of the more reliable estimates from the aquifer pumping test analyses. Hydraulic conductivity values from slug tests are summarized in Table 4–1, and calculations are on file in the Grand Junction Office.

Water levels in nine monitor wells (0590, 0743, 0744, 0746, 1001, 1002, 1013, 1017, and 1022) were measured continuously during 1998 using downhole dataloggers (locations are shown in Plate 1). Results were used to determine variations in ground water levels through time and to correlate these with fluctuations in the level of surface water in the Colorado River (see Section 4.2.3).

4.2.2 Dakota Sandstone and Mancos Shale Analysis

Since ground water in these underlying units has not been affected by site-related activities, the bedrock units have not been extensively investigated. The alluvium directly overlies both formations, depending on the relation to the subcrop. Figure 4–2 is a structure contour map of the top of the Dakota Sandstone. The previous interpretation of these underlying units has been modified with additional characterization, and the consensus is that the alluvium beneath the main portion of the processing site directly overlies shaly units of the Dakota Sandstone. Both the Dakota Sandstone and the Mancos Shale form an effective aquitard beneath the alluvial aquifer.

Table 4–1. Summary of Hydraulic Parameters in the Alluvial Aquifer at the Grand Junction Site

Well	P/O/S	D/R	Q gpm	t min	T ft^2/day	K ft/day	Notes
1034	P	R	4	717	1613	202	Factory slotted screen
1002	O	D			556	93	
1002	O	R			408	68	
1013	O	D			450	56	
1013	O	R			340	43	
1035	O	D			N/R	N/R	Response <1 ft
1035	P	R	8 to 6	707	2261	282	Continuous-wrapped V-wire screen
1002	O	D			942	157	
1002	O	R			969	161	
1013	O	D			1987	249	
1013	O	R			2434	304	
1034	O	D			1120	140	
1034	O	R			2290	287	
590	P	R	30	840	408	68	
1018	P	R	1	820	161	18	
1012	S					11	On Site
1013	S					2	On Site
1014	S					2	On Site
1015	S					4	On Site
1016	S					2	On Site
1018	S					5	On Site
1019	S					1	On Site
1021	S					1	Background
1023	S					12	Background
1025	S					4	Background
1026	S					4	Resource Center
1027	S					3	Resource Center
1028	S					5	Resource Center

Notes:
D = discharge
K = hydraulic conductivity
N/R = Not reliable
O = observation well
P = pumping well
Q = discharge rate
R = recovery
S = slug test
T = duration of test
T = transmissivity

4.2.3 Surface Water Analysis

Surface water levels in the Colorado River have been continuously measured since February 1998 with a datalogger in a stilling well (SW-1033 on Figure 4–4) at the western end of the site. Manual measurements of the Colorado River were taken every 2 weeks from the footbridge at the eastern end of the site (Figure 4–4).

The stilling well was installed along the southwestern side of Watson Island in late January 1998. A transducer was placed inside a capped and perforated PVC pipe that was anchored into the river bed, with the transducer cable (also enclosed in a PVC pipe) running up the bank to an elevation considered protected from spring flooding. A steel upright pipe was cemented in and a locked cover installed to protect the transducer recorder.

Comparison of water levels with mean stream flow (in cubic feet per second) measured at the USGS gauging station at Palisade (about 15 miles [24 km] east of the millsite) shows good correlation (RVR-FLW on Figure 4–3). A comparison of water elevations in the river with fluctuations in water levels in several monitor wells near the river (wells 0744 and 1001) also shows some correlation, indicating some connection between shallow ground water and the water in the Colorado River (Figure 4–4).

4.3 Geochemistry

Surface water, ground water, soil, sediments, and alluvial aquifer materials were sampled and analyzed. Sample locations, collection methods, analytical methods, tests performed, and analytical results are presented in this section.

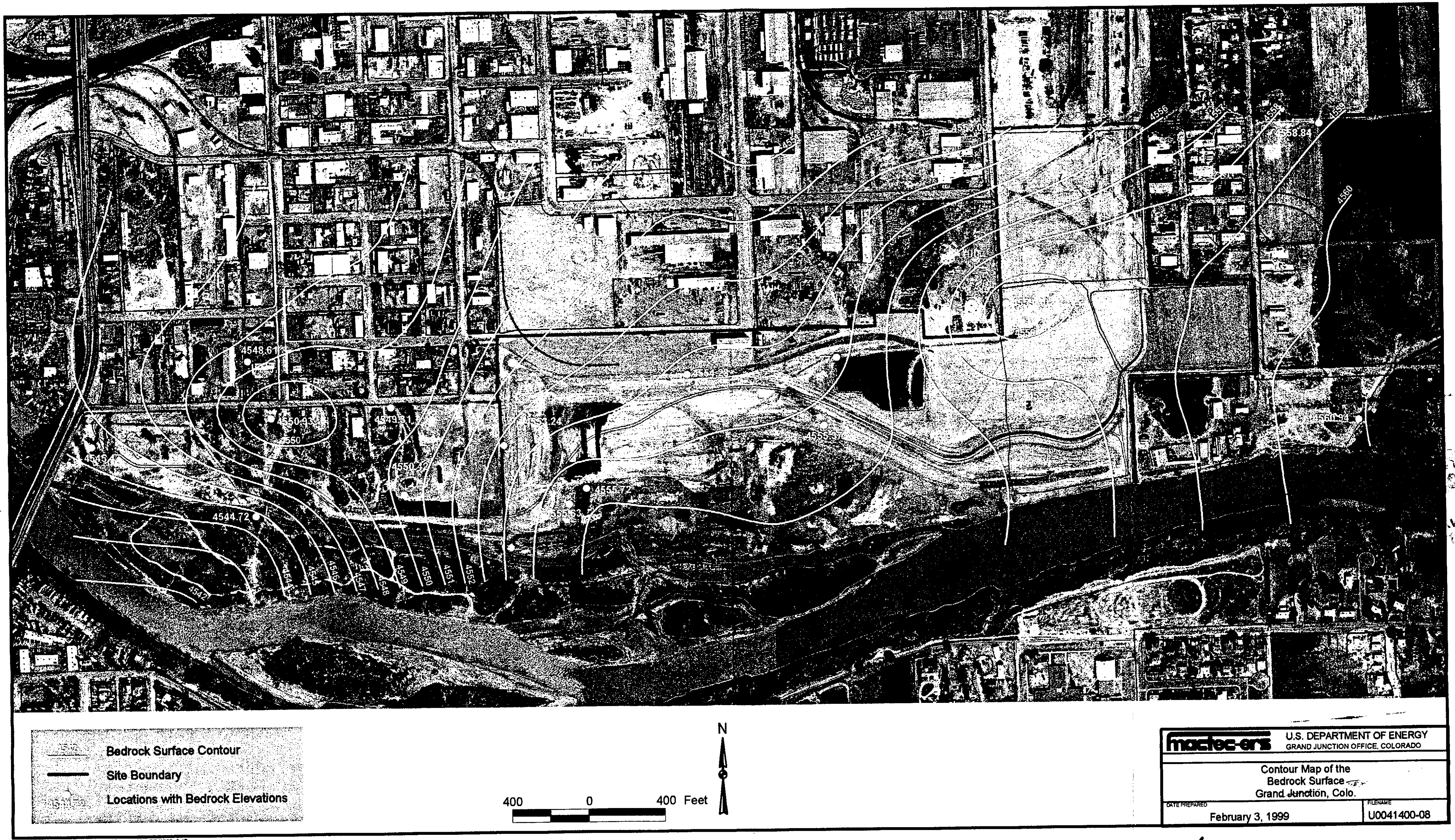
4.3.1 Water and Sediment Chemistry Sampling and Sample Analysis

Ground water monitoring wells were sampled in January and July 1998 to characterize the current contaminant levels. The results of sampling and analysis are presented in this section. All results reported here are for filtered samples.

Contaminants that enter the surface environment through natural discharge of ground water to the surface should be detectable by analysis of surface water and sediments. The results can be used to estimate the risk of exposure to the accessible environment. Surface water and surface sediments were sampled in October and November 1997 to supplement previous samplings. The alluvial aquifer discharges to the Colorado River. Water and sediments were sampled from the river to determine if the river's water quality is affected by millsite contaminants. Ponds are present on the Colorado River floodplain; some are seasonal and are present only after flooding, and some may be fed by ground water. Water and sediments were collected from the ponds and analyzed for chemicals of potential concern (COPCs). Because the valley alluvium is affected by irrigation, water was also sampled from several of the irrigation ditches.

4.3.1.1 Ground Water

Two rounds of ground water sampling were conducted in 1998—one in January and one in July. A total of 33 alluvial and 5 bedrock wells were sampled during each round. A summary of the sampling results is presented in Appendix E. As expected, the alluvial wells located on site have the highest concentrations of contaminants associated with site processes (e.g., uranium,



Contour Map of the
Bedrock Surface
Grand Junction, Colo.

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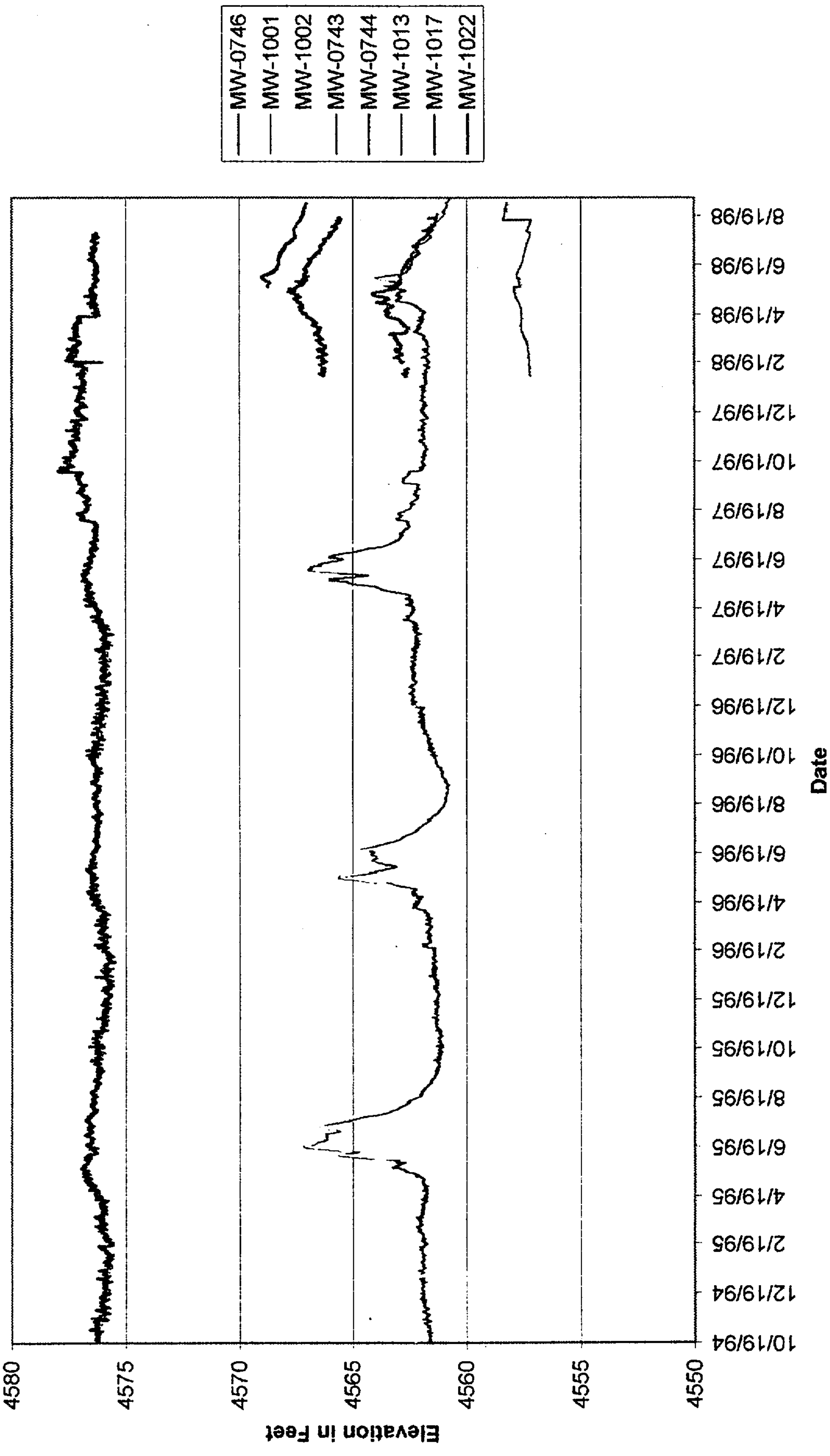

Figure 4–4. Datalogger Ground Water Elevations in the Alluvial Aquifer

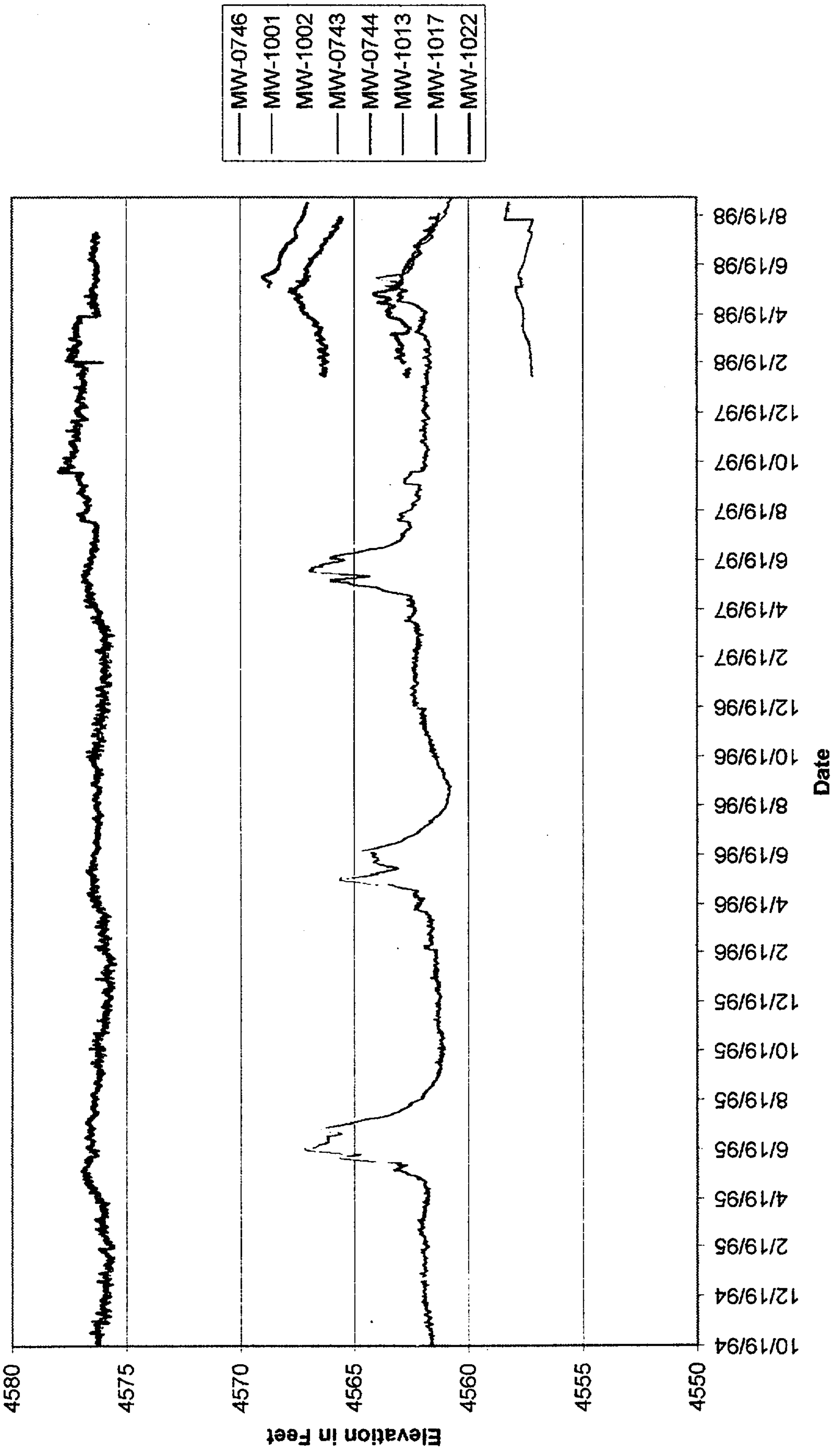

Figure 4–4. Datalogger Ground Water Elevations in the Alluvial Aquifer

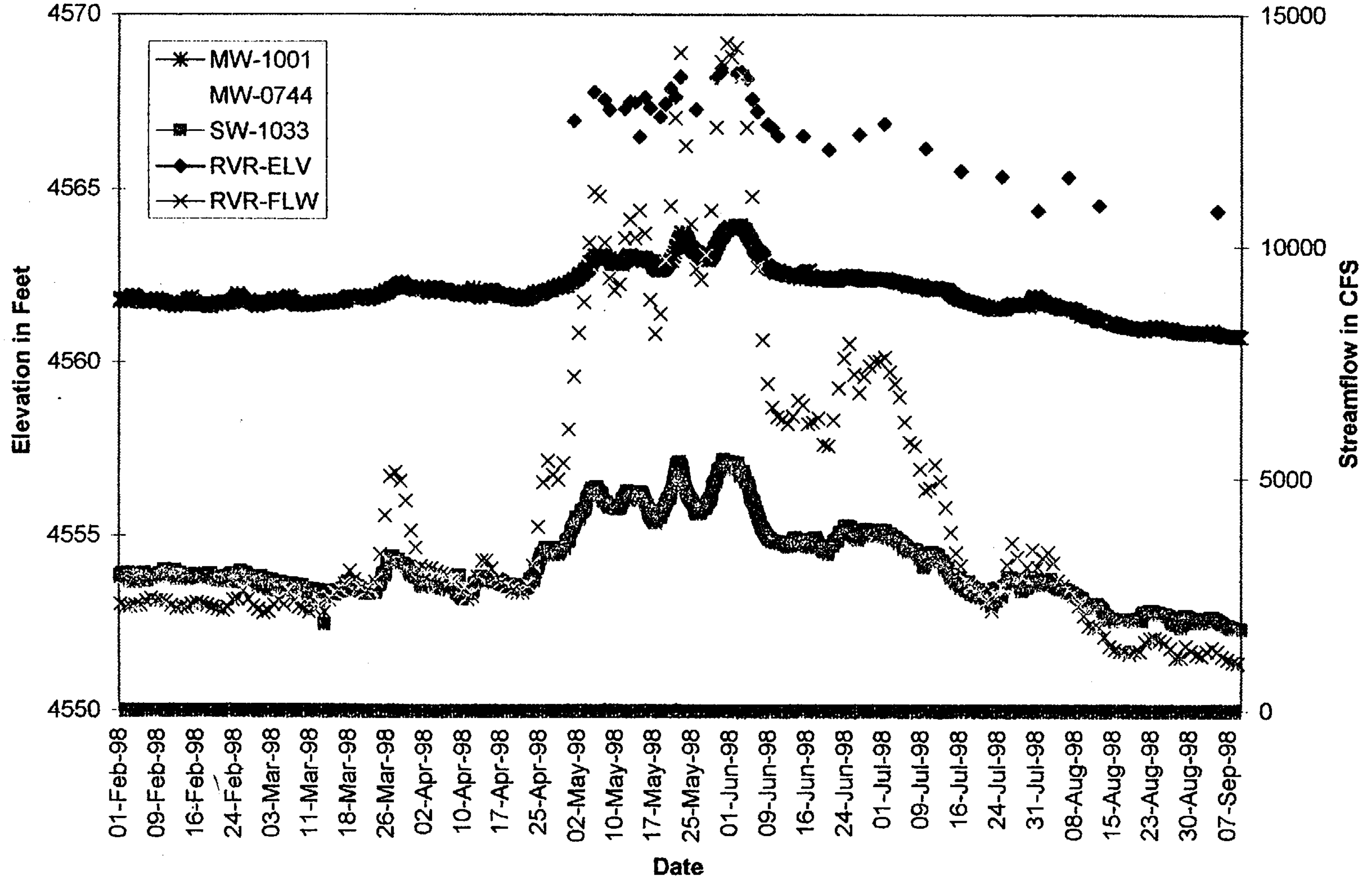

Figure 4–3. Ground Water and Colorado River Elevations

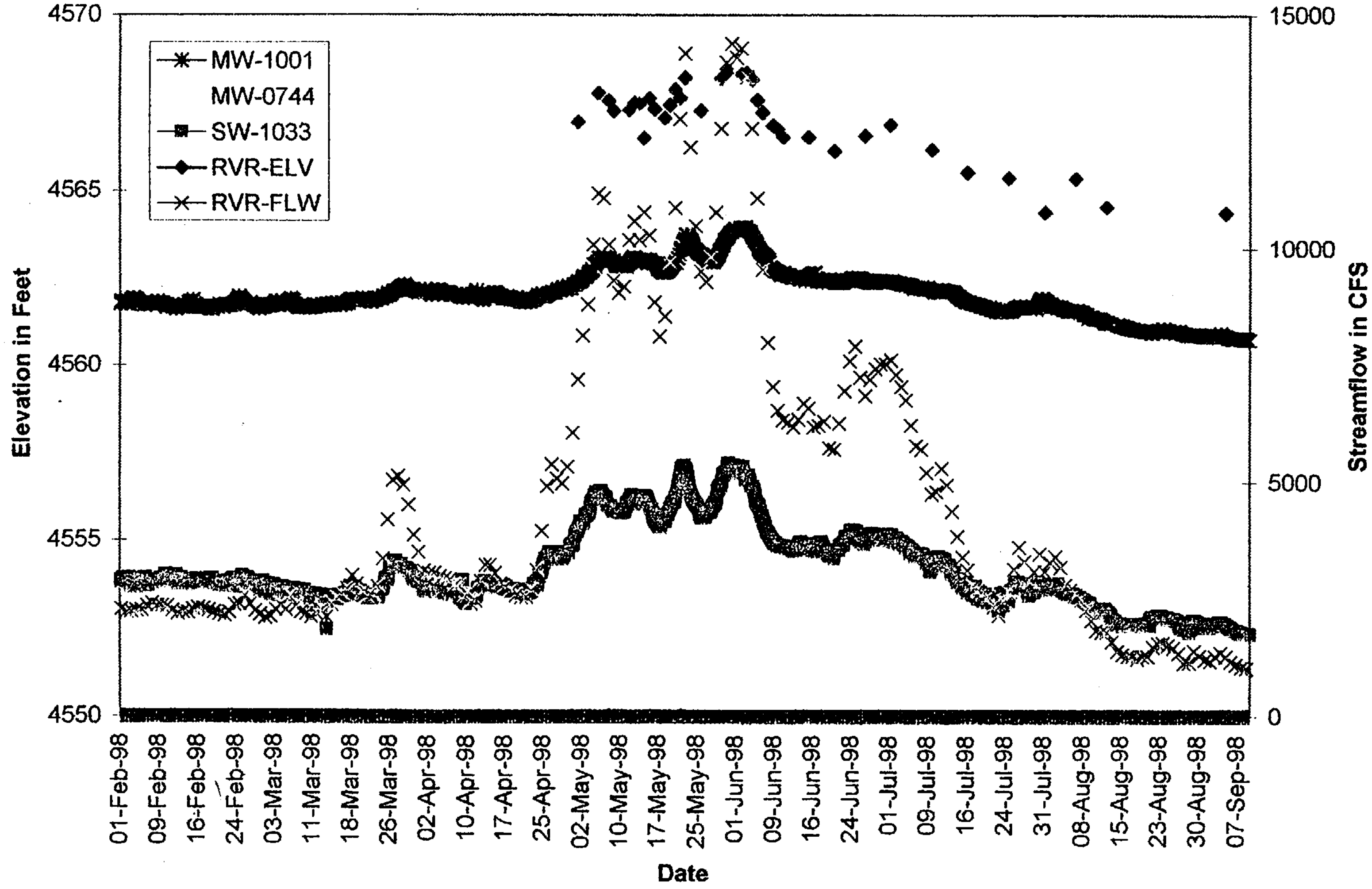

Figure 4–3. Ground Water and Colorado River Elevations

vanadium, arsenic) compared to upgradient and downgradient locations (see Section 5.3.1 for further discussion of background water quality; see Section 5.3.3 for a discussion of the extent of contamination).

Chemistry of the ground water from bedrock wells is distinctly different from that of alluvial ground water. Bedrock wells are generally lower in gross alpha and gross beta radiation as well as in concentrations of uranium, calcium, manganese, magnesium, and potassium. Bedrock ground water is generally higher than alluvial ground water in concentrations of chloride and sodium and is slightly more basic in pH.

Ground Water Major-Ion Chemistry

Piper diagrams are commonly used to help classify water types by composition and to differentiate between water types. Major-ion chemistry data from the June 1998 sampling round were plotted on a Piper diagram (Figure 4–5). Anions in the alluvial ground water are dominated by sulfate, and cations are nearly equally distributed among calcium, magnesium, and sodium. The major-ion chemistry in the alluvium at the millsite and downgradient is similar to upgradient. Total dissolved solids concentrations are also similar among on-site, downgradient, and upgradient alluvial ground water samples (Figure 4–6).

Four locations (588, 1021, 1024, and 1029) sampled for alluvial ground water have major-ion compositions distinctly different from the norm (Figure 4–5). Location 588 is downgradient from a large pond at the Grand Valley Rendering Plant; location 1021 is west (possibly downgradient) of several large recreation ponds; location 1024 is downgradient of the Clifton Water Works, where water is being discharged into the alluvial aquifer; and location 1029 is downgradient from a large pond at the American Auto Salvage yard. Thus, ground water at all four of these anomalous locations is likely to have been affected by water locally recharging the aquifer and is not representative of "typical" alluvial ground water.

The major-ion composition of Dakota Sandstone ground water is highly variable. The variability is likely due to the variable depths from which the ground water samples were collected. Some wells were sampled from the gray shales that lie at shallow depths, and others were sampled from deeper sandstones. In all cases, however, the Dakota wells are readily distinguished from alluvial wells on a Piper diagram (Figures 4–5 and 4–6). Anions in the Dakota Sandstone ground water are dominated by chloride, and cations are dominated by sodium.

Mineral precipitation and dissolution causes chemical changes in the ground water system. The chemical speciation program PHREEQC (Parkhurst 1995) was used to calculate the concentrations of aqueous species and mineral saturation indices (SIs) for the January 1998 sampling of the ground water. A mineral SI provides a measure of whether a ground water has a tendency to precipitate or dissolve a mineral. A positive SI indicates oversaturation and the tendency to precipitate the mineral, whereas a negative SI indicates undersaturation and the tendency to dissolve the mineral.

Average mineral SIs for calcite and gypsum, two commonly occurring minerals in the alluvial aquifer, are presented in Table 4–2. The alluvial aquifer ground water is nearly saturated with calcite ($CaCO_3$) upgradient and downgradient of the millsite and slightly oversaturated at the millsite. The differences between the on-site and upgradient averages are probably due to localized influences on sample locations. In the upgradient area, some sample locations

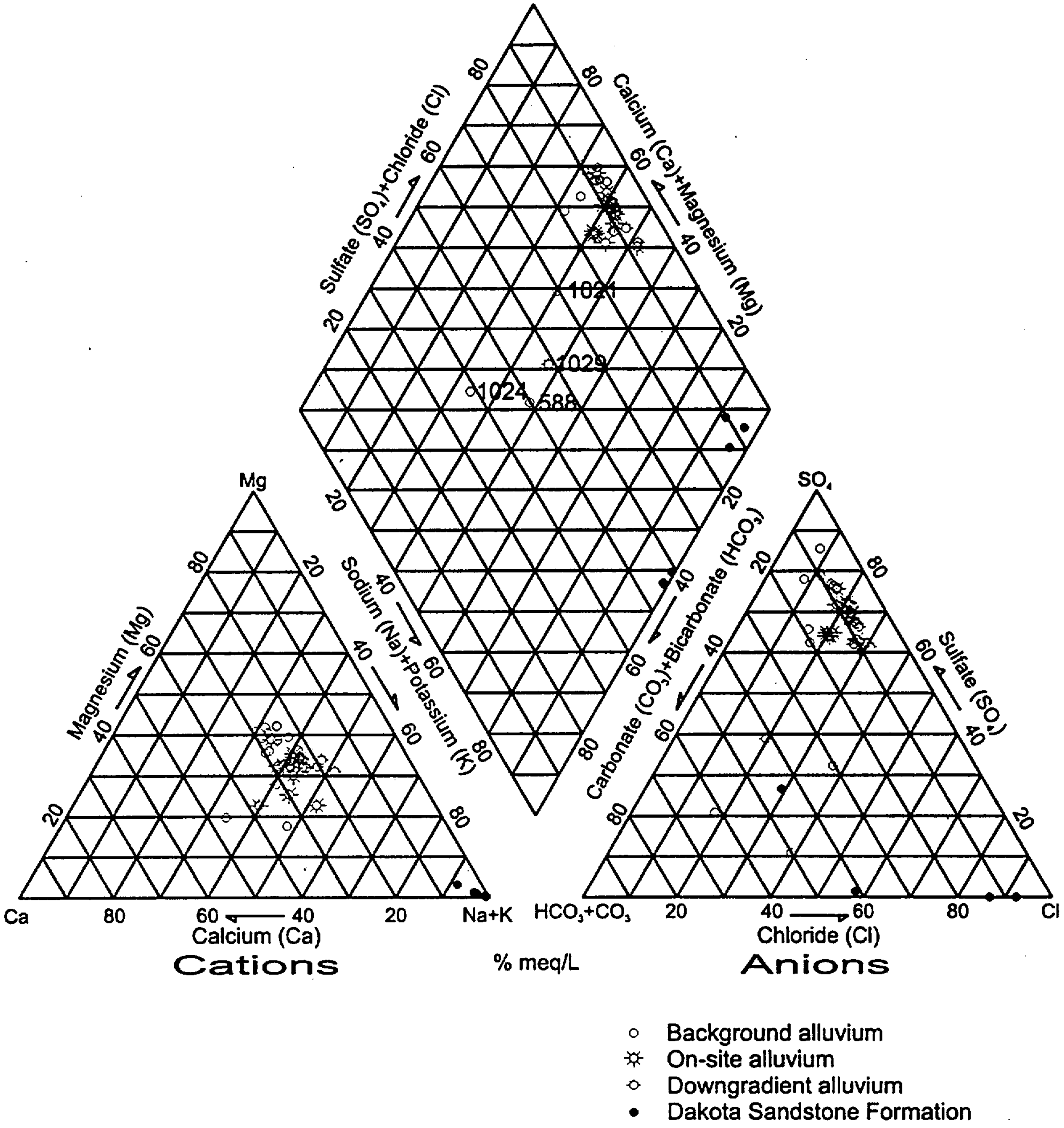

Figure 4–5. Piper Diagram of Major-Ion Chemistry in Alluvial Ground Water

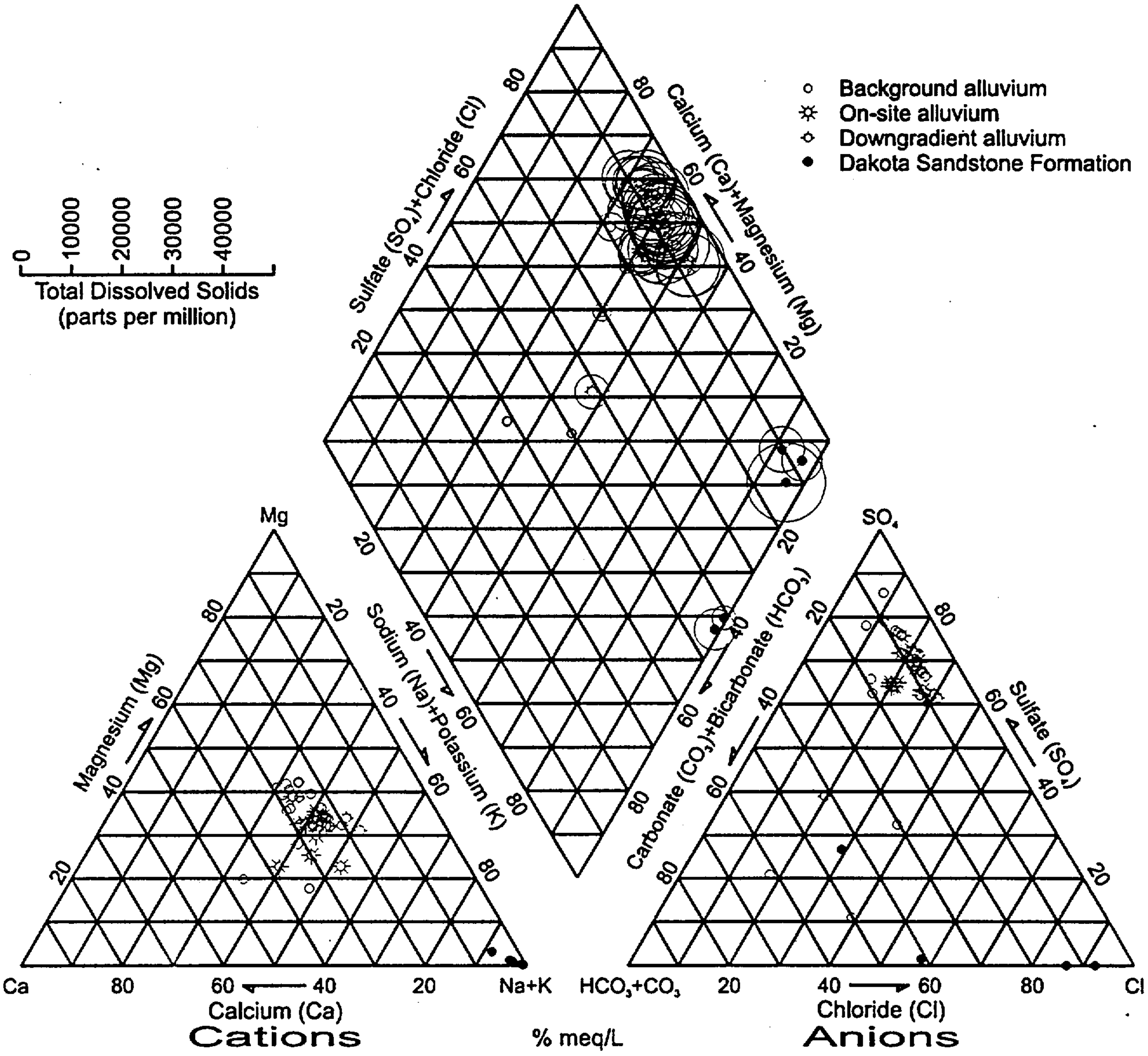

Figure 4–6. Piper Diagram Showing Total Dissolved Solids

Table 4–2. Average Mineral Saturation Indices for Calcite and Gypsum

Location	Number Of Samples	Calcite SI	Gypsum SI
Upgradient Alluvium	16	–0.04	–0.40
On-Site Alluvium	12	0.32	–0.06
Downgradient Alluvium	8	0.06	–0.14

are downgradient from standing water that probably diluted the samples. The SIs for calcite presented in Table 4–2, therefore, are all considered close to saturation and indicate that the entire aquifer (except where diluted by local recharge) is at equilibrium with calcite. Gypsum is also close to saturation except where the aquifer may be influenced by recharge. These calculated SI values are consistent with the observation that calcite and gypsum are common in the alluvial aquifer and surrounding rocks. The calculations suggest that the alluvial ground water at the millsite has reached equilibrium with the aquifer solids.

The PHREEQC program was also used to determine the speciation of one trace component present in elevated concentrations in site ground water. Analytical results for ammonia report total ammonia as NH_4 (ammonium). However, to evaluate risks associated with the use of ground water, it is important to know how much of the total ammonia is actually present in the NH_3 form. NH_3 is highly volatile and is much more toxic when inhaled as a gas than is NH_4 when ingested in solution as a constituent of water. The PHREEQC program was run using the most recent chemical analysis from the on-site well with the highest total ammonia concentration (well 1017). That well, which had a total NH_4 concentration of 233 mg/L, had an actual NH_3 concentration of 1.1 mg/L. The mean total NH_4 concentration for the plume wells of 71.4 mg/L corresponds to an actual NH_3 concentration of 0.337 mg/L. These values for NH_3 were used in the updated human health risk calculations presented in Section 6.1. See Appendix I for raw data and more detail on the PHREEQC modeling results.

4.3.1.2 Surface Water

A variety of surface water locations (ponds, irrigation ditches, and Colorado River) were sampled in the Grand Junction area to characterize both background surface water quality and potential effects of site contamination on surface water at and downgradient of the millsite. Surface water sample locations are shown on Figure 4–7. Uranium was selected as a key indicator contaminant to identify the likely extent of site-related contamination.

A subset of the field screening locations was subsequently sampled for laboratory analysis of a larger number of analytes; Table 4–3 lists locations for which laboratory data were obtained and indicates the dates of sample collection. These locations were chosen as representative of upgradient, on-site, and downgradient water quality based on field screening results and results of historical sampling. Analytical results for river and pond samples are discussed separately in the following sections. All results are for filtered water samples.

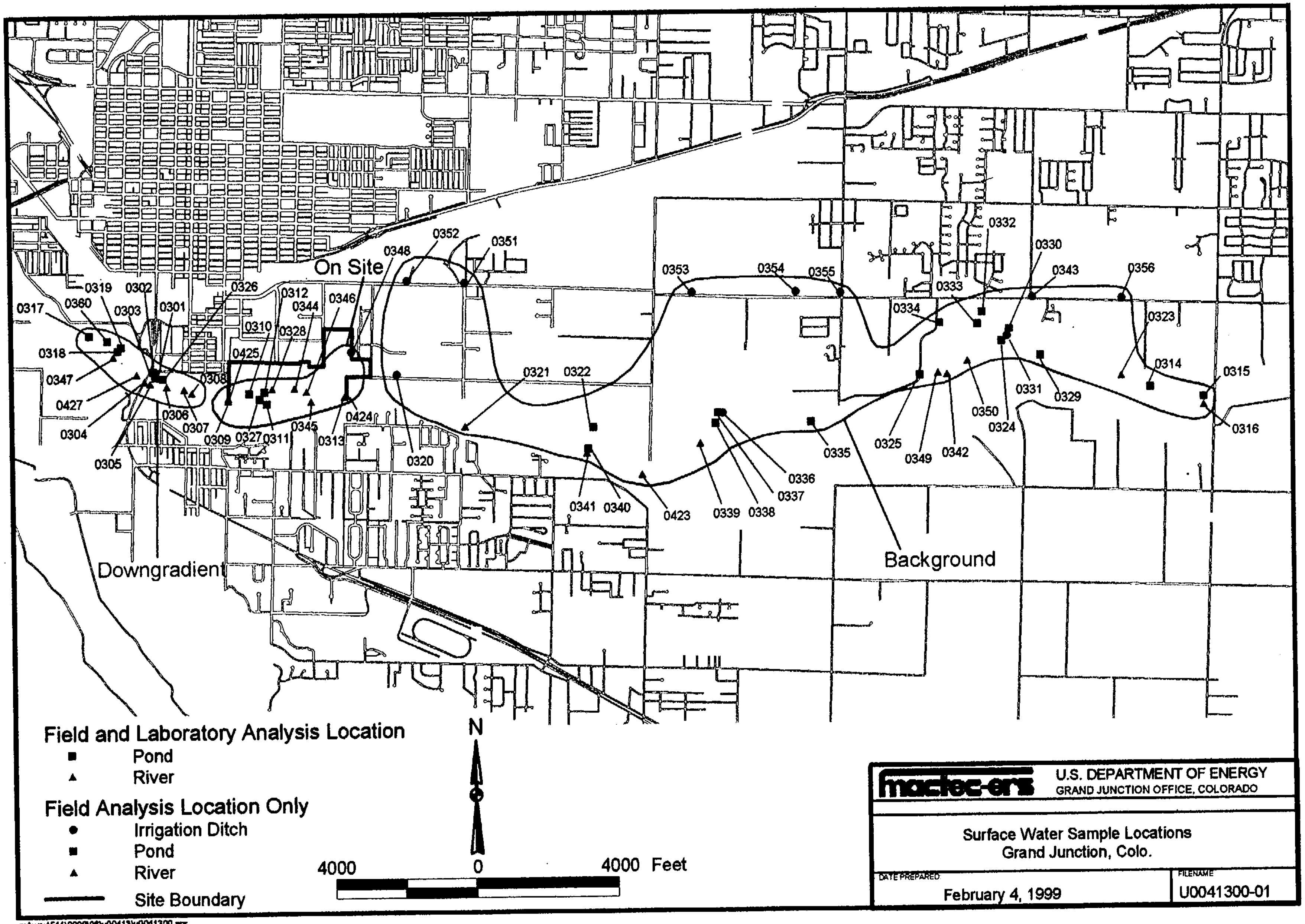

Figure 4–7. Surface Water Sample Locations

Table 4–3. Surface Water Samples Collected for Laboratory Analysis

Type of Surface Water Sample	Location No.	Location	Date Sampled	Analytes
Pond	325, 330	Upgradient	Nov 1997, Jan and June 1998	As, Cd, Co, F, Fe, Mn, Mo, Ni, NO_3, Se, SO_4, U, V
	310, 312, 328	On site	Nov 1997, Jan and June 1998	
	326, 360	Downgradient	Nov 1997, Jan and July 1998 (326), July 1998 (360)	
Colorado River	342, 349, 350, 423	Upgradient	Nov 1997 (342, 349, 350) Jan 1998, June 1998 (all)	
	312, 344, 346, 424, 425	On site	Nov 1997 (312, 344, 346) Jan 1998, June 1998 (all)	
	308, 427	Downgradient	Nov 1997 (308) Jan 1998, June 1998 (all)	

Colorado River Water Quality

Historically, samples of Colorado River water have been collected from locations 423, 424, 425, and 427. Between 1991 and 1993, seven rounds of water samples were collected; an additional sampling event was conducted in December 1996. Some samples were collected at low flows to maximize the possibility of detecting contaminants. The results of these analyses indicate that site contamination has not adversely affected the water quality of the Colorado River (DOE 1996d).

On October 22, 1997, Colorado River water was sampled at eight upgradient locations (316, 321, 323, 339, 341, 342, 349, and 350), five on-site locations (309, 312, 344, 345, and 346), and six downgradient locations (304, 305, 306, 307, 308, and 347) (Figure 4–8). These samples were collected for field screening to evaluate the effect, if any, that site-related contaminants might have on Colorado River water quality. The samples were analyzed in the field for uranium, which was selected as an indicator of contamination because it has high concentrations in the alluvial ground water at the millsite and is relatively mobile. The distribution of uranium concentrations in the Colorado River is shown in Figure 4–8. Mean concentrations at the upgradient, on-site, and downgradient locations are 0.0068, 0.0063, and 0.0055 mg/L, respectively. These results support the conclusion that the Colorado River is not affected by millsite contamination.

Additional sampling was conducted in November 1997, January 1998, and June 1998 as indicated in Table 4–3. All samples were collected for laboratory analysis of the analytes listed in Table 4–3. For all samples at all locations, concentrations of arsenic, cadmium, cobalt, iron, nickel, selenium, vanadium, and zinc were at or below method detection limits. A summary of results for the remaining analytes is presented in Table 4–4 for the three sampling events.

Analytical results of samples of river water collected over a 7-year period show that concentrations of COPCs in the Colorado River at the millsite have consistently been similar to those upgradient of the millsite. The results do not necessarily indicate that no contamination is entering the river. A small flux of contaminated ground water to the Colorado River would not be detected because dilution by the river is substantial.

Table 4–4. Concentrations of Selected Constituents in Samples of Colorado River Water Collected for Laboratory Analysis

Sampling Location		Analyte Concentration, mg/L					
		F	Mn	Mo	NO_3	SO_4	U
River Upgradient (432, 349, 350, 423)	Max	0.375	0.907	0.014	6.30	1810	0.025
	Min	0.155	0.017	0.002	0.036	56	0.001
	Mean	0.223	0.472	0.0093	3.00	905	0.012
River On Site (312, 344, 346, 424, 425)	Max	1.26	3.03	0.088	26.4	2990	0.073
	Min	0.158	0.005	0.002	0.011	62.3	0.001
	Mean	0.286	0.273	0.118	2.68	365	0.008
River Downgradient (308, 427)	Max	0.241	0.029	0.008	0.664	156	0.003
	Min	0.159	0.005	0.002	0.011	63.7	0.001
	Mean	0.191	0.014	0.005	0.308	107	0.002

Pond Water Quality

Shallow ground water in the alluvial aquifer could discharge to surface water in ponds and create an exposure pathway for humans and the environment. To investigate the extent of surface exposure, water was sampled from ponds at the millsite, and the results were compared to those from upgradient and downgradient samples.

Eight ponds were constructed on the floodplain of the Colorado River at the millsite in 1994. These ponds were fed by ground water from the millsite. The ponds were sampled in January 1995 and were subsequently destroyed by flooding later that year. Uranium concentrations up to 0.473 mg/L were measured in the 1995 samples. Much of the contamination in these ponds was attributed to evaporation (DOE 1996d).

On October 22, 1997, pond water was sampled at 12 upgradient locations (314, 315, 322, 325, 329, 330, 332, 333, 334, 335, 337, and 340), four on-site locations (310, 311, 327, and 328), and seven downgradient locations (301, 302, 303, 317, 318, 319, and 326) (Figure 4–9). These samples were analyzed in the field for uranium, which was selected as an indicator of contamination because it has high concentrations in the alluvial ground water at the millsite and is relatively mobile.

The distribution of uranium concentrations in the ponds is shown in Figure 4–9. Only two values exceeded the UMTRA uranium standard (assuming isotopic equilibrium) of 0.044 mg/L. Both samples (317 and 318) were collected from the same pond at the American Auto Salvage vicinity property. Recent soil remediation at American Auto Salvage has likely influenced the uranium concentrations in this pond. Another sample (319) collected from a nearby pond also had a relatively high uranium concentration (0.025 mg/L), which was also probably related to the remediation at American Auto Salvage.

Mean concentrations of uranium in the upgradient, on-site, and downgradient field screening samples of pond water are 0.010, 0.009, and 0.027 mg/L, respectively. If the three samples from the American Auto Salvage ponds (317, 318, and 319) are omitted, the mean downgradient uranium concentration is reduced to 0.015 mg/L.

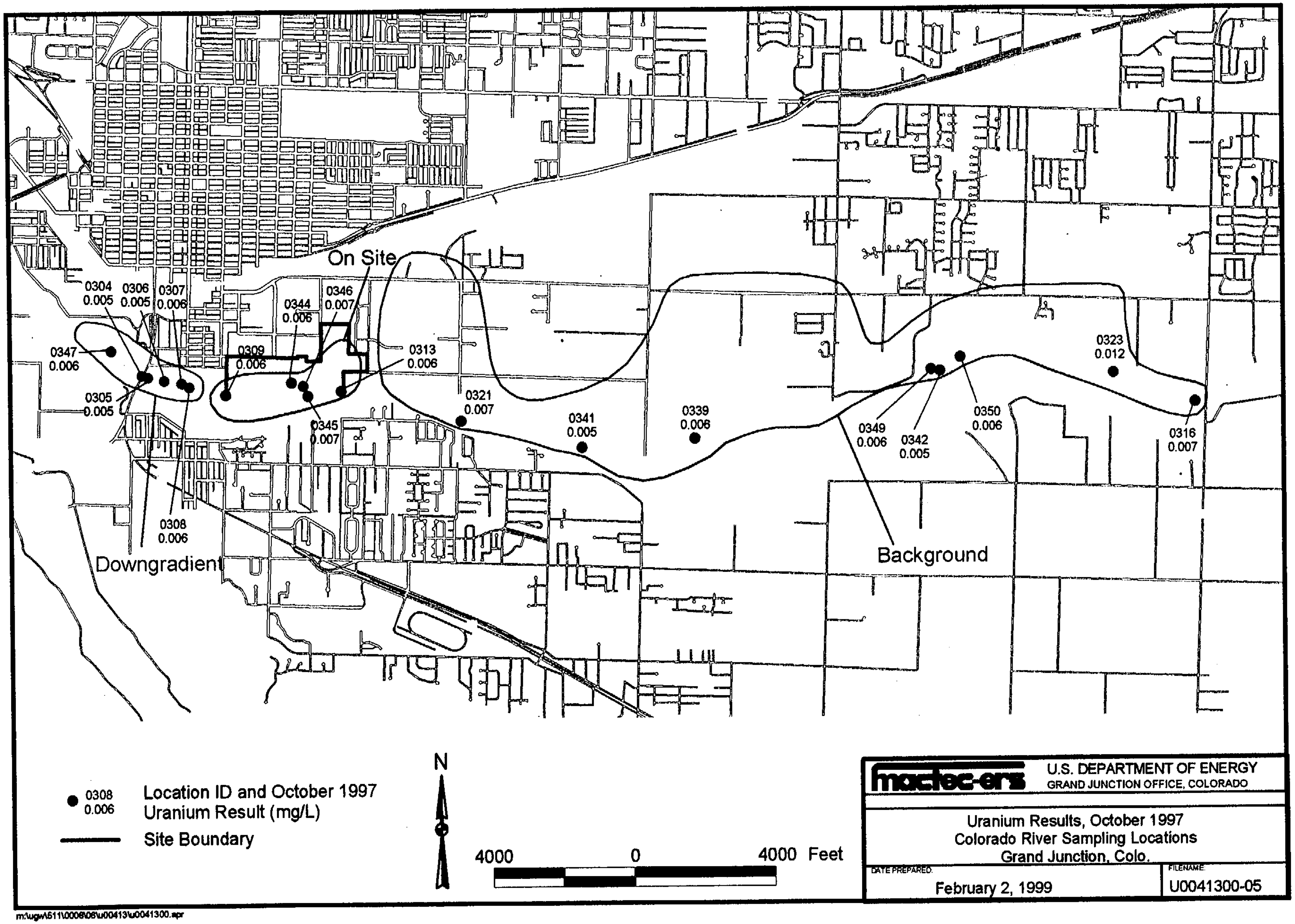

Figure 4–8 Distribution of Uranium Concentrations in the Colorado River, October 22, 1997

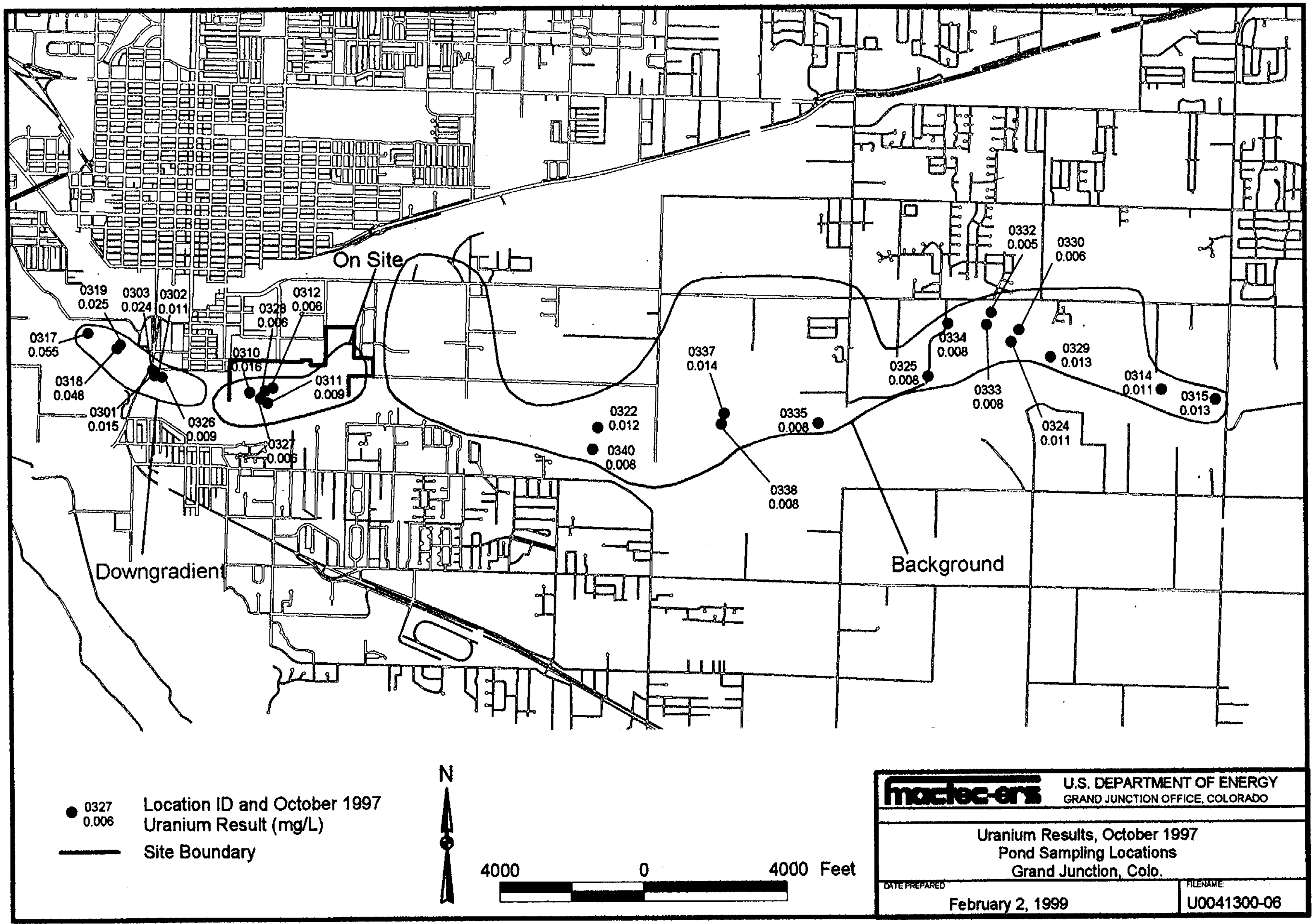

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Figure 4–9. Pond Water Sample Results

Pond water analyses are more difficult to interpret than ground water analyses because of the effect of evaporation and ground water–surface water interaction. However, these results suggest that pond water near the millsite is not significantly contaminated from uranium.

Pond water sampling for laboratory analysis was conducted in November 1997, January 1998, and June 1998 as indicated in Table 4–3. All samples were analyzed for the constituents shown in the table. For all samples at all locations, concentrations of arsenic, cadmium, cobalt, iron, nickel, selenium, vanadium, and zinc were at or below method detection limits. A summary of results for the remaining analytes is presented in Table 4–5 for the three sampling events.

Mean concentrations of fluoride and molybdenum in on-site and downgradient pond samples are elevated but not significantly above concentrations in the upgradient samples. Manganese, nitrate, sulfate, and uranium concentrations are higher in the on-site ponds than in upgradient ponds. These, however, are mainly the result of sampling location 310. This location may be contaminated from ground water, or the elevated concentrations may be the result of evaporation.

Table 4–5. Concentrations of Selected Constituents in Samples of Pond Water Collected for Laboratory Analysis

Sampling Locations		Analyte concentration, mg/L					
		F	Mn	Mo	No_3	SO_4	U
Ponds, Upgradient (325, 330)	Max	0.324	0.006	0.014	0.070	237	0.005
	Min	0.097	0.001	0.002	0.021	55.9	0.001
	Mean	0.210	0.002	0.008	0.047	161	0.004
Ponds, On Site (310, 312, 328)	Max	1.21	0.928	0.026	7.07	2820	0.094
	Min	0.119	0.006	0.002	0.011	67	0.001
	Mean	0.372	0.200	0.009	1.20	702	0.022
Ponds, Downgradient (360, 326)	Max	0.794	0.104	0.056	0.113	5550	0.066
	Min	0.132	0.001	0.008	0.011	466	0.004
	Mean	0.438	0.032	0.031	0.040	2160	0.028

The results show that concentrations of COPCs in most of the ponds near the millsite are typically similar to those in upgradient locations. At one sampling location at the millsite, (1228 in ecological risk) concentrations of several COPCs are elevated, suggesting that contaminated ground water may be feeding that area. However, the contribution from contaminated ground water cannot be separated from the possible influence of evaporation. (See further discussion in Section 5.3.2.)

One sample of a white efflorescence was collected from the north (south facing) bank of a pond at sample point 1228, and a second sample was collected about 20 feet (6 m) north of the first sample from the south-facing bank of the next uphill scarp. The ground is saturated nearly to the surface in this area, and these crystalline salts probably represent desiccation of ground water by capillary action. The samples were ground to a powder and analyzed by x-ray diffraction using a Rigaku Miniflex instrument. Samples were run at diffraction angles from 3 to 60 degrees using CuK-alpha radiation and a nickel filter. A peaks search-and-match routine was used to identify the mineral phases. Results indicated that the sodium sulfate species, blödite ($Na_2Mg(SO_4)_2 \cdot 4H_2O$), thenardite ($Na_2SO_4$), and wattevillite ($Na_2Ca(SO_4)_2 \cdot 4H_2O$) as well as halite (NaCl) were precipitating on the ground surface in these areas. These minerals are all soluble and are easily dissolved during periods of rainfall or high river waters and reprecipitated during drier periods.

4.3.1.3 Surface Sediments

A total of 30 sediment samples were collected in October 1997 from ponds, streams, and the Colorado River at a subset of field screening locations that were also sampled for water (Section 4.3.1.2). The samples were collected from beneath or close to standing water and were used to determine if mill-related contaminants were in the benthic zone. Sample locations are shown on Figure 4–10. A description of the sampling sites is included in Appendix E.

Uranium was selected as a key indicator contaminant. Samples were air dried and sieved to less than 2 mm. A 2.5 g sample was leached with 50 mL of 5 percent nitric acid by end-over-end agitation for 4 hours. The effluent was filtered through a 0.45 µm filter and analyzed for uranium by laser-induced fluorescence. Leachate and sample volumes were used to convert leachate analyses (in mg/L) to sediment concentration (in mg/K). See discussion in Section 4.3.3.2 for sample calculation. Samples were analyzed within a few days of collection.

Samples were collected upgradient, downgradient, and at the millsite (Figure 4–10). Minimum, maximum, and mean concentrations of uranium for each group are listed in Table 4–6. The downgradient samples had a higher mean uranium concentration than on-site or upgradient samples. The downgradient sample mean is skewed because of sample 317 at American Auto Salvage, which had a concentration of 4.36 mg/kg. A sample of surface water at this location also had an elevated concentration of uranium. The contamination in this newly formed pond is probably associated with the recent remediation at this vicinity property (Section 4.3.1.2). Without sample 317, the downgradient mean is 1.47 mg/kg. Thus, except for the vicinity property pond, there is no significant difference in uranium concentrations at upgradient, on-site, and downgradient sample locations.

Table 4–6. Uranium Concentrations in Nitric-Acid-Leached Sediments Collected October 22, 1997

Group	Number[a]	Minimum	Maximum	Mean
Upgradient	12/12	1.00	2.60	1.41
On Site	11/11	1.04	2.20	1.53
Downgradient	7/7	1.24	4.36	1.88

[a] number of detections/number of samples analyzed

A subset of 12 of the 30 sampling locations was selected for laboratory analysis of U and additional analytes. These 12 locations are the same locations used for surface water sampling in November 1997. The sediment samples were collected on October 22. Samples were leached with a 5 percent nitric acid solution; the leachate was analyzed in the Analytical Chemistry Laboratory for As, Cd, Co, F, Fe, Mn, Mo, Ni, NO_3, Se, SO_4, U, V, and Zn. Except for fluoride and selenium, COPCs had higher concentrations in either on-site or downgradient samples than in upgradient samples (Table 4–7). For some COPCs the differences in the means between on-site and upgradient locations are small. The results suggest that there is still some influence of the millsite in the sediments. The sediments probably contain small amounts of residual tailings that were not removed during remediation.

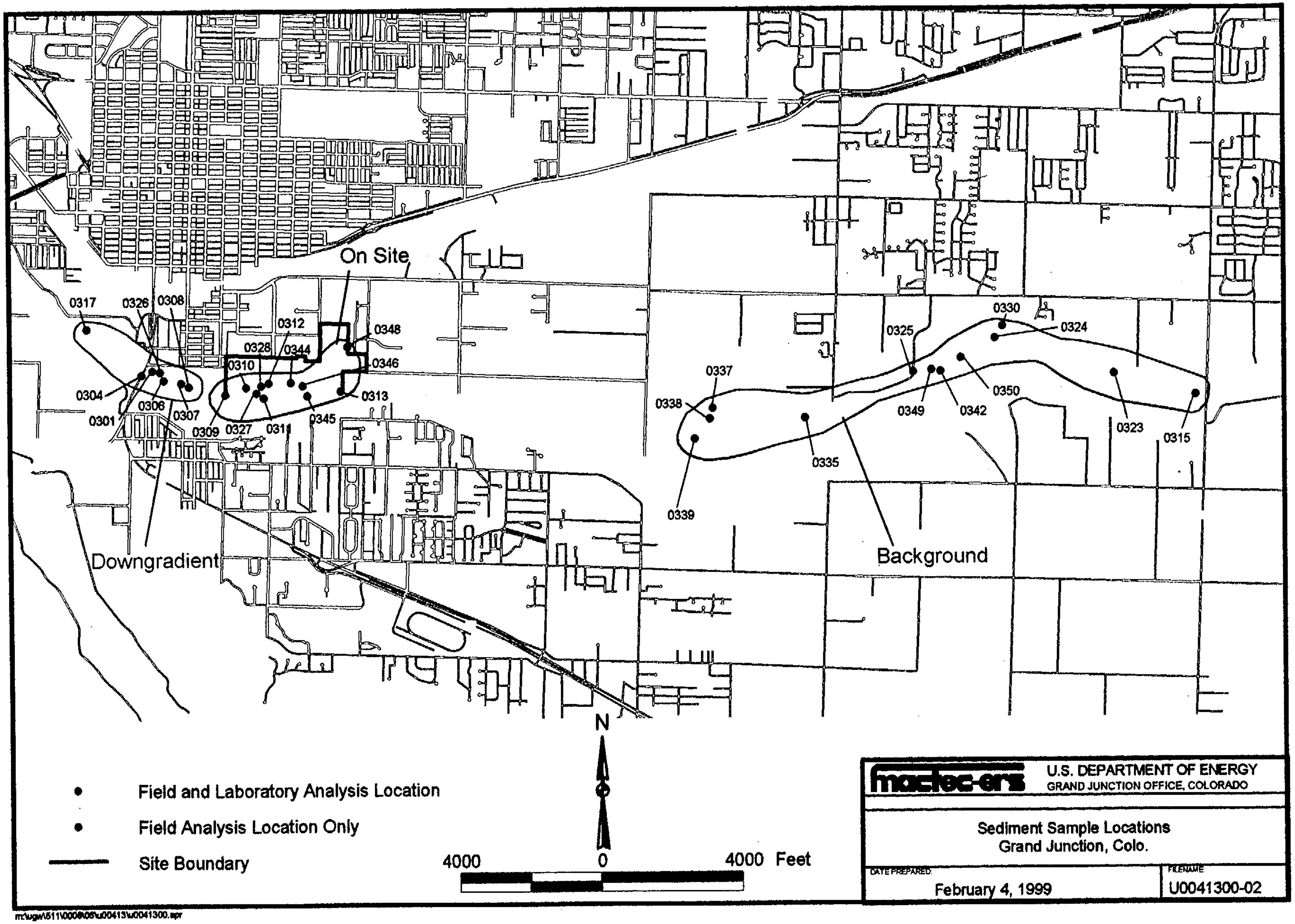

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Figure 4–10. Sediment Sample Locations

Table 4–7. Analyte Concentrations in 5 Percent Acid Leachate From Sediment Samples Collected October 22, 1997

Analyte	Group	Number[a]	Minimum	Maximum	Mean
As	Downgradient	2/2	1.1	1.8	1.45
	On Site	5/5	1.5	3.4	2.2
	Upgradient	5/5	0.48	1.5	1.15
Cd	Downgradient	2/2	0.37	0.59	0.48
	On Site	5/5	0.5	1.1	0.65
	Upgradient	5/5	0.38	0.77	0.5
Co	Downgradient	2/2	1.4	2.0	1.7
	On Site	5/5	1.8	2.6	2.24
	Upgradient	5/5	1.0	2.2	1.66
F	Downgradient	2/2	43.6	69	56.3
	On Site	5/5	34.7	77.5	52.6
	Upgradient	5/5	38.7	83.0	63.0
Fe	Downgradient	2/2	1720	1890	1805
	On Site	5/5	2360	4170	3028
	Upgradient	5/5	1780	3240	2378
Mn	Downgradient	2/2	300	302	301
	On Site	5/5	170	342	297
	Upgradient	5/5	117	278	210
Mo	Downgradient	2/2	0.07	0.36	0.215
	On Site	5/5	0.09	0.49	0.19
	Upgradient	5/5	0.05	0.12	0.09
Ni	Downgradient	2/2	1.8	2.6	2.2
	On Site	5/5	2.7	5.2	3.7
	Upgradient	5/5	1.4	5.3	3.22
NO_3	Downgradient	2/2	8.6	11.7	10.2
	On Site	5/5	6.3	15.8	12.3
	Upgradient	5/5	5.9	10.2	7.32
Se	Downgradient	0/2	<0.04	<0.04	<0.04
	On Site	0/5	<0.04	<0.04	<0.04
	Upgradient	1/5	<0.04	0.11	0.054
SO_4	Downgradient	2/2	387	2,140	1,264
	On Site	5/5	515	4,100	1,265
	Upgradient	5/5	226	701	485
U	Downgradient	2/2	0.58	1.6	1.09
	On Site	5/5	0.65	1.5	1.02
	Upgradient	5/5	0.42	2.5	1.01
V	Downgradient	2/2	4.0	4.4	4.2
	On Site	5/5	7.4	34.8	15.6
	Upgradient	5/5	3.1	6.7	5.12
Zn	Downgradient	2/2	16.1	43.5	29.8
	On Site	5/5	17.5	50.9	32.0
	Upgradient	5/5	15.8	51.2	31.0

[a] number of detections/number of samples analyzed

4.3.2 Distribution Coefficients

Distribution coefficient (Kd) is a measure of the degree of interaction between a dissolved contaminant and the aquifer minerals. Distribution coefficients were measured during this investigation to aid in predicting contaminant transport. Details of the experimental methods and calculations are shown in Appendix F, calculation U0032900, a summary of which is presented below. Laboratory data were collected using ASTM procedure D4646-87, "Standard Test Method for 24-h Batch-Type Measurement of Contaminant Sorption by Soils and Sediments." A representative portion of a core sample was air dried at room temperature. All samples were collected in upgradient areas to avoid the complication of having contamination present in the solid before the analysis. The samples were sieved to less than 10 mesh (2 mm). A synthetic solution was prepared that simulates ground water at the Grand Junction site. The pH was adjusted to about 7.0, and the measured alkalinity was about 260 mg/L as $CaCO_3$. Five grams of each core sample was placed in a 125-mL Nalge bottle with 100 mL of the synthetic ground water. Samples were agitated for 24 hours, centrifuged, and filtered through a 0.45 μm filter. They were then preserved with 1 percent nitric acid and submitted to the Analytical Chemistry Laboratory for analysis of arsenic, cadmium, molybdenum, and uranium. These contaminants were selected because previous sampling indicated that they were present in concentrations that exceed background and because they are the regulated COPCs. For additional detail on calculations and data used, see Appendix I.

The results of single-point Kd measurements are presented in Table 4–8. Kd values for arsenic range from 75 to 8,241 milliliters per gram (mL/g) and have a mean of 1,149 mL/g. The sample with the Kd value of 8,241 mL/g was collected in soil immediately above the alluvial aquifer. Kd values for the alluvial aquifer (omitting the soil sample) range from 75 to 1,168 mL/g and have a mean of 361 mL/g. The two alluvial aquifer samples with the highest Kd values (1,168 and 635 mL/g) had plant roots in them; some of the arsenic present may be a result of root uptake. Even without the root-bearing samples, however, Kd values are relatively high, ranging from 75 to 358 mL/g with a mean of 207 mL/g. The high Kd values indicate that arsenic migration will be retarded as ground water migrates through the alluvial aquifer.

Table 4–8. Calculated Kd Values (mL/g)

Well Number	Description[a]	Depth (Ft)	Arsenic	Cadmium	Molybdenum	Uranium
1020	Sandy gravel	10–12	84	182	0.10	2.41
1021	Silty sand, dark brown	5–7	358	356	0.72	3.64
1023	Soil, clayey silt	5–7	8,241	248	1.27	1.79
1023	Silty sand, dark brown	10–12	75	49	0.10	0.97
1023	Sandy gravel	15–15.4	137	64	0.51	1.08
1024	Silty sand, dark brown	5–7	356	134	0.72	3.35
1025	Clayey silt, dark brown, roots	5–7	635	280	1.27	2.29
1025	Clayey silt ,dark brown, roots	10–12	1,168	279	1.50	2.67
1025	Silty sand, dark brown	15–17	228	64	0.30	1.43
1028	Clayey silty gravel, dark brown	5–7	209	181	0.41	1.91
Mean			1,149	184	0.69	2.15

[a] All samples are alluvial aquifer except 1023, 5–7ft, which is soil.

Kd values for cadmium range from 49 to 356 mL/g and have a mean of 184 mL/g. Kd values for the alluvial aquifer (omitting the sample collected from the soil above the alluvial aquifer) have a mean of 177 mL/g. This mean is nearly the same as that of arsenic and indicates that cadmium migration also will be retarded as ground water migrates through the alluvial aquifer. As with arsenic, Kd values for the root-bearing sediments are well above the mean, suggesting that some cadmium may have been sorbed by the roots.

Kd values for molybdenum range from 0.1 to 1.50 mL/g and have a mean of 0.69 mL/g. All the final concentrations are within 10 percent of the initial concentration and within the analytical uncertainty; some of the Kd values could be close to 0 mL/g. One of the three highest Kd values is from the soil just above the alluvial aquifer. When this value is omitted, the mean of the alluvial aquifer Kd values is 0.6 mL/g. The other two highest values are from the root-bearing samples. Without the three highest values, the mean is 0.4 mL/g. The results indicate that molybdenum is relatively mobile in the alluvial aquifer.

Single-point Kd values for uranium range from 1.08 to 3.64 mL/g and have a mean of 2.15 mL/g (Table 4–8). The values show little correlation to sample type (such as root-bearing samples). These results indicate that uranium migration is slightly retarded in the alluvial aquifer but much less so than migration of arsenic or cadmium.

Kd values sometimes vary with the concentration of contaminant. Therefore, multiple Kd determinations for uranium were made on two samples collected from well 1023. In Figure 4–11, the final concentration of dissolved uranium is plotted against the mass of sediment used for one of the samples (depth 10 to 12 feet). Data are plotted with 10 percent error bars (a reasonable value for analytical uncertainty) and are compared to calculated curves for various Kd values. Within the 10 percent uncertainty, all but one data point are consistent with a Kd value of 1 mL/g. Data from the other sample are plotted on Figure 4–12. Within the 10 percent error bars, these data are also consistent with a Kd value of 1 mL/g. The results indicate that, at least for uranium, transport models do not need to be corrected for variable uranium concentrations.

The Kd results indicate that migration of arsenic and cadmium is much more retarded in the alluvial aquifer sediments than the migration of molybdenum or uranium. This finding is consistent with observations at other uranium mill tailings sites, where typically the mill-related uranium and molybdenum have migrated farther from the processing sites than have the mill-related arsenic or cadmium. Recommended Kd values for the alluvial aquifer are provided in Table 4–9. Values for arsenic, cadmium, and molybdenum are the means of the alluvial aquifer samples excluding the soil sample collected above the alluvial aquifer. The value for uranium is the best fit to the plots of the multiple-point determinations.

Table 4–9. Recommended Kd Values for the Grand Junction Alluvial Aquifer

COPC	Kd (mL/g)
As	361
Cd	177
Mo	0.6
U	1.0

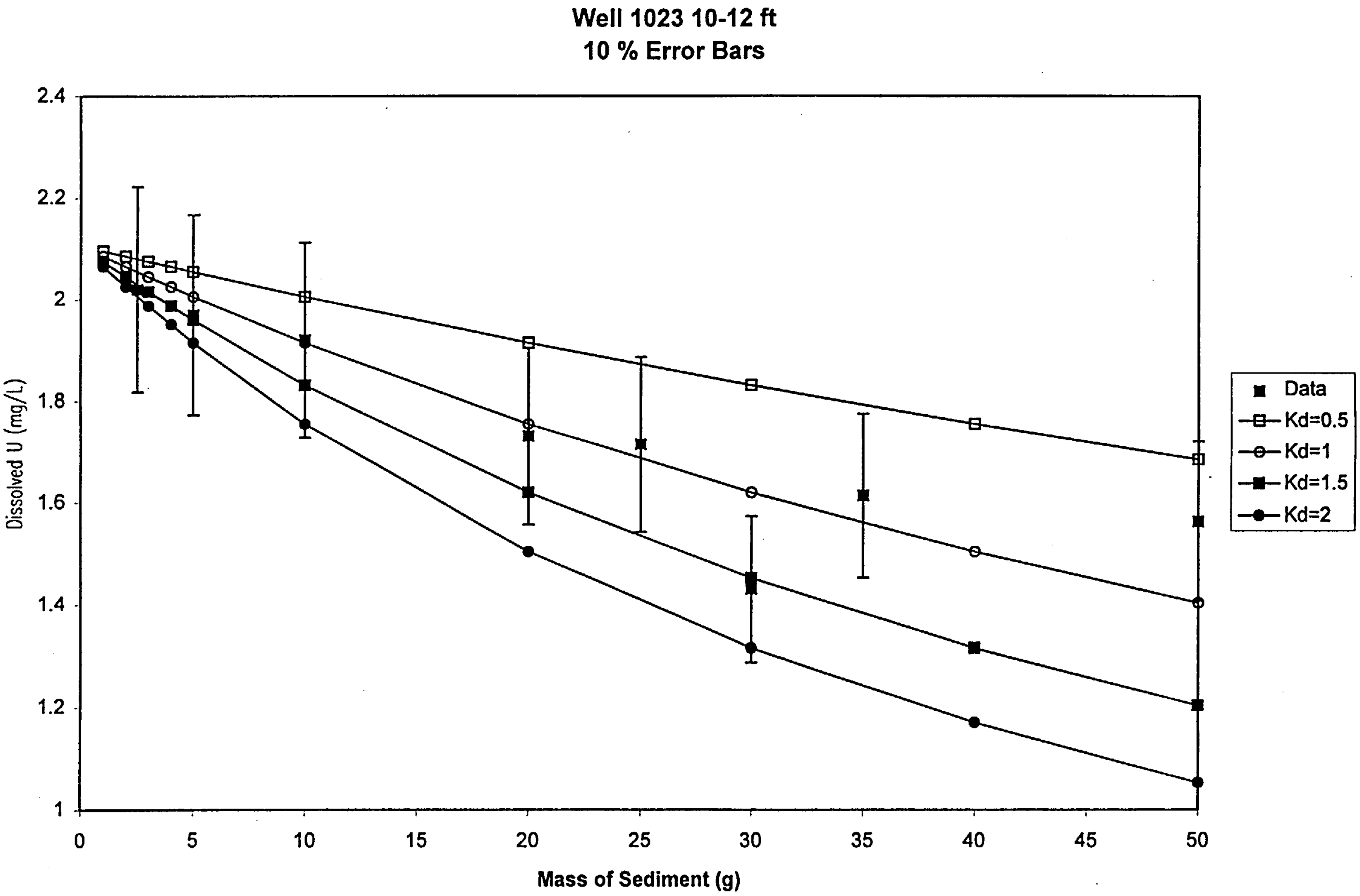

Figure 4–11. Dissolved Uranium Concentration Compared to Mass of Sediment, Well 1023, 10–12 ft

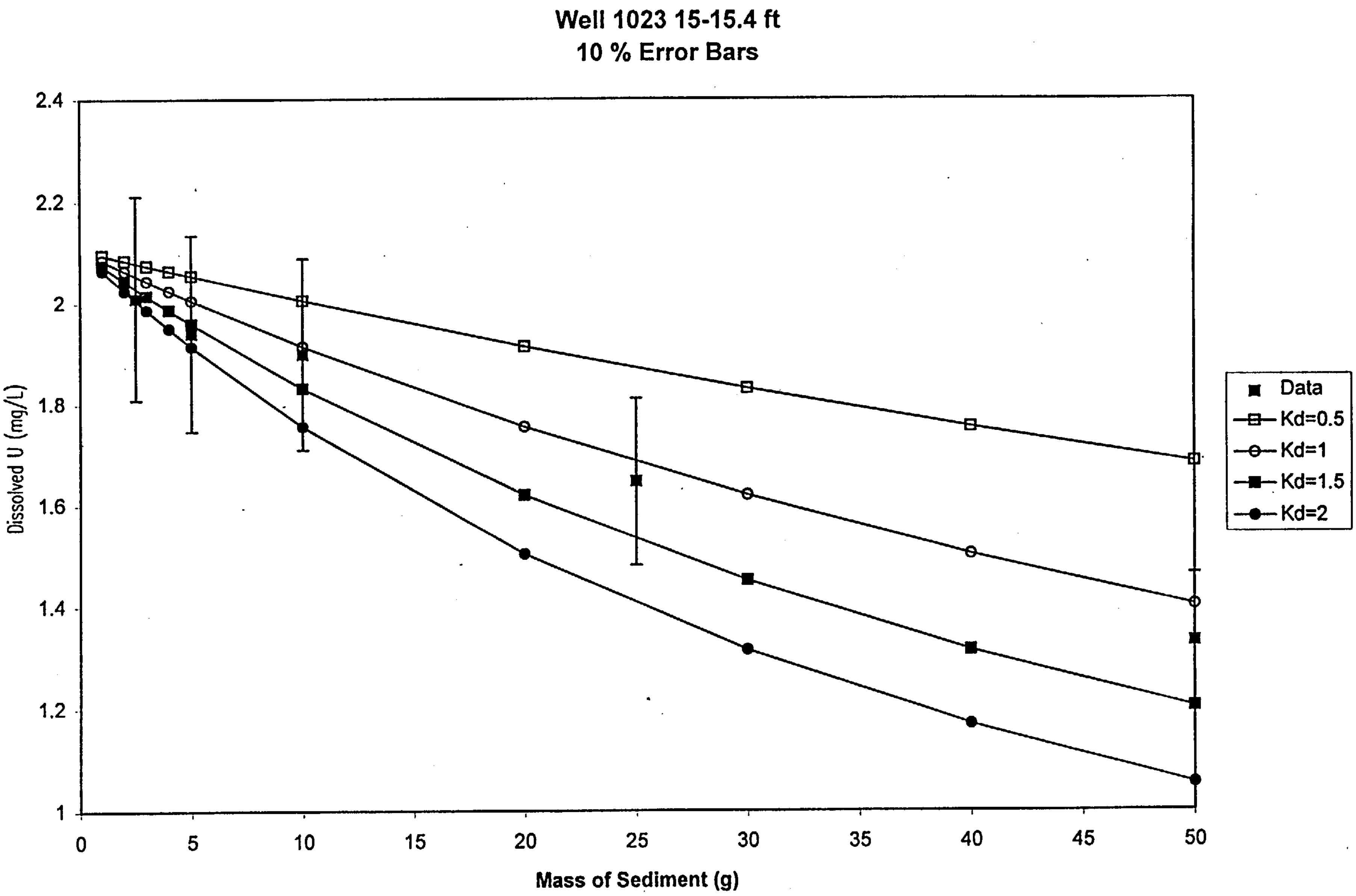

Figure 4–12. Dissolved Uranium Concentration Compared to Mass of Sediment, Well 1023, 15–15.4 ft

4.3.3 Subpile Soil Analysis

4.3.3.1 Background

During the uranium milling and processing operations at the Grand Junction site, several ponds were used for disposal and evaporation of process-related fluids. Mill tailings from operations at the site and from remediation of Grand Junction vicinity properties were temporarily stored in and around the evaporation ponds. Surface cleanup of the Grand Junction site took place in the early 1990s, and material contaminated with radionuclides was removed and disposed of in the Cheney Disposal Cell southeast of Grand Junction. Disturbed areas of the Grand Junction site were covered with at least 6 inches of clean soil and sown with vegetation.

Remediation of the Grand Junction site was based on standards in 40 CFR Part 192, Subpart B, that apply to the cleanup of residual radioactive material from land and buildings. The standards call for remediation until the concentration of ^{226}Ra in land averaged over any area of 100 square meters does not exceed the background level by more than 5 picocuries per gram (pCi/g) in the first 15 cm of soil below the surface and 15 pCi/g in 15-cm-thick layers of soil more than 15 cm below the surface. The purpose of these standards for land cleanup is to limit the risk from inhalation of radon decay products in houses built on land contaminated with tailings, and to limit gamma radiation exposure to people using contaminated land. However, milling-related radionuclides and nonradionuclides remaining in place after remediation to surface cleanup standards may still pose a potentially unacceptable source of ground water contamination. Leachate from the former evaporation ponds and tailings piles may have migrated downward and contaminated the underlying soils. Therefore, these "subpile soils" have the greatest potential for acting as a continuing source of ground water contamination.

To evaluate the possibility that subpile soils are a continuing contaminant source, leaching studies were conducted on soils collected from locations representing former on-site evaporation ponds and tailings piles (see Plate 1) to estimate the amount of remaining contamination; samples were also collected from three background locations for comparison. The subpile soil testing procedure is summarized below. For additional detail, see Appendix G.

4.3.3.2 Subpile Soil Test Procedure Summary

Samples were collected from eight on-site and three background locations (Figure 4–13). Samples were collected from two depths at five of the on-site and one of the background locations. The objective of the study was to sample soil horizons below the former tailings piles and evaporation ponds and determine the amount of residual contamination. Soils, as opposed to sediments or rocks, are more likely to serve as a continuing contaminant source through adsorption and retention of contaminants, largely due to their fine-grained nature and high organic content. However, an examination of the well logs for Grand Junction sample locations indicates that most, if not all, samples collected were actually of alluvial material. Any true soils that once existed on site were probably removed and replaced by fill during remediation. Because the Grand Junction climate is arid, and because the borehole sample locations are near the Colorado River and other surface drainage features, no well-developed soil horizons were observed during drilling at the subpile sample locations.

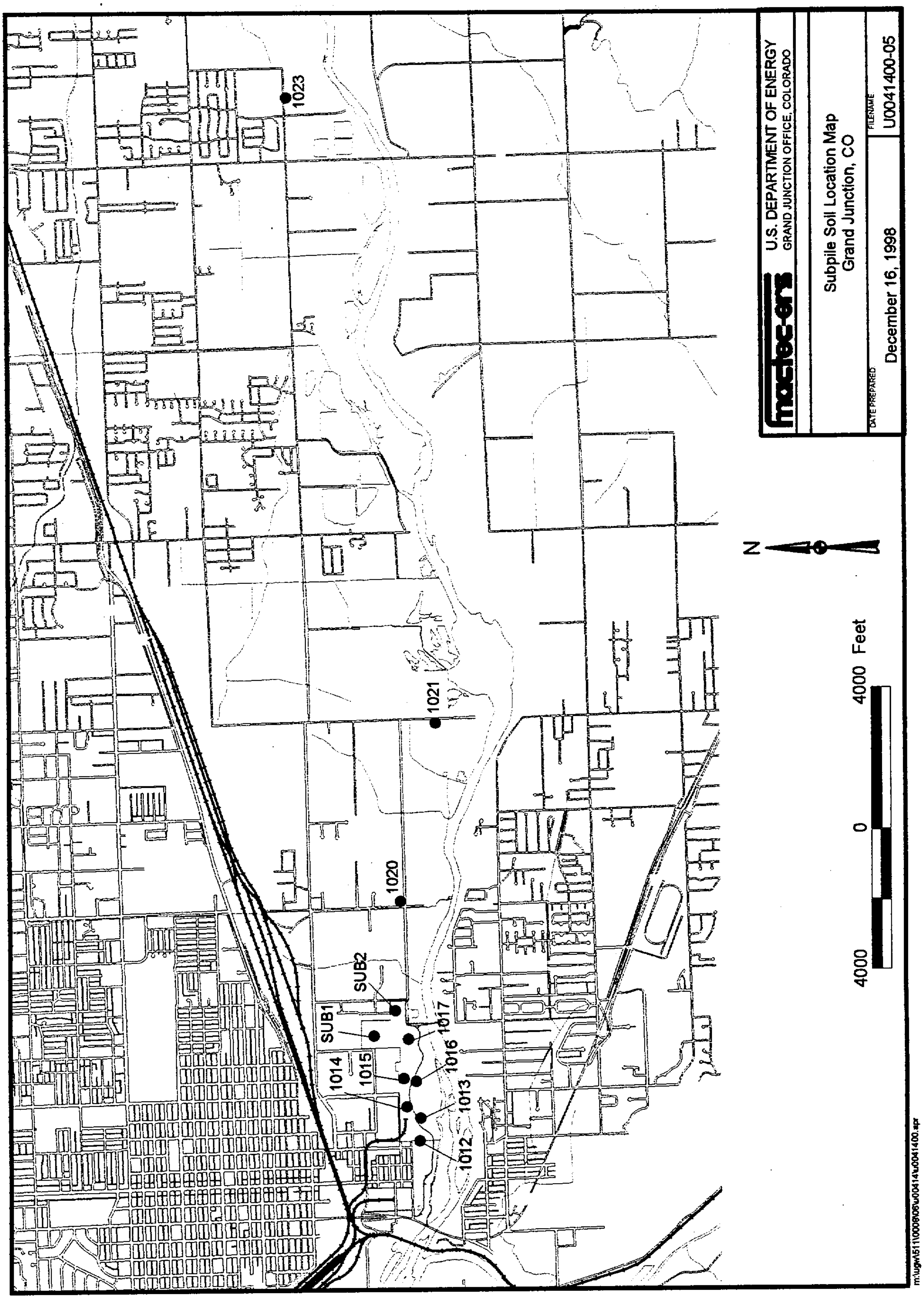

Figure 4–13. Subpile Soil Sample Locations

Samples were sieved to separate the <2 mm size fraction for further testing. This fraction was leached in a 5 percent nitric acid solution. The nitric acid solution is assumed to extract all leachable contaminants but not the contaminants locked in recalcitrant minerals such as apatites or other heavy mineral grains. The extractants from the leaching tests were analyzed for several COPCs regulated under UMTRA—arsenic, cadmium, molybdenum, ^{226}Ra, and uranium. Results of the leachate analyses were used along with volume of material extracted to estimate the amount of extractable contaminant per volume of soil (i.e., an estimated soil concentration that represents a continuing source term; see Table 4–10). For example, for the arsenic analysis for sample SUB1, 2 g of sample were extracted with 200 mL of 5 percent nitric acid. The concentration of arsenic in milligrams per kilogram (mg/kg) of soil is calculated as follows:

Volume of nitric acid solution = 200 mL
Volume of soil sample used = 2 g
Concentration of arsenic in leachate = 9.8 micrograms per liter (µg/L)

$$\frac{200\text{ mL}}{2\text{g}} \times \frac{9.8\,\mu\text{g}}{\text{L}} \times \frac{1\text{ L}}{1{,}000\text{ mL}} \times \frac{1\text{ mg}}{1{,}000\,\mu\text{g}} \times \frac{1{,}000\text{ g}}{\text{kg}} = 0.98\text{ mg/kg (concentration of arsenic in soil)}$$

A statistical analysis comparing concentrations of contaminants in on-site subpile soil samples to background soil samples indicates that on-site samples are not significantly elevated over background concentrations in cadmium and ^{226}Ra at the 95 percent confidence level. On-site samples do contain elevated concentrations of arsenic, molybdenum, and uranium.

Distribution coefficients calculated for site samples (as described in Section 4.3.2) were used in conjunction with subpile soil analyses to give a rough estimate of the importance of subpile soils as a continuing contaminant source (Table 4–10). Calculations were performed to determine the concentration of contaminants in water that would be in equilibrium with the calculated soil concentrations.

For example, for the concentration of arsenic in sample SUB1 as calculated above, and the recommended Kd for arsenic of 361 L/kg, the equilibrium water concentration for arsenic is determined by:

$$\begin{aligned} C_{\text{water, As}}\ \text{mg/L} &= C_{\text{soil mg/kg}} \div \text{Kd}_{\text{ L/kg}} \\ &= 0.98_{\text{ mg/kg}} \div 361_{\text{ L/kg}} \\ &= 0.00271_{\text{ mg/L}} \end{aligned}$$

Results indicate that concentrations of arsenic and cadmium in subpile soils are so low that partitioning to ground water is expected to be insignificant. However, uranium and molybdenum concentrations are high enough in subpile soils and their Kd values are low enough that significant amounts of these contaminants (exceeding UMTRA standards) could partition to the ground water. Water concentrations calculated for some of the uranium and molybdenum samples are probably unrealistic based on known solubility data; however, results can be used qualitatively to assess the potential of these contaminants to act as a continuing source of ground water contamination.

Table 4–10. Results of Subpile Soil Testing

5 percent Nitric Acid Extraction											
			Calculated Soil Concentrations					*Equilibrium Water Concentrations*			
Sample	**Area**	**Depth (ft)**	**As (mg/kg)**	**Cd (mg/kg)**	**Mo (mg/kg)**	**Ra-226 (pCi/g)**	**U (mg/kg)**	**Cw - As (mg/L)**	**Cw - Cd (mg/L)**	**Cw - Mo (mg/L)**	**Cw - U (mg/L)**
								Kd=361	Kd=177	Kd=0.6	Kd=1.0
SUB 1	pile/pond	.5'+	0.98	0.4	0.33	0.602	1.2	0.00271	0.0023	0.55	1.20
SUB 2	pile/pond	1'+	1.8	0.22	0.5	0.614	1.4	0.00499	0.0012	0.83	1.40
1012-1	pile	12-13.25'	0.74	0.4	1.4	0.473	1.5	0.00205	0.0023	2.33	1.50
1013-1	pile	9-11'	3.3	0.28	7.5	0.423	23.9	0.00914	0.0016	12.5	23.90
1013-2	pile	11-13'	3.7	0.23	3.5	0.289	10.4	0.01025	0.0013	5.833	10.40
1014-1	pile	13-14.25'	3.2	0.97	1.3	0.492	45.2	0.00886	0.0055	2.167	45.20
1014-2	pile	17-19'	1.4	0.73	0.8	0.309	7.7	0.00388	0.0041	1.333	7.70
1015-1	pile	10-12'	1.1	0.36	0.79	0.443	0.95	0.00305	0.0020	1.317	0.95
1015-2	pile	14-15.4'	0.82	0.37	1	0.249	0.56	0.00227	0.0021	1.667	0.56
1016-1	pile	9-11'	1.5	0.18	0.77	0.229	1.7	0.00416	0.0010	1.283	1.70
1016-2	pile	13-14.3'	1.2	0.23	0.34	0.319	0.6	0.00332	0.0013	0.567	0.60
1017-1	pond	9-11'	1	0.29	0.68	0.472	0.99	0.00277	0.0016	1.133	0.99
1017-2	pond	11-13'	1.6	0.18	0.53	0.38	0.59	0.00443	0.0010	0.883	0.59
1020-1	bkgd	5-7'	1.2	0.4	0.3	0.646	0.78	0.00332	0.0023	0.5	0.78
1021-1	bkgd	5-7'	0.9	0.32	0.33	0.472	1.1	0.00249	0.0018	0.55	1.10
1023-1	bkgd	5-7'	1	0.42	0.14	0.611	0.74	0.00277	0.0024	0.233	0.74
1023-2	bkgd	10-12'	0.92	0.25	0.21	0.24	0.44	0.00255	0.0014	0.35	0.44
UMTRA STANDARDS (mg/L)			0.05	0.01	0.1	5.0	0.044				

However, because of the high mobility of these contaminants, they would be expected to flush from the aquifer in a relatively short period of time (see further discussion in Section 5.3).

4.4 Ecological Field Investigations

Ecological investigations at the former millsite and surrounding areas were conducted to satisfy data needs to update the baseline risk assessment (BLRA; DOE 1995). Section 5.2 of the *Work Plan for Characterization Activities at the UMTRA Grand Junction Project Site* (DOE 1997) identified the following ecological data needs:

- Characterization of current plant communities overlying contaminated ground water and projections of the future plant ecology of the area given land-use scenarios.
- Selection and characterization of the plant ecology of a reference (background) area.
- Comparison of ecological COPCs in vegetation, sediment, and surface water, on site and in the reference areas, with ecotoxicity benchmarks.
- Screening assessment of ecological risks associated with irrigation ponds constructed at the botanical gardens since publication of the BLRA.

4.4.1 Plant Ecology Investigation

Vegetation at the former millsite and at the reference area was characterized using a semiquantitative relevé technique (Bonham 1989). The species composition and relative abundance of plant communities were evaluated by subjectively selecting representative stands of each vegetation type, walking through the stands, and compiling a list of all species observed. Each species was then assigned one of six cover classes. Cover was not measured precisely. The millsite and reference area were traversed on May 12, 1998.

4.4.1.1 Millsite Ecology

The millsite was seeded with a mixture of grasses, forbs, and shrubs after the removal of tailings in 1994. Since then, two types of upland vegetation and two types of riparian vegetation have developed on the site (See Figure 4–14). In one small area the seeding of crested wheatgrass (*Agropyron cristatum*) was successful. No other seeded grasses, forbs, or shrubs were found. The rest of the upland area is dominated by the invasive weed kochia (*Kochia scoparia*). A few young greasewood (*Sarcobatus vermiculatus*) shrubs are also present in this area. Overall, the millsite revegetation was unsuccessful.

Two riparian vegetation types along the Colorado River were identified on the basis of the relative abundance of tamarisk and cottonwood. The tamarisk type is dominated by tamarisk (*Tamarix ramosissima*) with some reed canarygrass (*Phalaris arundinaceae*), willows (*Salix exigua*), and cottonwood seedlings (*Populus fremontii*). Downgradient from the plume and mainly on Watson Island is the cottonwood type, which is dominated in the canopy by cottonwoods and has a weedy subcanopy of tamarisk, Russian olive (*Eleagnus angustifolia*), and Chinese elm (*Ulmus pumila*). The understory consists of a variety of grasses; the most prevalent are slender wheatgrass (*Elymus trachycaulus spp. trachycaulus*), inland saltgrass (*Distichlis* *spicata*), blue wildrye (*Elymus glauca*), and reed canarygrass. There are also forbs in the understory, both native plants and invasive weeds such as Russian knapweed (*Centaurea repens*). Table 4–11 details the cover class of each species in the different vegetation types.

Table 4–11. Relevé Data Showing Species Cover of Plant Types at the Grand Junction Site

Latin Name	**Common Name**	**Kochia Type**	**Wheat Grass Type**	**Tamarisk Type**	**Cotton-Wood Type**
Agropyron cristatum	Crested wheatgrass	1	3		1
Aster sp.	Aster				1
Atriplex canescens	Fourwing saltbush				+
Bromus inerme	Smooth brome	2			
Bromus tectorum	Cheatgrass				1
Centaurea repens	Russian knapweed				1
Chenopodium simplex	Goosefoot				1
Conyza canadensis	Horseweed				+
Descurania pinnata	Tansy mustard		1		+
Distichlis spicata	Inland saltgrass				2
Eleagnus angustifolia	Russian olive			1	2
Elymus elymoides	Bottlebrush squirreltail				1
Elymus sp.	Wildrye				2
Elymus trachycaulis	Slender wheatgrass				2
Kochia scoparia	Kochia	4	2	3	2
Phalaris arundinaceae	Reed canary grass			2	2
Phragmites communis	Common reed				1
Polygonum sp.	Knotweed			+	
Populus fremontii	Cottonwood			2	3
Salix exigua	Sandbar willow			2	1
Sarcobatus vermiculatus	Greasewood	+			
Scirpus acutus	Bulrush			1	
Sporobolis airoides	Alkali sacaton				1
Typha latifolia	Cattail			1	
Tamarix ramosissima	Tamarisk			4	3
Ulmus pumila	Chinese elm				2
Xanthium strumarium	Cocklebur			1	

COVER CLASSES: +: <1 percent, 1: 1-5 percent, 2: 5-25 percent, 3: 25-50 percent, 4: 50-75 percent, 5: 75-100 percent

4.4.1.2 Reference Area Ecology

The reference area is upgradient of the millsite at the Wildlife Area section of Colorado River State Park. It consists of wildlife habitat areas and a series of ponds created from reclaimed gravel pits. The ponds are lined with cattails, common reed, and sandbar willow and provide habitat for geese, ducks, herons, and other waterfowl. The upland area is on a bench between the ponds and a small channel of the Colorado River. Characteristic upland vegetation continues east of the ponds. A pedestrian trail traverses these upland areas. The upland vegetation on this site is a good example of the potential vegetation of the millsite. It captures the range of conditions that demonstrate possible pathways of succession at the millsite, depending on future land-use scenarios.

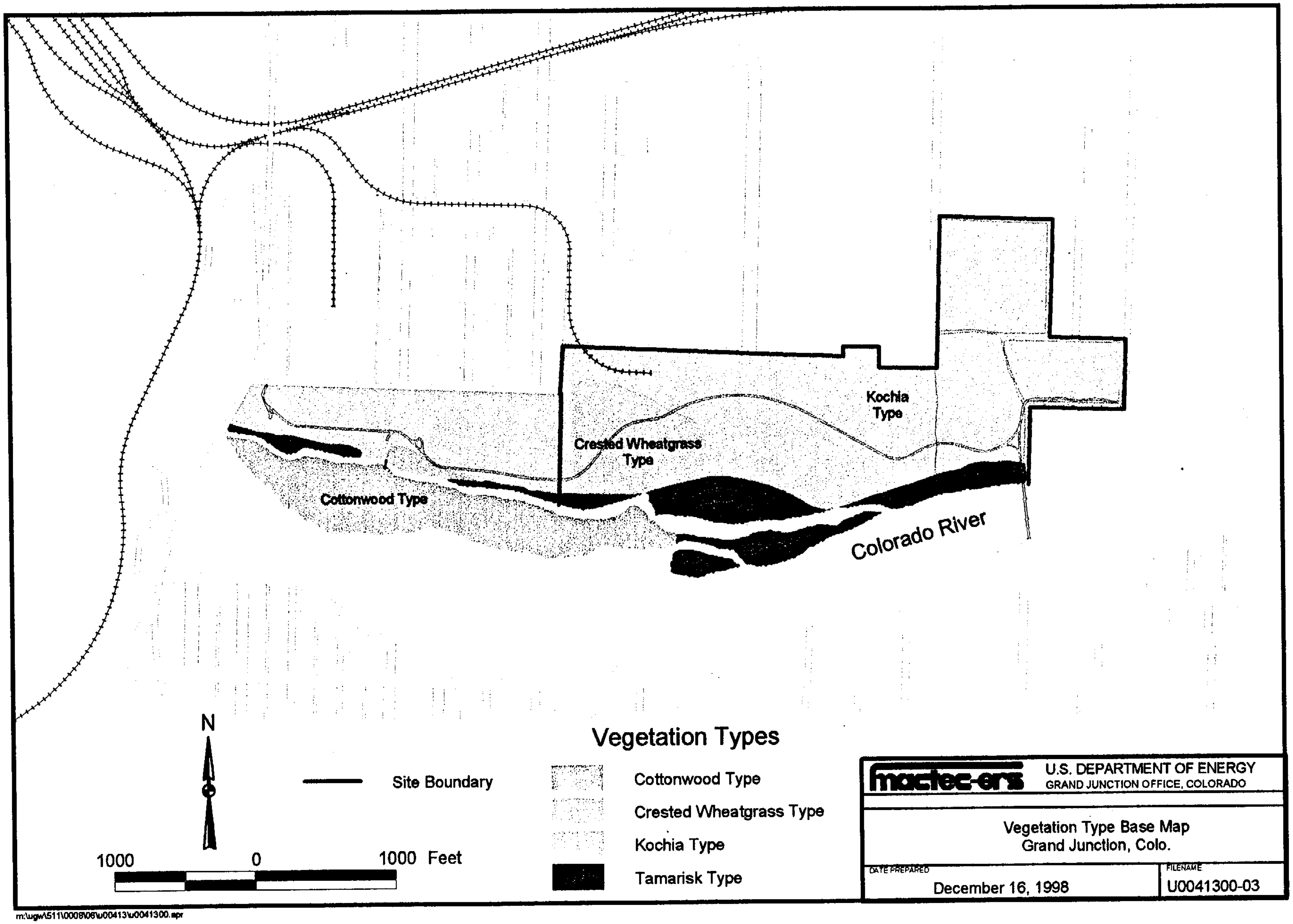

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Figure 4–14. Base Map of Vegetation Types

Three vegetation types were delineated in the reference area. An upland vegetation type is dominated by either greasewood or rabbitbrush (*Chrysothamnus nauseosus*) in a mosaic pattern reflecting complex soil, geologic, and hydrologic interaction. A riparian vegetation type is found on the south side of the site along a backwater channel of the Colorado River. It is dominated by tamarisk, sandbar willow, and reed canarygrass. A wetland vegetation type is located on the pond margins and in other low-lying areas on the site. The dominant wetland plant species are cattails and sandbar willow. Table 4–12 shows the cover class of each species found in the three vegetation types in the reference area.

Table 4–12. Relevé Data Showing Species Cover of Vegetation Types at the Reference Area

Latin Name	Common Name	Upland Type	Riparian Type	Wetland Type
Bromus tectorum	cheatgrass	3	2	
Centaurea repens	Russian knapweed		1	
Chrysothamnus nauseosus	rubber rabbitbrush	4	1	
Distichlis spicata	inland saltgrass	2		
Eleagnus angustifolia	Russian olive		1	
Elymus glauca	blue wildrye	3		
Kochia scoparia	kochia	1		
Phalaris arundinacea	reed canarygrass		3	
Phragmites communis	common reed			2
Polypogon monspeliensis	rabbitsfoot grass		1	
Populus fremontii	Fremont cottonwood		2	1
Rhus trilobata	skunkbush sumac		1	
Salix exigua	sandbar willow		3	3
Sarcobatus vermiculatus	greasewood	3		
Scirpus acutus	hard stem bulrush		1	2
Tamarix ramosissima	tamarisk		3	
Typha latifolia	cattails		+	3
Ulmus pumila	Chinese elm		1	

COVER CLASSES: +: <1 percent, 1: 1–5 percent, 2: 5–25 percent, 3: 25–50 percent, 4: 50–75 percent, 5: 75–100 percent

4.4.1.3 Future Millsite Ecology

In the absence of disturbance, the upland plant community at the millsite will trend toward shrubland dominated by either greasewood or rabbitbrush. The riparian plant communities are being dominated by invasive weeds such as tamarisk, Russian olive, and reed canarygrass. Over time these plants may completely dominate, inhibiting reproduction of cottonwood, willow, and other more desirable plant species. Currently, greasewood, cottonwood, and tamarisk inhabit the site. These plants are all phreatophytic (plants that root in ground water), creating the potential for exposure pathways on the site.

4.4.2 Sampling for Chemical Analysis

Field sampling to support the BLRA update was conducted from June 22 through July 1, 1998. Surface water, sediment, and vegetation samples were collected along the Colorado River adjacent to and downstream of the Grand Junction site, at the botanical gardens irrigation pond located downstream from the Grand Junction site, and at the upstream reference area east of the site. This sampling was completed in addition to sediment and surface water sampling described in Sections 4.3.1.2 and 4.3.1.3. Results of the sampling and analyses are discussed in Section 5.4 and reported in Appendix I.

The selection of a reference area with the desired phreatophytic vegetation was limited to two areas upgradient of the Grand Junction site: the Colorado River Wildlife Area and Corn Lake farther east. Both areas were considered to represent background and had been previously sampled for surface water. The Colorado River Wildlife area was chosen since it was closer to and ecologically similar to the Grand Junction site.

4.4.3 Abiotic Sampling

Surface water and sediment samples were collected at the Grand Junction site and the upgradient reference area (Figures 4–15 and 4–16). Ten co-located samples of sediment and surface water were collected at each of ten locations at each site. Five of the sampling locations at both the site and the reference area had been sampled previously. These existing 300-series sampling locations were surveyed and identified with tags attached to metal t-posts. Only four of the surveyed 300-series locations could be re-located by the field team. As a result, six locations were chosen using stratified random sampling. Five 300-series and five random locations were also selected at the reference area; only areas (strata) having appropriate plant species were selected.

The number of samples (10 each) was chosen to satisfy a coefficient of variation of 20, a minimum detectable relative percent difference of 20, a confidence of 95 (Type I error, false positive) and a power of 90 (Type II error, false negative) based on a 1-sided, single sample distribution. This is consistent with EPA guidance (EPA 1989a). Other factors that were considered in the selection of sample size were the small areal extent of the affected sites, the amount of historical data available, and generally low contaminant concentrations. The surface water samples were collected as grab samples, and the sediment samples consisted of materials collected from a nominal depth of 0–6 in. (0–15 cm) below the sediment surface. Surface water sample collection preceded sediment and vegetation sample collection. All surface water and sediment sampling containers were obtained pre-cleaned from an industrial supplier and accompanied by a cleanliness certificate.

Sample locations were identified as follows:

Locations 1216–1225: Reference area
Locations 1226–1235: Grand Junction site and downstream (west) of the site

Random sample locations not associated with 300-series location codes were originally established using a Garmin GPS (global positioning system) III unit; these locations were subsequently verified using a Trimble mapping-grade GPS unit. Location coordinates were collected using the WGS 84 datum, converted into state plane coordinates, and entered into the SEE UMTRA database.

4.4.3.1 Surface Water

Both filtered and unfiltered surface water samples were collected at the same locations as the sediment samples. The filtered portion represents the soluble component for aquatic receptors, whereas terrestrial receptors ingest unfiltered surface water. The analyte list for filtered surface water samples collected at locations 310, 312, 325, 326, 328, 330, 342, 349, and 350 differed only slightly from the analyte list for the remaining field locations.

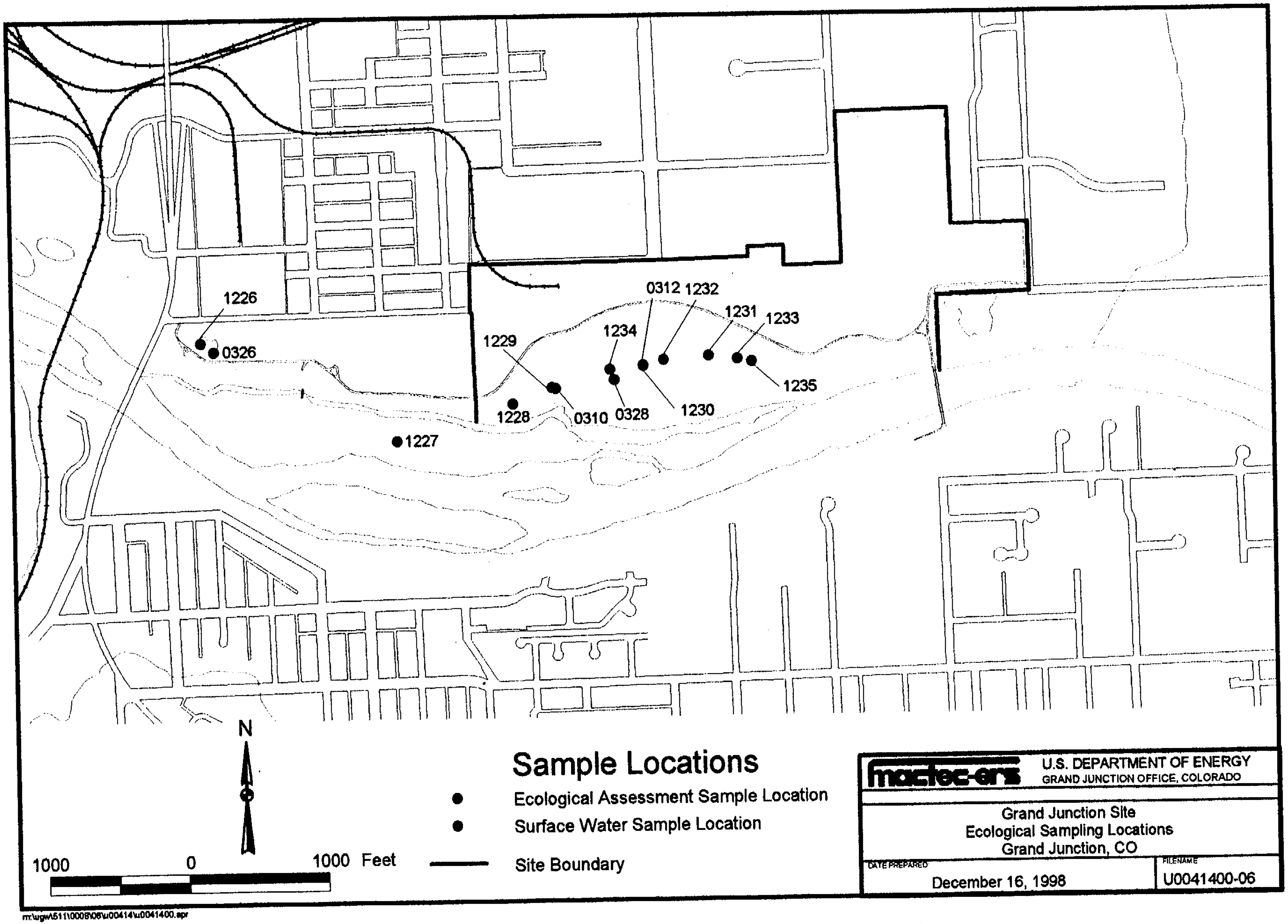

Figure 4–15. Grand Junction Site Ecological Sampling Locations

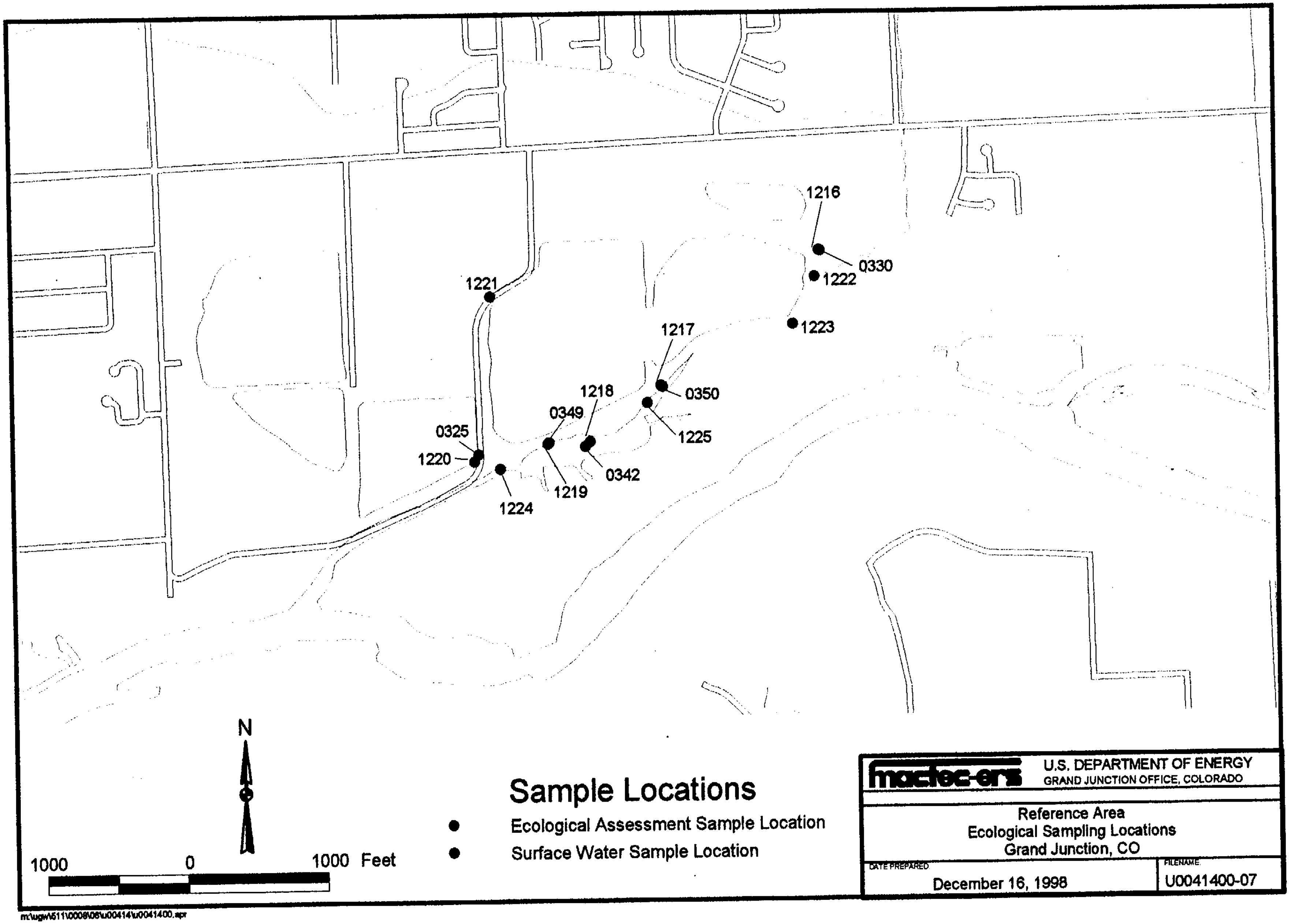

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Figure 4–16. Reference Area Ecological Sampling Locations

Filtered surface water samples were identified with an "F" suffix to the sample identification number, and unfiltered samples received a "U" suffix. Each sample bottle was first rinsed with the surface water before sample collection. The sample was collected by immersing the bottle just below the water surface and filling to just below the lid. Samples were then filtered through a 0.45 µm filter and acidified accordingly. Table 4–13 provides a summary of analytes, preservatives, containers, and other information pertaining to surface water sample collection.

Table 4–13. Surface Water Sample Collection, Preservation, and Analysis

Analyte	Preservative	Container	Holding Time	Method
Arsenic Cadmium Cobalt Copper Iron Manganese Molybdenum Nickel Selenium Strontium Uranium Vanadium Zinc	HNO_3 to pH<2; cool 4 °C	500 mL amber HDPE	6 months	ICPAES ICPMS ICPAES ICPAES ICPAES ICPAES ICPMS ICPAES ICPAES ICPAES ICPMS ICPAES ICPAES
^{226}Ra ^{228}Ra	HNO_3 to pH <2; 4 °C	1 liter HDPE	6 months	LSS LSS
Ammonia as NH_4	H_2SO_4 to pH <2; 4 °C	125 mL HDPE	28 days	SPEC
Fluoride Sulfate	cool 4 °C	125 mL HDPE	28 days	IC IC

Note:
HDPE = high density polyethylene
H_2SO_4 = sulfuric acid
HNO_3 = nitric acid
mL = milliliter
C = centigrade or Celsius
ICPMS = Inductively-coupled plasma mass spectrometry
ICPAES = Inductively-coupled plasma atomic emission spectroscopy
IC = Ion chromatography
LSS = Liquid scintillation spectrometry
SPEC = Spectroscopy

Sample labels showing the date, time, location, laboratory bar code, sampler, analyses requested, preservatives, and comments were applied to each container and secured with clear plastic tape. All sample containers were placed in coolers containing ice until transported to the Analytical Chemistry Laboratory. A chain of custody form was completed for all samples and a custody seal was placed over each cooler. All samples were maintained under strict chain of custody.

Because of a laboratory omission, data for ammonia as ammonium (NH_4), sulfate, and fluoride were not obtained on the unfiltered portions for locations 1222, 1223, 1224, and 1225. Nitrate was not detected in filtered surface water for locations 1226, 1229, 1230, and 1234 but was detected in the reference area. Because nitrate is present in the surface water at other locations, the nitrate results for the on-site locations are not considered reliable. Nitrate was not analyzed in unfiltered surface water since it was not identified as an ecological COPC in the work plan (DOE 1997).

4.4.3.2 Sediment

Each sediment sample represented a composite of typically three or four locations where vegetation was present. The collection area was typically a circle of radius less than 5 ft. Excess organic matter and larger rocks and pebbles were removed from the sample before compositing. The contents of one stainless steel auger (i.e., one subsample) was collected at each composite location and placed in a large stainless steel mixing pan. All subsamples were mixed thoroughly with a stainless steel spoon, and about 4 ounces (114 g) of material were removed for metals analysis. In addition, a 125-mL HDPE bottle was collected for analysis of ammonia and another for fluoride and sulfate analysis. Table 4–14 provides a summary of analytes, preservatives, containers, and other information pertaining to sediment sample collection.

Table 4–14. Sediment Sample Collection, Preservation, and Analysis

Analyte	Preservative	Container	Holding Time	Method[a]
Arsenic	cool 4 °C	4 oz. amber glass	6 months	ICPAES
Cadmium				ICPMS
Cobalt				ICPAES
Copper				ICPAES
Iron				ICPAES
Manganese				ICPAES
Molybdenum				ICPMS
Nickel				ICPAES
Selenium				ICPAES
Strontium				ICPAES
Uranium				ICPMS
Vanadium				ICPAES
Zinc				ICPAES
^{226}Ra	cool 4 °C	4 oz. amber glass	6 months	LSS
^{228}Ra				LSS
Ammonia as NH_4	cool 4 °C	125 mL HDPE	28 days	SPEC
Fluoride	cool 4 °C	125 mL HDPE	28 days	IC
Sulfate				IC

[a] ICPMS = Inductively-coupled plasma mass spectrometry
ICPAES = Inductively-coupled plasma atomic emission spectroscopy
IC = Ion chromatography
LSS = Liquid scintillation spectrometry
SPEC = Spectroscopy

Sample labels were applied to each container and secured with clear plastic tape. All sample containers were placed in coolers containing ice until transport to the Analytical Chemistry Laboratory. A chain of custody form was completed for all samples and a custody seal was placed over each cooler. All samples were maintained under strict chain of custody. The analytical method for the sediment samples specified above included a complete acid digestion rather than an acid leach as in previous sediment sample analyses discussed in Section 4.3.1.3. Therefore, analytical results for these sets of samples are not directly comparable.

4.4.3.3 Quality Assurance Samples

One unfiltered field blank and one equipment rinsate were collected at the reference area. The field blank was prepared by pouring distilled, deionized water directly into the appropriate sample bottle and preserving as necessary. The equipment rinsate consisted of pouring distilled, deionized water over the cleaned sampling equipment (auger, sampling pan, shears, and spoons) and collecting the rinsate in the appropriate sample containers and preserving and cooling as necessary.

Field duplicate surface water and sediment samples were collected at reference location 1221 and at Grand Junction site location 1229. Field duplicates were identified with a D suffix to the sample identification number.

4.4.4 Biotic Sampling

4.4.4.1 Field Sampling Methods

Vegetation samples consisting of cattails (*Typha* sp.), reed canarygrass (*Phalaris arundinaceae*) and sandbar willow (*Salix exigua*) were collected at the reference and Grand Junction site locations. A single bulrush (*Scirpus* sp.) sample was collected at the reference area; the quantity of bulrush available at the millsite was insufficient for a sample. Because the reference area sample could not be compared to an on-site sample, results of the bulrush analysis were not used for the ecological risk assessment. The biota samples were co-located with the surface water and sediment samples. Samples were collected by using a stainless-steel shovel to dig up an entire plant or cluster of plants. Sediment was rinsed off the plants, and the roots and stems were separated with pruning shears having stainless steel and polyethylene cutting edges. The roots and stems were rinsed thoroughly with surface water, followed by tap and distilled deionized water rinses until rinsates contained no visible soil or sand particles. All plant materials received a final distilled, deionized water rinse before bagging. Stems and roots were composited separately from three or four samples, depending on the size of the original plant or plant cluster. Stems and roots were double-bagged in clean plastic zipper-type storage bags. Sample labels were applied to each outer bag and secured with clear plastic tape. All samples were kept in coolers containing ice for transporting to the Analytical Chemistry Laboratory. A chain of custody form was completed for all samples and a custody seal was placed over each cooler. All samples were maintained under strict chain of custody.

Samples that could not be processed directly at the laboratory by freeze-drying were placed in refrigerators at 4 °C. Table 4–15 provides a summary of analytes, preservatives, containers, and other information pertaining to biota tissue collection.

Sample locations were identified as follows:

Locations 1216–1225: Reference Area
Locations 1226–1235: Grand Junction site and downstream (west) of the site

Vegetation samples were identified by adding an "R" (root) or "S" (stem) suffix to each sample identification number. All sample bags for each field location containing the same laboratory identification number were processed as one sample (i.e., all roots for the same sample identification and field location number were processed as one sample). The same procedure applied to the stem material for each field sampling location. All analyses are based on total sample digestion.

Due to the scarcity of desirable vegetation species along the Colorado River adjacent to the Grand Junction site, the same numbers and types of species could not be collected at both the site and reference areas. Table 4–16 summarizes the species collected at each location.

Table 4–15. Biota Sample Collection, Preservation, and Analysis

Analyte	Matrix	Preservative	Container	Holding Time	Method[a]
Arsenic	cattail, reed canarygrass, willow	Cool 4 °C	double 1-gal plastic zipper bags	6 months	ICPAES
Cadmium	cattail, reed canarygrass, willow	Cool 4 °C	double 1-gal plastic zipper bags	6 months	ICPMS
Cobalt	cattail, reed canarygrass, willow	Cool 4 °C	double 1-gal plastic zipper bags	6 months	ICPAES
Copper	cattail, reed canarygrass, willow	Cool 4 °C	double 1-gal plastic zipper bags	6 months	ICPAES
Iron	cattail, reed canarygrass, willow	Cool 4 °C	double 1-gal plastic zipper bags	6 months	ICPAES
Manganese	cattail, reed canarygrass, willow	Cool 4 °C	double 1-gal plastic zipper bags	6 months	ICPAES
Molybdenum	cattail, reed canarygrass, willow	Cool 4 °C	double 1-gal plastic zipper bags	6 months	ICPMS
Nickel	cattail, reed canarygrass, willow	Cool 4 °C	double 1-gal plastic zipper bags	6 months	ICPAES
Selenium	cattail, reed canarygrass, willow	Cool 4 °C	double 1-gal plastic zipper bags	6 months	ICPAES
Strontium	cattail, reed canarygrass, willow	Cool 4 °C	double 1-gal plastic zipper bags	6 months	ICPAES
Uranium	cattail, reed canarygrass, willow	Cool 4 °C	double 1-gal plastic zipper bags	6 months	ICPMS
Vanadium	cattail, reed canarygrass, willow	Cool 4 °C	double 1-gal plastic zipper bags	6 months	ICPAES
Zinc	cattail, reed canarygrass, willow	Cool 4 °C	double 1-gal plastic zipper bags	6 months	ICPAES
^{226}Ra	cattail, reed canarygrass, willow	Cool 4 °C	double 1-gal plastic zipper bags	6 months	LSS
^{228}Ra	cattail, reed canarygrass, willow	Cool 4 °C	double 1-gal plastic zipper bags	6 months	LSS

[a] ICPMS = Inductively-coupled plasma mass spectrometry
ICPAES = Inductively-coupled plasma atomic emission spectroscopy
LSS = Liquid scintillation spectrometry

Table 4–16. Summary of Vegetation Collected by Location

Location Code	300-Series Code	Location	Vegetation (includes both roots and stems)
1216	330	Reference	Cattail, bulrush
1217	342	Reference	Reed canarygrass
1218	350	Reference	Willow
1219	349	Reference	Willow
1220	325	Reference	Reed canarygrass
1221	None	Reference	Cattail
1222	None	Reference	Cattail
1223	None	Reference	Reed canarygrass
1224	None	Reference	Willow
1225	None	Reference	Cattail
1226	326	On Site	Cattail
1227	None	On Site	Reed canarygrass
1228	None	On Site	Reed canarygrass
1229	310	On Site	Willow
1230	312	On Site	Reed canarygrass
1231	None	On Site	Cattail
1232	None	On Site	Willow
1233	None	On Site	Reed canarygrass
1234	328	On Site	Reed canarygrass
1235	None	On Site	Cattail

4.4.4.2 Quality Assurance Samples

A field duplicate cattail sample was collected at reference location 1222, and a field duplicate reed canarygrass sample was collected at on-site location 1228. These field duplicates do not correspond to the surface water and sediment duplicate samples because of the variable availability of vegetation at the locations. Field duplicates were identified with a "D" suffix added to the sample identification number. Equipment rinsates and field blanks applied to the biota collection as well.

4.5 Land Surveys

A new survey was performed on all currently sampled and new monitoring wells, the stilling well, surface sampling locations, and various other locations including the new dike/sidewalk, footbridge and a brass cap on the footbridge, the north side of the Colorado River, and ponds in the Western Colorado Botanical Gardens area. This information was entered into the SEE UMTRA database and used for generating maps, tables, and references for this SOWP. XY coordinates used the NAD 83 format, and elevations were tied to the North American Vertical Datum of 1929. All lithologic and well completion logs in Appendix B use this information.

4.6 Vicinity Property Study

DOE, in conjunction with the CDPHE, recently completed removal of uranium mill tailings, which had been used as fill and for other construction purposes, from over 4,000 private and commercial properties in the Grand Junction area. Most of the tailings were removed from these properties, known as vicinity properties, but some tailings were left in place through the application of supplemental standards or area averaging. DOE and the CDPHE were concerned that mill tailings left in place at vicinity properties could leach contaminants into ground water at these sites. To address this concern, one large complex commercial property, the Regional Center and one collection of residential properties, West Main Street, were studied. Large volumes of tailings had been removed from the Regional Center property, and substantial volumes of tailings were left in place at both properties through the application of supplemental standards or area averaging. These properties were considered to represent worst case scenarios for potential ground water contamination. A separate report entitled *Ground Water Study at Two UMTRA Project Vicinity Properties in Grand Junction, Colorado* (DOE 1999) addressing the vicinity property study is being prepared concurrently with this final Grand Junction SOWP.

5.0 Conceptual Site Model

5.1 Geology

5.1.1 Regional Structure and Setting

The Grand Junction site is in the Grand Valley on the eastern edge of the Colorado Plateau, a large region encompassing parts of Colorado, Utah, New Mexico, and Arizona that began to be uplifted during the Laramide orogeny; the uplifting intensified about 10 million years ago in response to the North American plate overriding the East Pacific plate (Kluth and Coney 1981). The Uncompahgre Plateau, which is the eastern part of the Colorado Plateau and west and southwest of the Grand Junction site, is a recurring structural high that formed part of the Ancestral Rocky Mountains during late Paleozoic time. During the Late Cretaceous into Tertiary time, the Uncompahgre Uplift tilted Mesozoic and early Tertiary rocks from Grand Junction to Montrose, Colorado, away from the plateau toward the northeast and east (Lohman 1965). Bedrock in the subsurface of the site dips gently northeast at 1 to 3 degrees. Bedrock strike is parallel to the axis of the Uncompahgre Uplift to the southwest, and the dip is away from the uplift toward the Piceance Basin to the northeast.

In the Grand Valley, unconsolidated Quaternary deposits consisting of sand, silt, gravel, and cobbles laid down by the Colorado River cover sedimentary bedrock formations of Late Cretaceous age. In places, the Quaternary material is covered by soil or fill material that was hauled in to replace contaminated soil that was excavated during surface remediation. Bedrock exposures closest to the site are to the south in the escarpment about 75 ft (23 m) high along the south side of the Colorado River. Approximately 15 ft (4.6 m) of Quaternary sand, silt, gravel, and cobbles overlies the bedrock and forms the top of the escarpment. This alluvial terrace material was deposited by the ancestral Colorado River, and the surface formed on the terrace is known as Orchard Mesa.

5.1.2 Stratigraphy

Bedrock underlying the site and exposed along cliffs south of the Colorado River directly south of the site consists of shales of the Late Cretaceous Dakota Sandstone. Mancos Shale, also of Late Cretaceous age, overlies the Dakota Sandstone and is exposed in an outcrop east of the site along the south side of the Colorado River and is present in the subcrop within 200 to 300 ft (61 to 91 m) east of the site. These formations and the overlying Quaternary material are shown in Figure 4–1, a southwest-to-northeast cross section A–A'. Below the Dakota Sandstone is the Early Cretaceous Burro Canyon Formation that does not crop out in the site area. Characteristics of the unconsolidated Quaternary material and fill, Mancos Shale, and Dakota Sandstone are described below.

5.1.2.1 Quaternary Sediments and Fill

Unconsolidated alluvial material and fill underlie portions of the site north of the Colorado River and range in thickness from 4 ft (1.3 m) to about 25 ft (7.6 m). The thickness generally increases northward from the river and reaches its greatest thickness locally in an east-trending area about 2 mi (3.2 km) north of the site around North Avenue (U.S. Bureau of Reclamation 1986). About 3 mi (5 km) east of the site, the alluvial material is thicker, as determined from borehole data. The thickest alluvium found in these boreholes was 78 ft (24 m) in borehole 717 about 2 mi

(3.2 km) north of the river (U.S. Bureau of Reclamation 1986). Quaternary material south of the site and south of the Colorado River caps the escarpment as a layer about 15 ft (5 m) thick and is a terrace deposit composed of cobbles and gravel with a sand and silt matrix.

Quaternary material north of the river can generally be divided into two types of deposits: bedload cobbles and gravel of the alluvial aquifer, and overlying floodplain deposits of sand, silt, and clay. The "cobble aquifer" was first recognized by Schneider (1975), who proposed that the Colorado River was formerly about 3 mi (5 km) north of its present channel, and the cobble aquifer was deposited as bedload during lateral migration of the river to its present position. As part of the Colorado River Basin salinity control project in the late 1970s and 1980s, the U.S. Bureau of Reclamation investigated the cobble aquifer and identified a boundary (U.S. Bureau of Reclamation 1986). The cobble aquifer is as much as 40 ft (12 m) thick in the Clifton area and is from 5 to 15 ft (1.5 to 5 m) thick in the millsite area. Material composing the cobble aquifer and lowest part of the alluvial aquifer in the site area includes silty gravel and silty gravel with sand.

Fine-grained floodplain deposits generally from 5 to 10 ft (1.5 to 3 m) thick composed of sandy clay, clayey sand, sandy silt, and silty sand overlie the cobble aquifer in the site area. Cahn and others (1988) noted that in places the base of the floodplain deposits consisted of clay in discontinuous lenses. Where continuous, this clay could confine the underlying cobble aquifer. This clay was not found in the site area.

5.1.2.2 Mancos Shale

Approximately 4,000 ft (1,200 m) of Mancos Shale deposited in the interior epicontinental seaway are present in the Grand Valley in the Grand Junction area. Only the lowermost part of the Mancos Shale, the nonresistant Tununk Member (about 200 ft [62 m] thick), is present less than 1 mile north of the site area. The lower part of the Tununk Member consists of calcareous, medium- to dark-gray shale and silty shale that weathers to yellowish brown or olive gray. The lower 20 ft (6 m) contains a zone of abundant oysters (*Pycnodonte newberryi*) (Willis 1994). Bentonite beds up to a few inches thick that have altered to montmorillonite (swelling) clay are common in the lowermost shales.

An in-place exposure of lowermost Mancos Shale was found in only one area along the escarpment south of the site area. This exposure (Plate 1) is just east of the slide area in the upper part of the escarpment slope immediately below the Quaternary terrace material. Here erosional "pillars" of olive-gray, calcareous, gypsiferous shale and silty shale are present starting about 25 ft (8 m) above the level of the Colorado River and extending up about 20 ft (6 m) to the contact of the Quaternary terrace material. Just south of the pedestrian bridge on the south bank, a thin, calcareous, fine-grained sandstone bed may also mark the lowermost Mancos.

An outcrop of Mancos Shale along the south bank of the Colorado River just northwest of the lower Mancos "pillars" was reported in the 1996 SOWP (DOE 1996d). This outcrop of dark-gray shale contained some *Pycnodonte newberryi*, a bentonite bed several inches thick, and was calcareous, placing it in the lowermost part of the Mancos. However, outcrops of carbonaceous, noncalcareous siltstone along the river just to the west and the presence of slump blocks in the slide area just to the south indicate that this Mancos outcrop is probably part of the slide area and not in place.

Organic-rich dark marine shales are known to carry anomalously high concentrations of a number of cations including uranium. Levinson (1980) described black marine shales that had uranium concentrations ranging from 3 to 1250 mg/kg, and a specific example, the marine Chattanooga Shale of Tennessee, has large areas that average 57 mg/kg uranium (Mickle and Mathews 1978). Butler and others (1994) analyzed six samples of Mancos Shale from the Grand Valley in which uranium concentrations ranged from 3.7 to 11.2 mg/kg and averaged 6.2 mg/kg. The crustal abundance of uranium averages 1.8 mg/kg (Mason and Moore 1996), and the average concentration in all shales is 4 mg/kg (Levinson 1980). Ground water passing through the Mancos Shale and over the interface between saturated Mancos Shale and the alluvial aquifer could leach uranium from this formation.

Selenium is known to be concentrated especially in Cretaceous marine shales found in many western states (Larkin and Byers 1941). The U.S. Geological Survey has been studying selenium origins and contamination because high selenium concentrations are present in the Imperial Valley of California and other locations downstream in the Colorado River drainage. High selenium values are not indigenous to those locations, and the problem is thought to result from upstream irrigation. Selenium leached from soil by irrigation water is eventually carried into the Colorado River. Therefore, the Colorado River is receiving selenium from various lithologies in its drainage system. The Grand Valley has been classified by the U.S. Geological Survey as having irrigation-induced selenium contamination because 25 percent of the surface water samples contain levels of selenium equal to or greater than 0.005 mg/L (USGS 1997). This situation is caused by high evaporation rates and high concentrations of naturally occurring selenium in the Mancos Shale.

5.1.2.3 Dakota Sandstone

Lohman (1965) and Young (1959) determined that the Dakota Sandstone was about 150 ft (46 m) thick in the Grand Junction area. However, field investigations suggest that it may be up to 200 ft thick in the immediate area of the site. In the project area, the Dakota consists of approximately one-third sandstone and two-thirds shale and siltstone. Unconformably underlying the Dakota are fluvial-lacustrine sandstones and siltstones of the Burro Canyon Formation of Early Cretaceous age. The Dakota, which represents the last terrestrial deposition before transgression of the Mancos sea, in this area has been subdivided into three informal members on the basis of lithology (Young 1959; Willis 1994). The lower member is resistant and consists mainly of crossbedded sandstone and conglomeratic sandstone. The middle member is nonresistant and consists of interbedded carbonaceous shale and sandstone, mudstone, impure coal, and bentonitic clay. The upper member is resistant and consists of fine-grained sandstone.

The lower sandstone member is exposed in the escarpment on the south side of the Colorado River west of the site and is present in the subsurface west of the site. Several sandstone beds, each several feet thick, crop out as ledges at the south end of the railroad bridge that crosses the Colorado River. The south bridge abutment rests on one of these sandstone layers. These sandstone beds occur along the south bank of the Colorado River eastward for about 500 ft (150 m) east of the U.S. Highway 50 bridge. The middle shale member is present in the escarpment along the south side of the Colorado River directly south of the site and was described in cores and cuttings from boreholes and augured boreholes on the site as well as north and east of the site. The upper sandstone member was not observed in the area of the site.

The middle shaley member of the Dakota is exposed above the lower member sandstones in many places along the escarpment from the railroad bridge eastward to the new pedestrian bridge and farther east. Carbonaceous shale and thin, carbonaceous, fine-grained sandstone along with mudstone are the most common rock types exposed along the escarpment. Thin (less than 2 ft [0.6 m] thick) beds of impure coal (with a lignitic appearance) occur in this member. Remains of old underground coal workings are present just west of the south end of the U.S. Highway 50 bridge (Lohman 1965).

The middle Dakota was deposited in paludal or deltaic marginal marine environments and appears similar to Mancos Shale when viewed in isolated outcrops. Characteristics of the Dakota that distinguish it from the Mancos are discussed in Section 4.1 and include carbonaceous material and impure coal, common sandy/silty grain size, noncalcareous matrix, presence of pyrite, bioturbated bedding, and bentonitic clay in which the volcanic ash has altered to kaolinite (nonswelling clay).

Sandstone of the upper member is rarely exposed along the escarpment; this member may be only a few feet thick or absent in places. Several sandstone slabs less than 1 ft (0.3 m) thick, possibly representing an offshore beach environment, occur in the upper part of the slide area (Plate 1). Also, a thin, calcareous, fine-grained sandstone bed occurs near the top of the escarpment just south of the pedestrian bridge, possibly marking the top of the Dakota or base of the Mancos.

Exposed members of the Dakota along the escarpment south of the Colorado River and their projected dip at 2 to 3 degrees northeastward beneath the site indicate that Dakota Sandstone, rather than Mancos Shale as stated in the original SOWP (DOE 1996d), is the first bedrock formation present beneath the site area. The estimated trace of the subcrop is shown in Plate 1. The cross section in Figure 4–1 shows the geologic relationships in boreholes in the area just west of the site. Recognition criteria for Dakota Sandstone (described in Section 4.1.2) were applied to core from five boreholes near the site on the north side of the Colorado River. All the core had characteristics of Dakota Sandstone; the deepest parts of holes 724 and 725 may have penetrated a coarser upper part of the underlying Burro Canyon Formation.

5.1.3 Bedrock Topography and Geomorphology

Figure 4–2 shows the top of the Dakota, the bedrock that underlies the entire site, based on old and new monitoring well data. Under the site, the top of the Dakota is higher in the east and drops off 6 feet to the south and to the west. West of the site the Dakota drops off more steeply to the south along the edge of the Colorado River channel and toward the confluence of the Gunnison and Colorado Rivers. The pre-1947 aerial photograph (Figure 3–1) shows an obvious channel crossing the site from the east, dog-legging to the south, and extending to the west. This photograph was enlarged and superimposed on Figure 4–2 to test for any correlation. None was found and it is assumed that channels were not cut deeply enough or extensively enough into the Dakota to be manifested in the well log information.

5.2 Hydrology

The three main hydrogeologic units beneath the Grand Junction site include the unconfined alluvial aquifer, the underlying aquitard composed primarily of shale units in the Cretaceous Dakota Sandstone, and the confined aquifer in sandstones of the Dakota Sandstone. Geologic descriptions of these units are provided in Section 5.1.2. The alluvial aquifer is considered the uppermost aquifer at the Grand Junction the site. Surface components of the hydrologic system in the area of the site include the Colorado River and irrigation canals and ditches north of the site.

5.2.1 Alluvial Aquifer

The alluvial aquifer is the uppermost hydrogeologic unit beneath the Grand Junction site and is composed of unconsolidated clays, silts, sands, gravels, and cobbles. The informal name "cobble aquifer" is commonly used in Grand Valley hydrologic literature (U.S. Bureau of Reclamation 1986). The cobble aquifer underlies most of Grand Junction and covers the Dakota Sandstone and Mancos Shale in a 1.5- to 3-mile-wide (0.9- 1.8-km) strip between Loma and Palisade (Figure 3–1 and Plate 2). Most of the cobble aquifer extends north of the Colorado River, although some parts occur to the south. The name "cobble aquifer" may be misleading, because the composition can range from 90 percent gravel, 9 percent sand, and 1 percent fines, to 1 percent gravel, 90 percent sand, and 9 percent fines (U.S. Bureau of Reclamation 1986). In many places in the valley, the cobble aquifer is overlain by a silty-clay unit. The base of this unit consists of discontinuous lenses of clay. Where intact, the clay layer confines the cobble aquifer. Together, the cobble aquifer and overlying silty clay lenses are called the alluvial aquifer. The alluvial sediments above the clay are variable, and range from sand to silt or clay. Typically, the uppermost layers have low hydraulic conductivity.

Ground water is present under unconfined conditions in the alluvial aquifer beneath the Grand Junction site. Depth to ground water ranges from zero near the river to approximately 20 ft (6 m) at the northern end of the site. The saturated thickness of the aquifer ranges from 10 to 20 ft (3 - 6 m). Ground water generally flows to the southwest toward the Colorado River at a hydraulic gradient of approximately 0.004 (Figure 5–1).

The alluvial aquifer is recharged by infiltration of precipitation directly on the site, leakage from upgradient irrigation canals and ditches in the area (passing through Mancos Shale), and infiltration of river water during spring runoff in the Colorado River. During periods of high water in the Colorado River, recharge enters the alluvial aquifer from the river along its southern boundary, flattening hydraulic gradients and creating a more westerly ground water flow orientation. Seasonal fluctuations in water levels beneath the site range from 2 to 5 ft (0.6 - 1.5 m) in response to changes in river stage. Limited amounts of recharge also occur as upward leakage of ground water from the underlying Dakota Sandstone aquifer. Ground water discharge is primarily limited to drainage into the river during low stage. Some discharge also occurs as evapotranspiration from vegetation growing in areas of shallow ground water depth near the Colorado River.

Ground water levels were measured with dataloggers in several monitor wells, including wells 0743, 0744, 0746, 1001, 1002, 1013, 1017, and 1022 (Figure 4–4). Results were used to observe variations in ground water levels through time and to correlate these with water level fluctuations in the Colorado River. During the period of observation, ground water levels fluctuated several feet in response to infiltration of precipitation and interaction with surface water.

Data collected from aquifer pumping tests in alluvial aquifer wells in the west (0590), central (1034/1035), and east (1018) portions of the site indicate that transmissivity ranges from 161 to 2,434 ft^2/day (15 to 226 m^2/day). Hydraulic conductivity ranges from 18 to 304 ft/day (5.5 to

93 m/day) based on saturated thickness in the alluvial aquifer ranging from 6 to 9 ft (1.8 to 2.7 m) in the wells. The estimated hydraulic conductivity near monitor well 0590 is 70 ft/day. This well is near the river and is likely in hydraulic connection. A discharge rate of 30 gallons per minute (gpm) was maintained for a 12-hour period. Recovery was relatively slow, indicating lower hydraulic conductivity in the vicinity of the well, but the high sustained rate of discharge indicates connection to the river, which was the principle source of water pumped during the test. The estimated hydraulic conductivity near monitor well 1018 is 20 ft/day. A sustained rate of discharge of only 1 gpm was attainable during the 12-hour test. In the middle of the site, multi-well aquifer pumping tests were performed in monitor wells 1034 and 1035 (with drawdown response measured in three adjacent observation wells). Pumping rates of 4 gpm in well 1034 and 6 gpm in well 1035 were sustained during these tests. The average linear ground water velocity beneath the processing site is about 2.0 ft/day (0.6 m/day) based on an average estimated hydraulic conductivity of 100 ft/day (30 m/day), a hydraulic gradient of 0.004, and an effective porosity of 20 percent.

As expected, the values of hydraulic conductivity are variable across the site, even in the relative proximity of wells 1034 and 1035. Variation in these values is a result of several factors: (1) lateral and vertical lithologic changes typically found in an alluvial depositional environment, including the possible effect of old channels in the alluvium; (2) Colorado River as a boundary condition, particularly in the vicinity of well 0590 (about 60 ft [18 m] from the river); and (3) well construction and screen type may cause variable well efficiency and response to pumping stress (e.g., screen type in 1035 has greater area of exposure to the aquifer than in 1034). Because variables affect hydraulic parameter values in an aquifer system, the results are an approximation that provides a general idea of the characteristics of the alluvial aquifer.

5.2.2 Dakota Sandstone Aquitard

Underlying the alluvial aquifer is an aquitard composed of low-permeability shale units in the Dakota Sandstone. It was verified during site characterization that bedrock beneath the alluvium at the site generally consists of shales and siltstones of the Dakota Sandstone. The Mancos Shale was previously thought to underlie the alluvium at the site, but it appears to pinch out in the subcrop just east of the site (Plate 1). Lithologic data indicate that the contact between the alluvium and the shale dips westward at approximately 10 to 20 ft/mi (1.9 to 3.8 m/Km). A subtle bedrock high has tentatively been mapped near the eastern boundary of the site, and this local feature may contribute to the apparent increased westerly hydraulic gradient in the cobble aquifer in this area. The uppermost portions of the shale aquitard were logged during previous investigations as "highly weathered" and may behave as part of the cobble aquifer. Thickness of the shale aquitard in the Dakota may be as much as 50 ft; depths to the top of the aquitard range from less than 10 ft to more than 75 ft below the ground surface.

Although the shale unit is regarded as an aquitard, wells completed within the unit indicate that it is saturated with ground water. Horizontal hydraulic conductivity for the aquitard varies depending on the degree of weathering of the unit, but the lower end of the range for unweathered material may be as low as 0.02 ft/day. Vertical hydraulic conductivities are probably one to several orders of magnitude less than the horizontal values. Several wells were installed in the shale aquitard to form paired installations with wells in the cobble aquifer. Although these wells have since been decommissioned, previously collected data indicate that vertical hydraulic gradients are generally upward, with a few exceptions noted during high water levels in the cobble aquifer associated with high river stages (DOE 1996d).

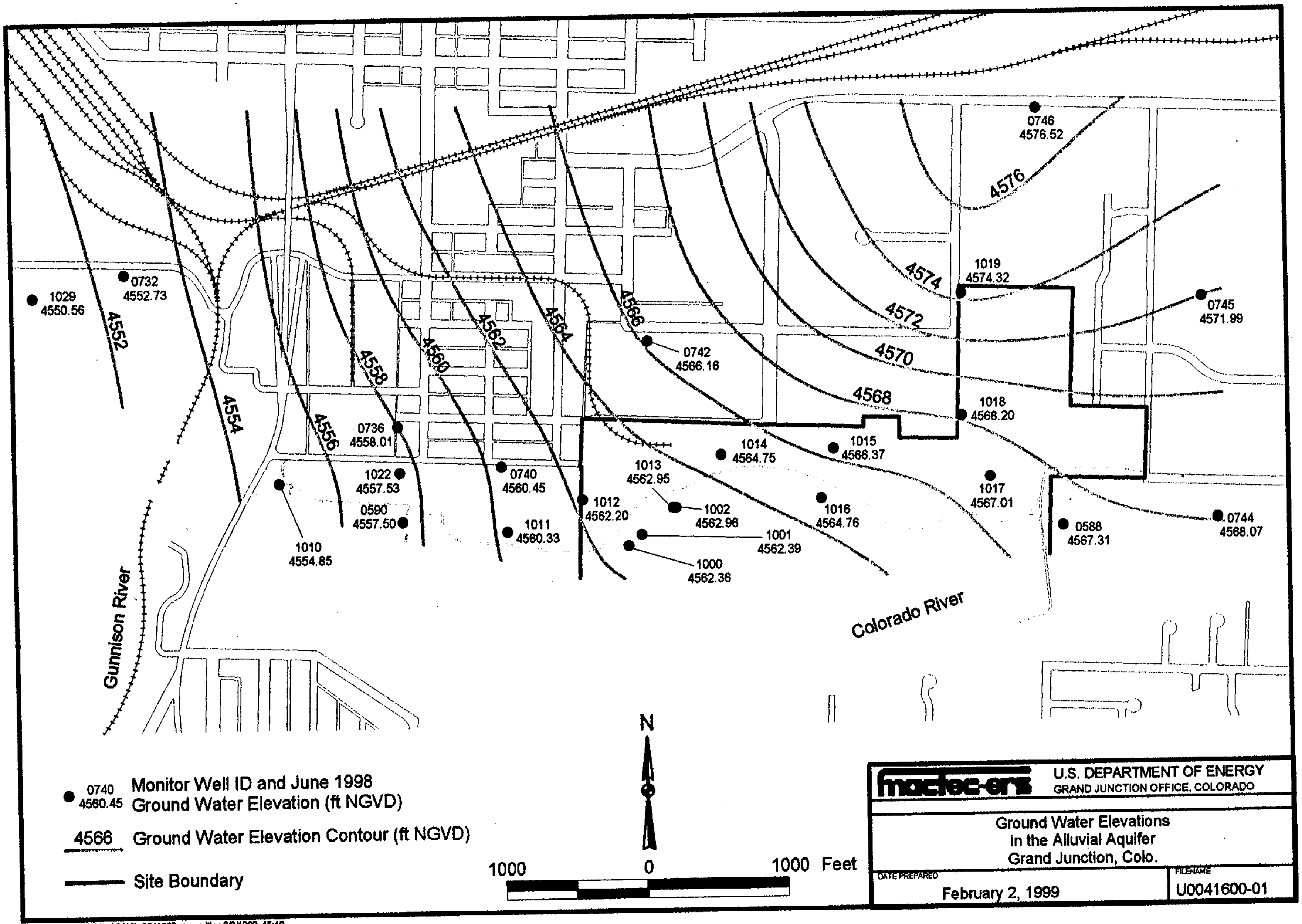

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Figure 5–1. Ground Water Elevation in the Alluvial Aquifer

5.2.3 Dakota Sandstone Aquifer

The confined aquifer in sandstones of the Dakota Sandstone underlies the shale aquitard (Lohman 1965). This aquifer was not extensively characterized during site investigations because the presence of the overlying aquitard and vertical upward hydraulic gradients minimize the potential for infiltration of contamination from the alluvial aquifer. This is confirmed by the lack of site-related COPCs detected in ground water in the Dakota aquifer. Recharge to the Dakota Sandstone occurs as infiltration of precipitation on outcrops to the south and west. Although not sufficiently mapped by on-site monitor wells, ground water flow direction in the Dakota beneath the site likely follows regional gradients, which vary between a northwest and a northeast orientation.

5.2.4 Surface Water Hydrology

The Colorado River is the dominant surface water feature in the vicinity of the Grand Junction site. The river forms the southern boundary of the site and flows from east to west. River stage fluctuates in response to snowmelt runoff, which typically occurs between April and July. Data collected during 1998 showed a 5-ft difference between high and low water levels during the period of measurement (Figure 4–3). These fluctuations cause the river to behave as the main point of ground water discharge from the alluvial aquifer during periods of low water and a source of recharge to the alluvial aquifer during periods of high water. During the high river stage, large portions of the site along the southern boundary are commonly flooded when the river crests its bank. Precipitation falling on the site drains to the south directly into the river and east into a surface drainage ditch that borders the eastern edge of the site (Plate 1).

In addition to the Colorado River, irrigation canals and ditches also influence ground water in the vicinity of the Grand Junction site. These unlined canals and ditches, which are used to irrigate (from April through November) and drain land in the site vicinity, have a seasonal influence on ground water levels and act as a local source of recharge to the alluvial aquifer.

5.2.5 Site Water Balance

The development of a site water balance is important to support numerical modeling at a site. Since this activity is not anticipated as part of the Grand Junction site characterization, the site water balance has not been evaluated in detail. The site water balance describes the various steady-state flow components that dictate the ground water flow in the vicinity of the site. Inflows to the system in the vicinity of the Grand Junction site include (1) ground water inflow from the east and north, (2) recharge from precipitation over the entire site, (3) recharge from the Colorado River during high-water stages, (4) recharge from irrigation canals and ditches during the period of operation, and (5) vertical ground water flow from the underlying Dakota Sandstone aquifer. Discharge from the flow system occurs as (1) evapotranspiration in vegetated areas of the site, (2) ground water discharge to the Colorado River, and (3) downgradient ground water discharge.

5.3 Geochemistry

5.3.1 Background Water Quality of the Alluvial Aquifer

Data from monitoring wells upgradient of the former millsite were evaluated to determine which wells were representative of background conditions. Statistical analyses were performed on 1998 analytical results of samples from the selected background wells to determine if the background population contained constituent concentrations that could be characterized as widespread ambient contamination. UMTRA ground water standards (40 CFR 192) and primary and secondary drinking water standards (40 CFR 141 and 143) were used as benchmarks for this determination.

Wells representative of background were selected for analysis. Locations were selected that were upgradient of the Grand Junction site and outside the potential influence of UMTRA vicinity properties. Initial candidates for background wells were wells 588, 713, 715, 744, 745, 746, 1020, 1021, 1023, 1024, 1025, and CW21 (see locations on Plate 2). Well 1024 was subsequently eliminated because of its location immediately downgradient from discharge ponds at the Clifton Water Treatment Plant. Discharge from the ponds could dilute natural constituent concentrations and the water would therefore not be representative of the alluvial aquifer. Well 746 was eliminated at the request of CDPHE because of its location in an area near a vicinity property.

Wells 588 and 744 were examined to determine if water quality in those wells was affected by recharge from the Colorado River and other surface water features near those locations. Well 588 is located directly downgradient of a pond containing a significant quantity of surface water. Well 744 is located next to a surface drainage that is expected to provide ground water recharge.

Major-ion chemistry for wells 588 and 744 was compared with data from two wells farther upgradient and away from the river—wells 745 and 746—along with surface water samples from location 424, collected from the river near well 588. Although constituent concentrations in well 746 may not be indicative of background water quality, major-ion chemistry should still be reflective of background ground water in the site vicinity. Processing at the site may have altered major-ion chemistry of on-site or downgradient ground water but not water upgradient of the site. Major-ion chemistry for wells 745 and 746 was distinct from that of the river water sample; water from wells 588 and 744 showed a composition between that of wells 745 and 746 and the river water sample but closer to the composition of the river water sample. This suggests a mixing relationship between ground and surface water, with surface water being dominant. If mixing occurs, these wells do not truly produce samples of the alluvial aquifer. Therefore, wells 588 and 744 were eliminated from the background data set as unrepresentative of the alluvial aquifer (for additional information see Appendix H).

The remainder of the background wells were retained (713, 715, 745, 1020, 1021, 1023, 1025, and CW21) and descriptive statistics were performed on the data for selected constituents. Results for uranium expressed as total uranium in milligrams per liter and as $^{234}U + ^{238}U$ in picocuries per liter (pCi/L) are presented in Tables 5–1 and 5–2, respectively. Results for selenium are presented in Table 5–3. The analysis in Tables 5–1 and 5–2 indicates that data for uranium fit both a normal and a lognormal distribution. The description of selenium data is not normal, but is bimodal in nature.

Background wells were also examined to determine concentrations of chloride, iron, manganese, and sulfate. Although no UMTRA ground water standards exist for these contaminants, secondary drinking water standards have been developed for them largely based on considerations of taste or odor. Data for all these contaminants are included in Table 5–4.

On the average, background concentrations of uranium and selenium in alluvial ground water in the Grand Valley exceed UMTRA ground water protection standards. The mean for uranium exceeds the standard established based on combined activities of U234 and U238 of 30 pCi/L as well as the standard based on mass of 0.044 mg/L total uranium (assuming secular equilibrium). Secondary drinking water standards are exceeded for chloride, iron, manganese, and sulfate. Non-site-related "contamination" is widespread across the area. These data support the conclusion that the background alluvial water can be considered limited use ground water as defined by the UMTRA regulations. Although some background samples had constituent concentrations below standards, particularly for selenium, the average (mean) concentrations probably more realistically approximate the concentrations that would be obtained over time from a well installed for domestic purposes into the alluvial aquifer.

As discussed in Section 4.3.3.1, major-ion composition in alluvial ground water is distinctly different from that of the Dakota Formation; this difference supports the conclusion that the two waters are not intermixing. Additionally, major-ion chemistry of contaminated on-site alluvial ground water is similar to that of the upgradient area, which suggests that the activities at the millsite has not significantly altered the major-ion composition of the aquifer.

5.3.2 Surface Water and Sediment Chemistry

The Climax millsite was located next to the Colorado River. The river received contaminated fluids and sediments from the millsite while the mill was operating from 1951 through 1970. The flux of contaminants to the surface environment decreased when the tailings piles were stabilized in 1971. Since the completion of the tailings removal in 1994, the flux of contaminants to the surface environment has nearly ceased. After 1994, only two pathways remained to contaminate the surface environment: (1) surface expression of contaminated ground water, and (2) continued erosion of residual contaminated soils. The UMTRA Surface Project used a radiometric standard, based on activity of ^{226}Ra, to guide the tailings removal. Although this was a reasonably effective practice, uranium and other contaminants that had separated from the ^{226}Ra by migrating into the subsurface could have been left in place. The results of subpile sampling (Section 4.3) indicate that a small amount of contamination remained after remediation.

The contaminated alluvial ground water system at the millsite discharges into the Colorado River. Sampling of the Colorado River (described in Section 4.3.3) indicated that the flux of contaminants is low enough, relative to the flux of river water, that it does not produce a detectable chemical signature in the river.

Table 5–1. Statistical Description of Background Uranium Concentrations in the Alluvial Aquifer (mg/L)

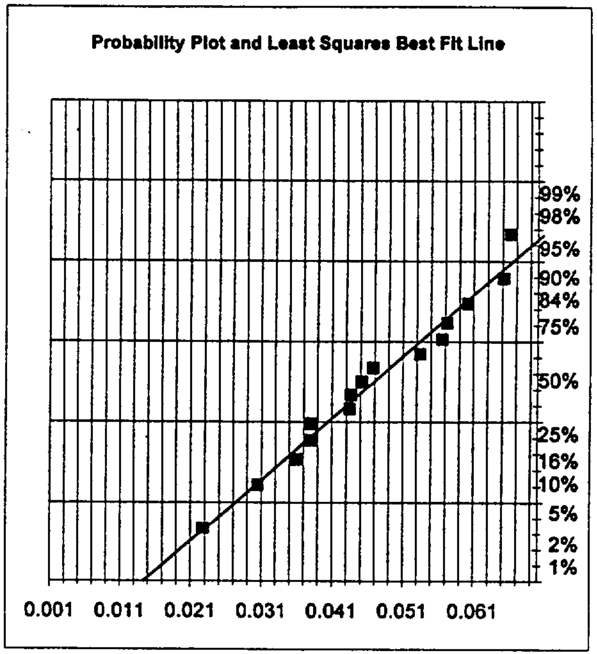
DATA EVALUATION STATISTICS

Data Description **Grand Junction Background Alluvial Ground Water**

Uranium

Action Level 0.044

Sample Data UNITS - mg/L			
		Descriptive Statistics	
0.0652		Number of Samples	15.000
0.0662		Mean	0.0469
0.0602		Median	0.0452
0.0535		Standard Deviation	0.0128
0.0381		CV	0.2721
0.038		Range	0.0434
		Minimum	0.0228
		Maximum	0.0662
0.0566		GM	0.0451
0.0573		GSD	1.3459
0.0305		Mean of LN(Data)	-3.0981
0.0228		SD of LN(Data)	0.2970
0.0468		Percent > Limit	53.3333
0.0452			
0.0435		**Normal Statistics**	
0.0437	n>30	Upper (95% CI mean) - Z	0.0534
0.036	n>30	Lower (95% CI mean) - Z	0.0404
		Upper (95% 1-tail CL mean) - Z	0.0523
		Upper (95%ile data) - Z	0.0679
	n<30	Upper (95% CI mean) - Norm t	0.0540
	n<30	Lower (95% CI mean) - Norm t	0.0398
		Upper (95% 1-tail CL mean) - Normal	0.0527
		UTL (min 95%, 95%) - K	0.0797
		UTL (avg 95%, 95%) - K	0.0701
		Percent > Limit	59.0086
		W Test (Data)	0.9690
		Normal (a=0.05)?	Yes
		Lognormal Statistics	
	n>30	Upper (95% CI mean) - Z	0.0548
	n>30	Lower (95% CI mean) - Z	0.0406
		Upper (95% 1-tail CL mean) - Z	0.0535
		Upper (95%ile data) - Z	0.0736
	n<30	Upper (95% CI mean) - LogNorm t	0.0556
	n<30	Lower (95% CI mean) - LogNorm t	0.0400
		Upper (95% 1-tail CL mean) - LogNorm	0.0540
		UTL (min 95%, 95%) - K	0.0967
		UTL (avg 95%, 95%) - K	0.0775
		Percent > Limit	53.4150
		W Test (Data)	0.9448
		Normal (a=0.05)?	Yes


Probability Plot and Least Squares Best Fit Line

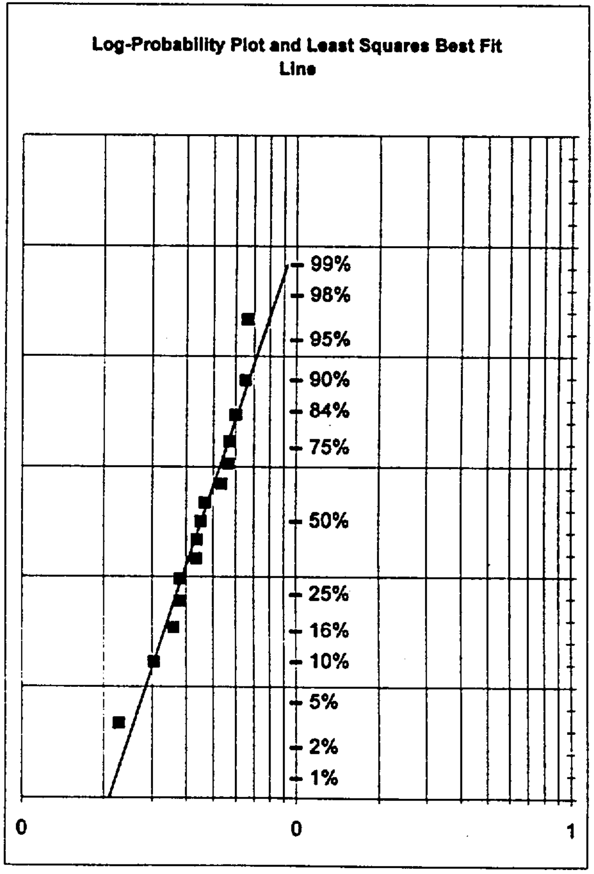

Log-Probability Plot and Least Squares Best Fit Line

Table 5–2. *Statistical Description of Background Uranium Concentrations in the Alluvial Aquifer (pCi/L)*

DATA EVALUATION STATISTICS
Grand Junction Background Alluvial Ground Water

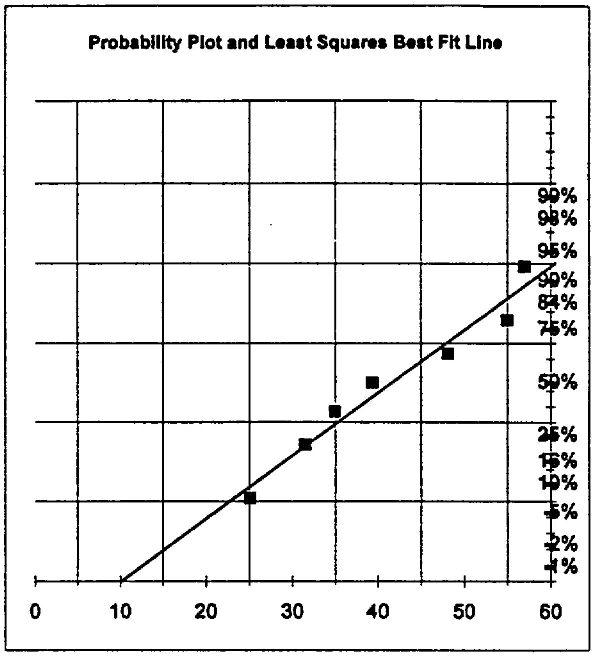
Data Description

U234+8
U238

Action Level	30

Sample Data
UNITS - pCi/L
57
55
31.5
48.1
25.1
39.4
35

	Descriptive Statistics	
	Number of Samples	7.000
	Mean	41.5857
	Median	39.4000
	Standard Deviation	12.1218
	CV	0.2915
	Range	31.9000
	Minimum	25.1000
	Maximum	57.0000
	GM	40.0199
	GSD	1.3548
	Mean of LN(Data)	3.6894
	SD of LN(Data)	0.3036
	Percent > Limit	85.7143
	Normal Statistics	
n>30	Upper (95% CI mean) - Z	50.5657
n>30	Lower (95% CI mean) - Z	32.6058
	Upper (95% 1-tail CL mean) - Z	49.1225
	Upper (95%ile data) - Z	61.5261
n<30	Upper (95% CI mean) - Norm t	52.7965
n<30	Lower (95% CI mean) - Norm t	30.3749
	Upper (95% 1-tail CL mean) - Normal	50.4886
	UTL (min 95%, 95%) - K	82.7877
	UTL (avg 95%, 95%) - K	66.7669
	Percent > Limit	83.0407
	W Test (Data)	0.9435
	Normal (a=0.05)?	Yes
	Lognormal Statistics	
n>30	Upper (95% CI mean) - Z	52.4786
n>30	Lower (95% CI mean) - Z	33.4663
	Upper (95% 1-tail CL mean) - Z	50.6153
	Upper (95%ile data) - Z	65.9468
n<30	Upper (95% CI mean) - LogNorm t	55.4945
n<30	Lower (95% CI mean) - LogNorm t	31.6476
	Upper (95% 1-tail CL mean) - LogNorm	52.3774
	UTL (min 95%, 95%) - K	112.3272
	UTL (avg 95%, 95%) - K	75.1978
	Percent > Limit	82.8718
	W Test (Data)	0.9494
	Normal (a=0.05)?	Yes



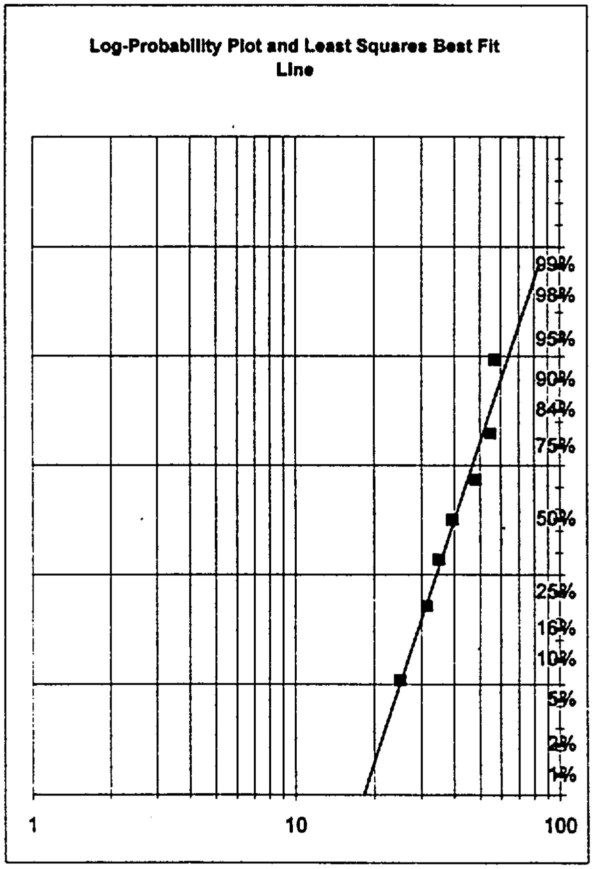


Table 5–3. Statistical Description of Background Selenium Concentrations in the Alluvial Aquifer

DATA EVALUATION STATISTICS
Grand Junction Background Alluvial Ground Water

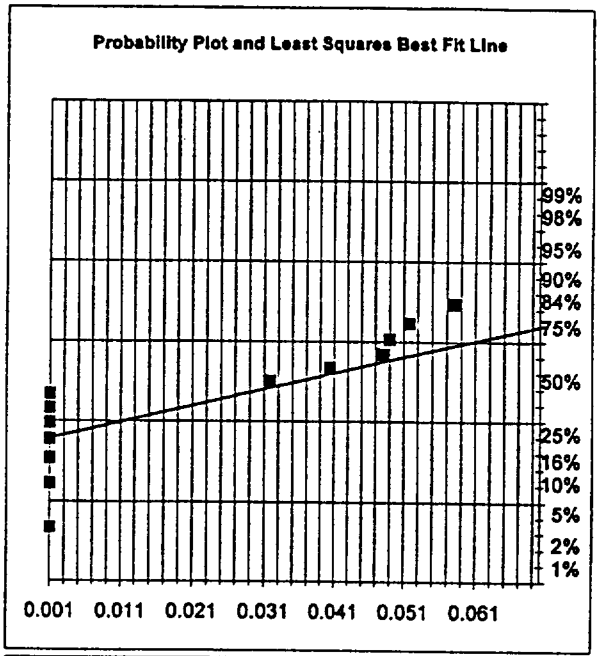
Data Description

Selenium

Action Level	0.010

Sample Data
UNITS - mg/L
0.048
0.049
0.0318
0.0404
0.001
0.001
0.001
0.001
0.001
0.001
0.137
0.116
0.0518
0.001
0.058

	Descriptive Statistics	
	Number of Samples	15.000
	Mean	0.0359
	Median	0.0318
	Standard Deviation	0.0433
	CV	1.2053
	Range	0.1360
	Minimum	0.0010
	Maximum	0.1370
	GM	0.0088
	GSD	8.4536
	Mean of LN(Data)	-4.7342
	SD of LN(Data)	2.1346
	Percent > Limit	53.3333
	Normal Statistics	
n>30	Upper (95% CI mean) - Z	0.0579
n>30	Lower (95% CI mean) - Z	0.0140
	Upper (95% 1-tail CL mean) - Z	0.0543
	Upper (95%ile data) - Z	0.1072
n<30	Upper (95% CI mean) - Norm t	0.0599
n<30	Lower (95% CI mean) - Norm t	0.0119
	Upper (95% 1-tail CL mean) - Normal	0.0556
	UTL (min 95%, 95%) - K	0.1471
	UTL (avg 95%, 95%) - K	0.1147
	Percent > Limit	72.5345
	W Test (Data)	0.7914
	Normal (a=0.05)?	No
	Lognormal Statistics	
n>30	Upper (95% CI mean) - Z	0.2527
n>30	Lower (95% CI mean) - Z	0.0291
	Upper (95% 1-tail CL mean) - Z	0.2124
	Upper (95%ile data) - Z	0.2944
n<30	Upper (95% CI mean) - LogNorm t	0.2797
n<30	Lower (95% CI mean) - LogNorm t	0.0263
	Upper (95% 1-tail CL mean) - LogNorm	0.2264
	UTL (min 95%, 95%) - K	2.1025
	UTL (avg 95%, 95%) - K	0.4269
	Percent > Limit	47.5892
	W Test (Data)	0.7436
	Normal (a=0.05)?	No


Probability Plot and Least Squares Best Fit Line

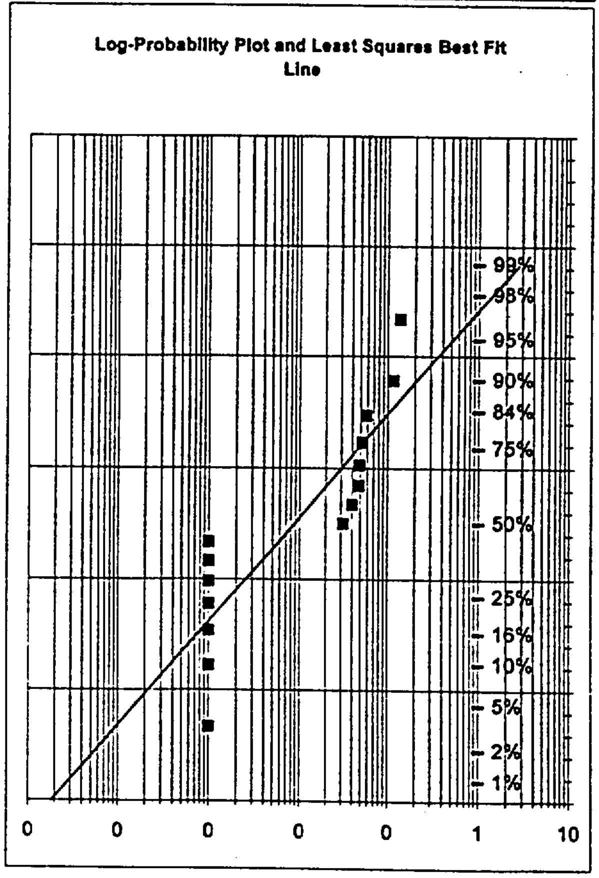

Log-Probability Plot and Least Squares Best Fit Line

Table 5–4. Mean Background Ground Water Concentrations of Selected Constituents

Contaminant	Mean (background)	SMCL
Chloride	437	250
Iron	0.552	0.3
Manganese	1.4	0.05
Sulfate	2,566	250
TDS	5,238	500

SMCL = Secondary Maximum Contaminant Level

Water enters the ponds as surface runoff, ground water, and/or irrigation water. If the pond has continuous flow, the water maintains a composition similar to the inflow composition. If the pond is closed, the concentration of all dissolved constituents will increase as water evaporates. As dissolved constituents increase in concentration, minerals may precipitate. Calcite and gypsum are close to saturation concentrations in the ground water and will preciptitate relatively early as the water evaporates. Some contaminants preferentially partition to these phases. If the ponds subsequently become diluted, these phases will redissolve, and any coprecipitated contaminants will be released back to the water. Dilution will only occur during storm events or during high river levels. Dissolved iron is also likely to precipitate as ferric oxyhydroxides due to the oxidizing environment in some of the ponds. Ferric oxyhydroxides are strong scavengers of uranium and metals.

Contaminated alluvial ground water may discharge into surface ponds before entering the river. A low scarp has begun to form on the south side of the millsite where it intersects the Colorado River channel. The scarp appears approximately where Watson Island begins on the east and extends westward nearly to the end of the millsite. In places this scarp is 2 to 4 feet high. The same floodwaters that formed the scarp left narrow linear depressions that support a few small ponds on the south side of this scarp. Some of these ponds are ephemeral, but some maintain surface water year round. During the ecological sampling, which occurred during low water, sample 1228 was collected from the largest of these linear ponds. The pond is about 50 ft (15 m) long, 3 to 9 ft (1 to 3 m) wide, and is probably fed by ground water that surfaces along the scarp forming its northern side. This pond may be the last remnant of the westernmost of the original 8 ponds developed as a wetlands area during final surface remedial action construction. These ponds were essentially removed during spring flooding in 1995 (see Section 3.3.2). Analysis of this pond water sample showed that concentrations of fluoride, manganese, iron, molybdenum, ammonia, sulfate, strontium, uranium, and vanadium were unusually high in this pond compared to other surface samples in the study (Appendix I). These elevated concentrations may be attributed to evaporation because water from a nearby monitoring well (well 1000 is about 200 ft [61 m] northeast) has lower concentrations of fluoride, molybdenum, ammonia, sulfate, uranium, and vanadium. These small ponds will continue to migrate or change locations as spring floodwaters infill and scour this scarp area along the southern millsite boundary. Several ponds were recently constructed downgradient of the millsite to irrigate the botanical gardens. These ponds are lined, which prevents hydraulic communication with the alluvial aquifer. However, unlined ponds could be constructed in the future.

The flux of contamination to the ponds should be higher at present than in the future because the tailings have been removed. Thus, the average concentration of contaminants in the ponds should currently be at a maximum.

Subaqueous sediment may contain contamination from three sources: (1) uptake from contaminated water in contact with it, (2) residual contamination (e.g., tailings) that was incorporated during milling, and (3) recently deposited contaminated sediments eroded from the millsite. Periodic flushing of the ephemeral ponds and the Colorado River will remove any contaminants present in the sediments. Because the tailings have been removed, the surface environments are becoming cleaner over time; thus, the ephemeral ponds should be getting cleaner as well. There are currently no significant persistent (unlined) ponds on site or downgradient of the millsite except for the small linear ponds and the pond at American Auto Salvage. These sediments will become less contaminated as surface runoff water desorbs contaminants by percolating through and entering the river and as clean sediments enter the pond and dilute the contaminant concentrations.

5.3.3 Extent of Ground Water Contamination

5.3.3.1 Contaminant Sources

All major sources of contamination have been removed from the site to meet UMTRA surface cleanup standards; only subpile soils may present a continuing source of ground water contamination. Alluvial ground water from the site flows in a southwesterly to westerly direction (Figure 5–1). Therefore any contaminant plumes in the alluvial ground water should extend from the site in that direction.

5.3.3.2 Current/Temporal Distribution of Contaminants in Ground Water

Current Conditions

Figures 5–2 through 5–9 are “spot plots” of on-site and downgradient alluvial well locations, showing concentrations of selected contaminants historically associated with the site. The data are averages of the two 1998 sampling rounds. In most instances, contaminant concentrations detected in a given well did not vary significantly between the two sampling events. For contaminants with an MCL, the MCL value is used as a cutoff point between two concentration ranges. For contaminants that do not have an MCL, a risk-based concentration was used as a cutoff point (see Section 6.1 for further discussion of risk-based concentrations).

Most of the contaminant plots indicate that the maximum contaminant concentrations are in on-site wells. This generality holds true for molybdenum, manganese, uranium, arsenic, and vanadium, though background wells for some of these contaminants (e.g., uranium and molybdenum) have concentrations that are nearly as high as those in on-site wells. Plots for iron and sulfate are less definitive and no clear concentration trends are apparent. Each of these figures is discussed individually below.

Ammonia. The highest concentrations of ammonia (derived from ammonium analysis) were from on-site wells and were detected in two locations. Ammonia concentration was 83 mg/L in well 1017 in the eastern section and 189 mg/L in well 1018. These wells are in the area of former uranium mill evaporation ponds and also in the area of the former stockyards that were in use when the sugar beet mill was in operation. The other area with higher concentrations of ammonia is in the southwestern part of the site; a sample from well 1001 contained 182 mg/L. This well is

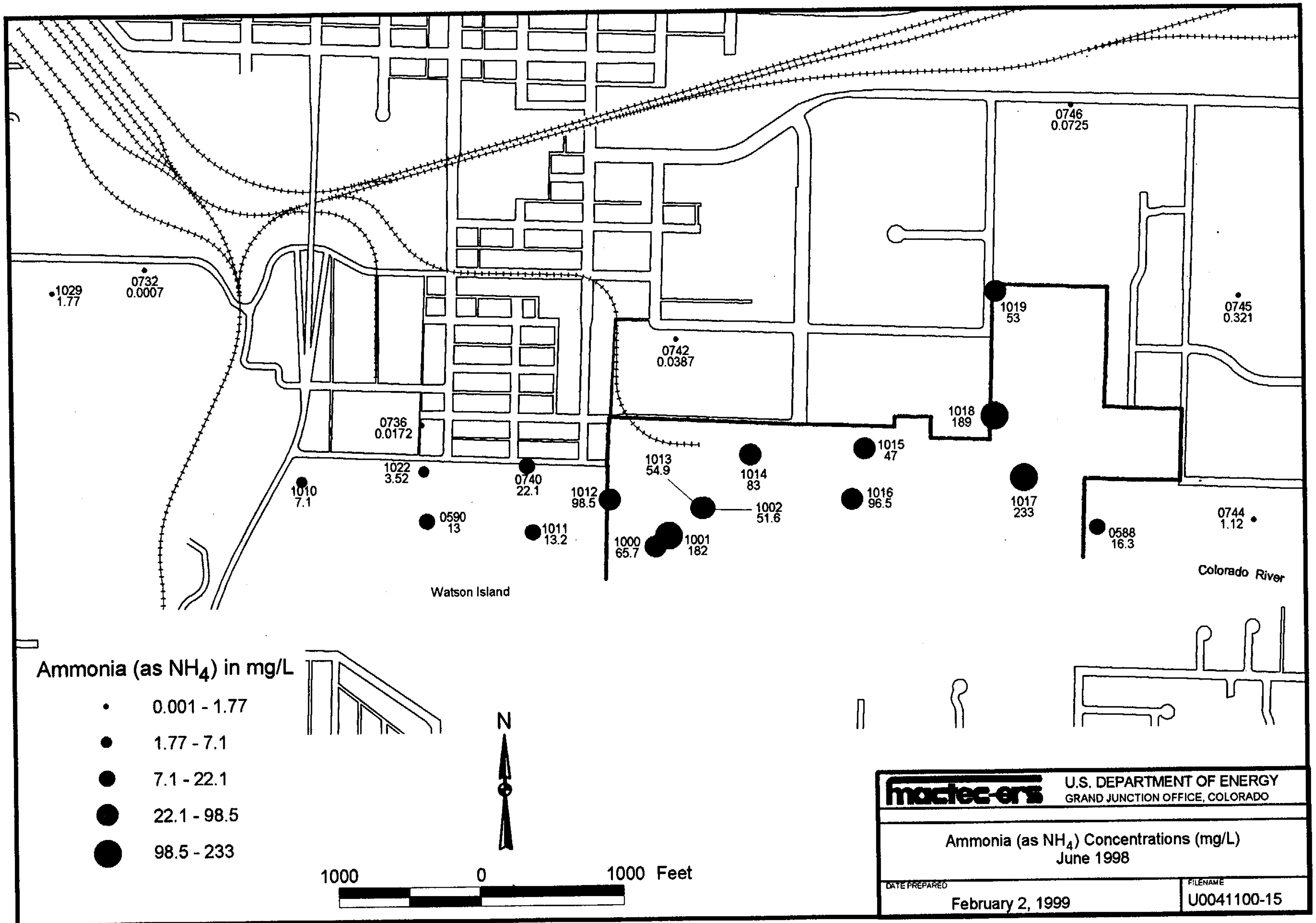


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Figure 5–2. Ammonia Concentrations in the Alluvial Aquifer

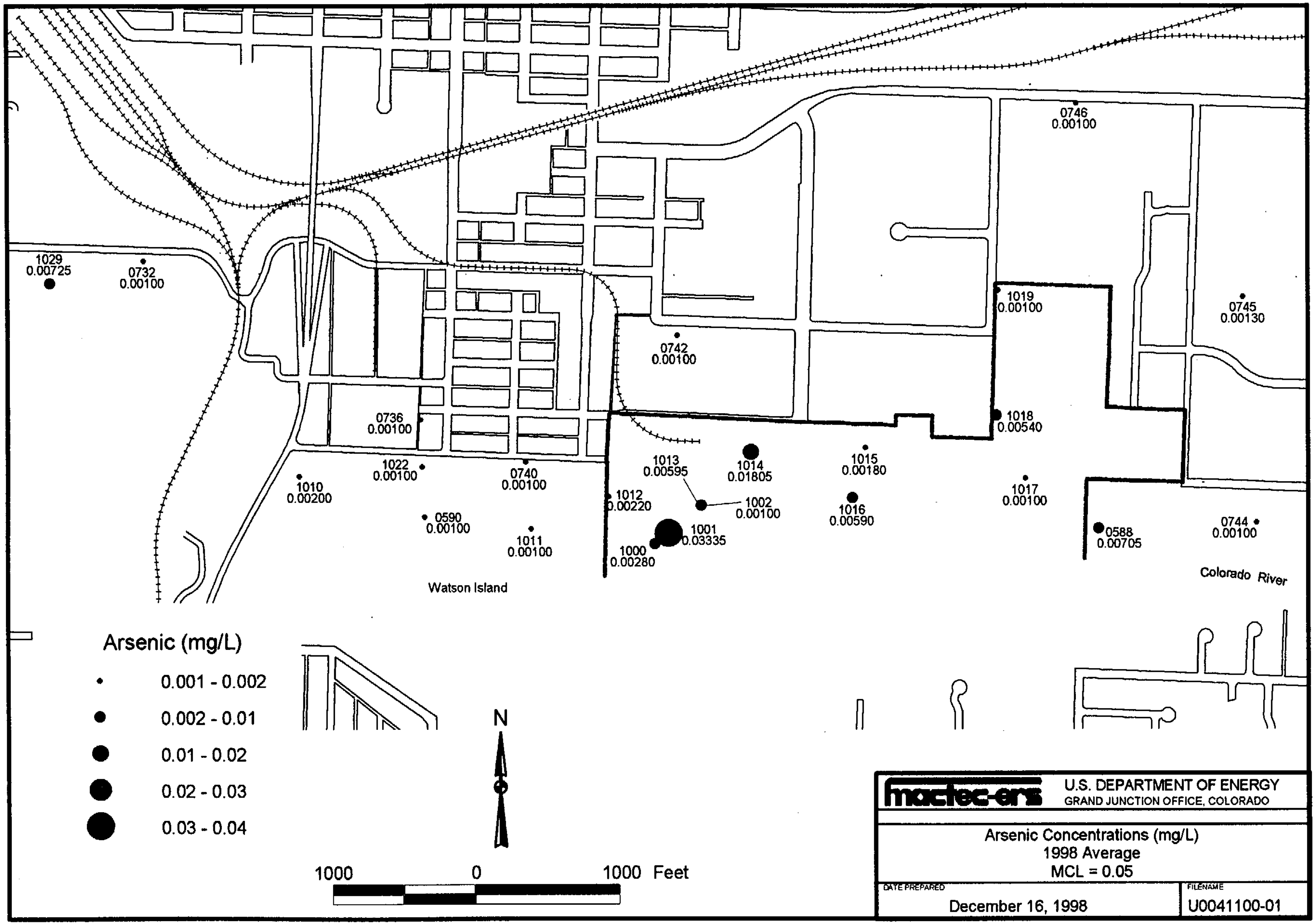

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Figure 5–3. Arsenic Concentrations in the Alluvial Aquifer

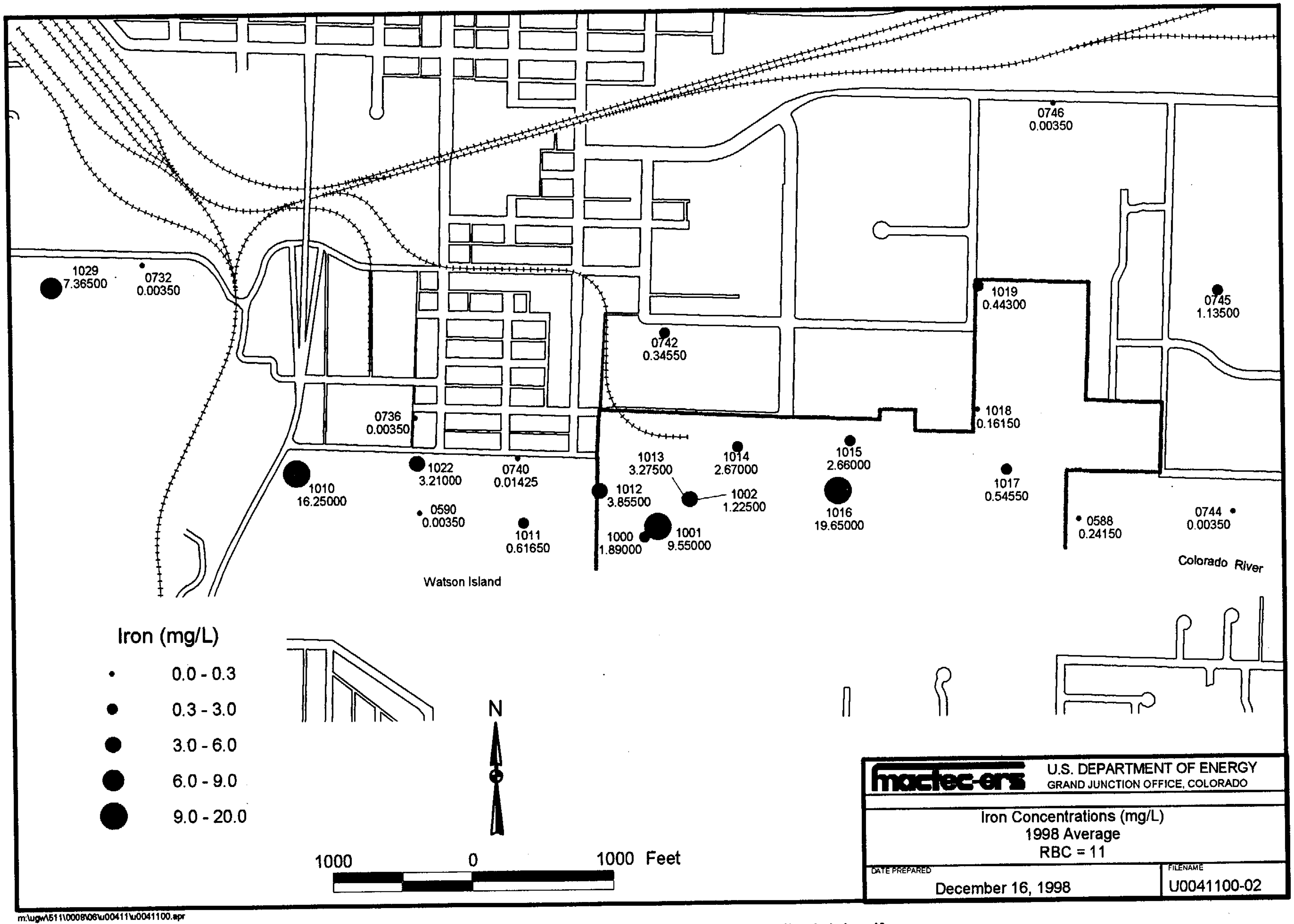

Figure 5–4. Iron Concentrations in the Alluvial Aquifer

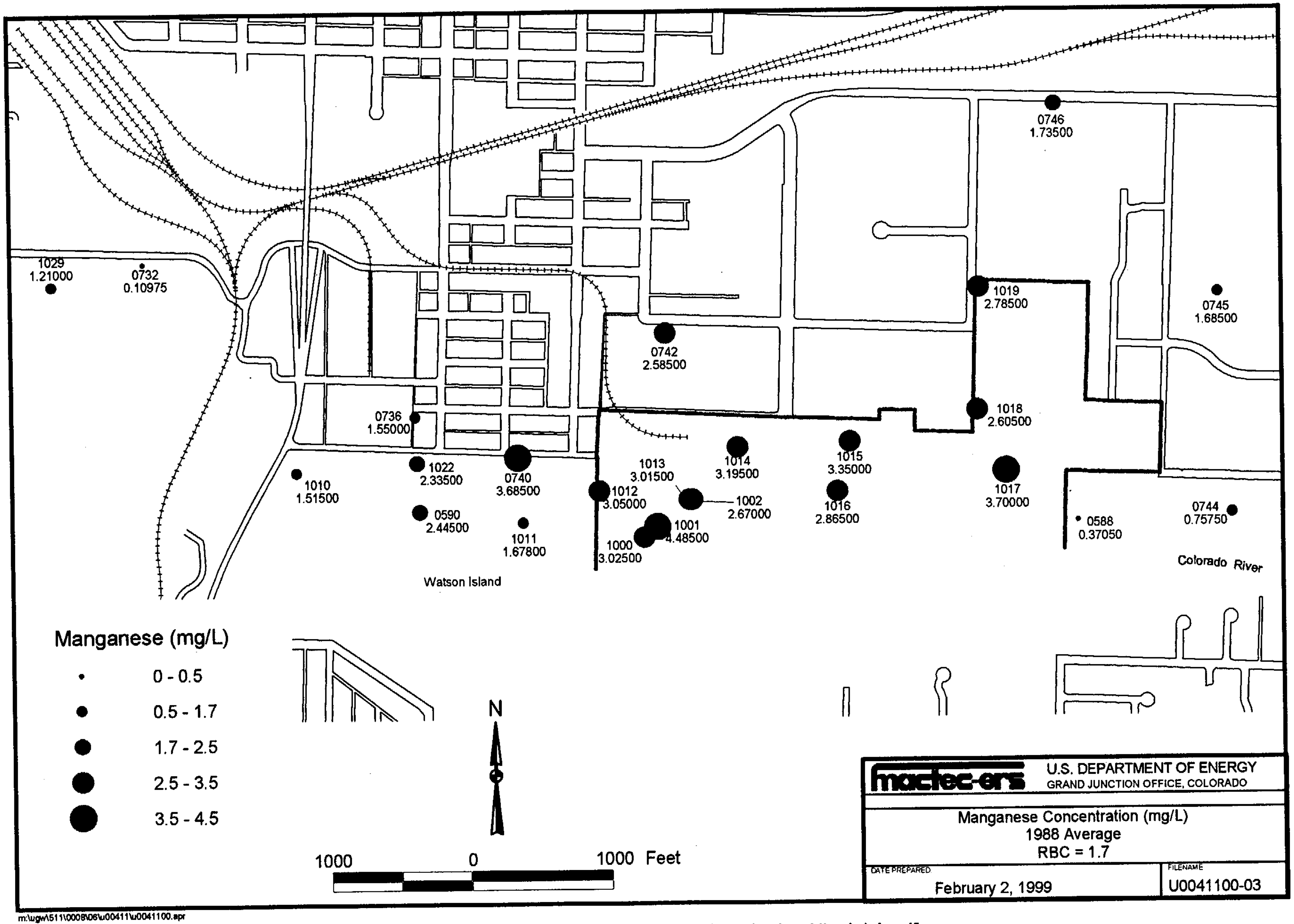

Figure 5–5. Manganese Concentrations in the Alluvial Aquifer

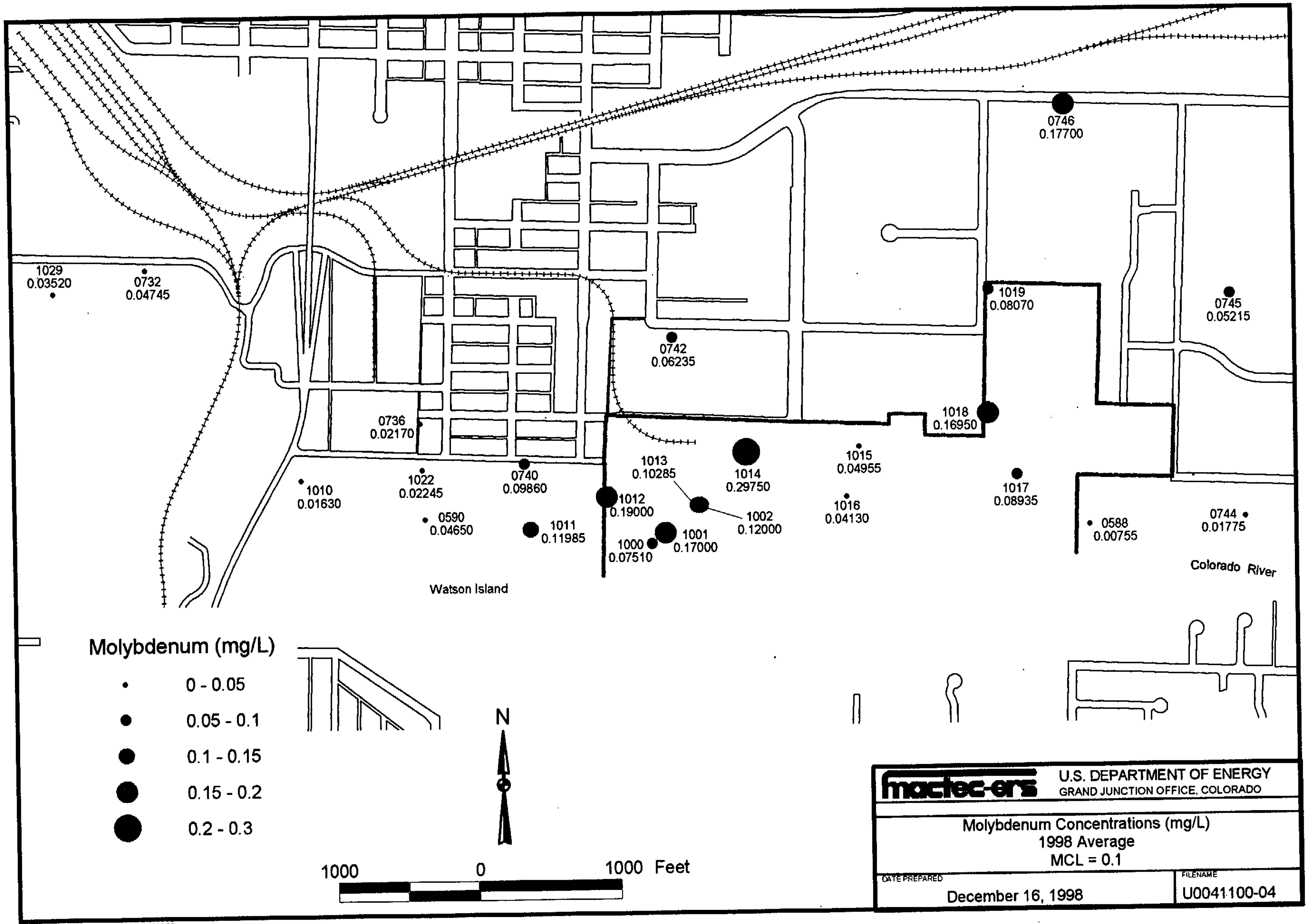

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Figure 5–6. Molybdenum Concentrations in the Alluvial Aquifer

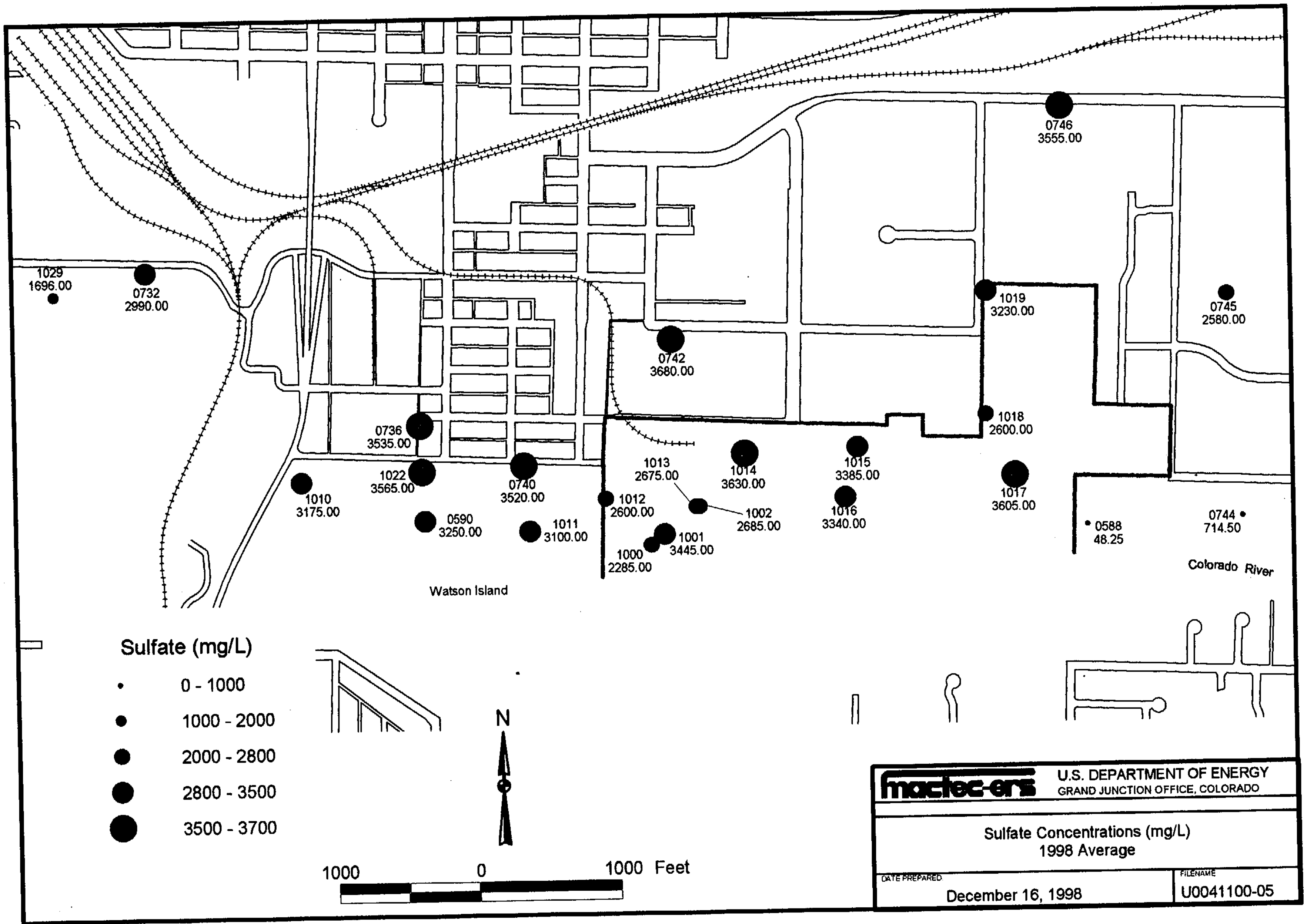

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Figure 5–7. Sulfate Concentrations in the Alluvial Aquifer

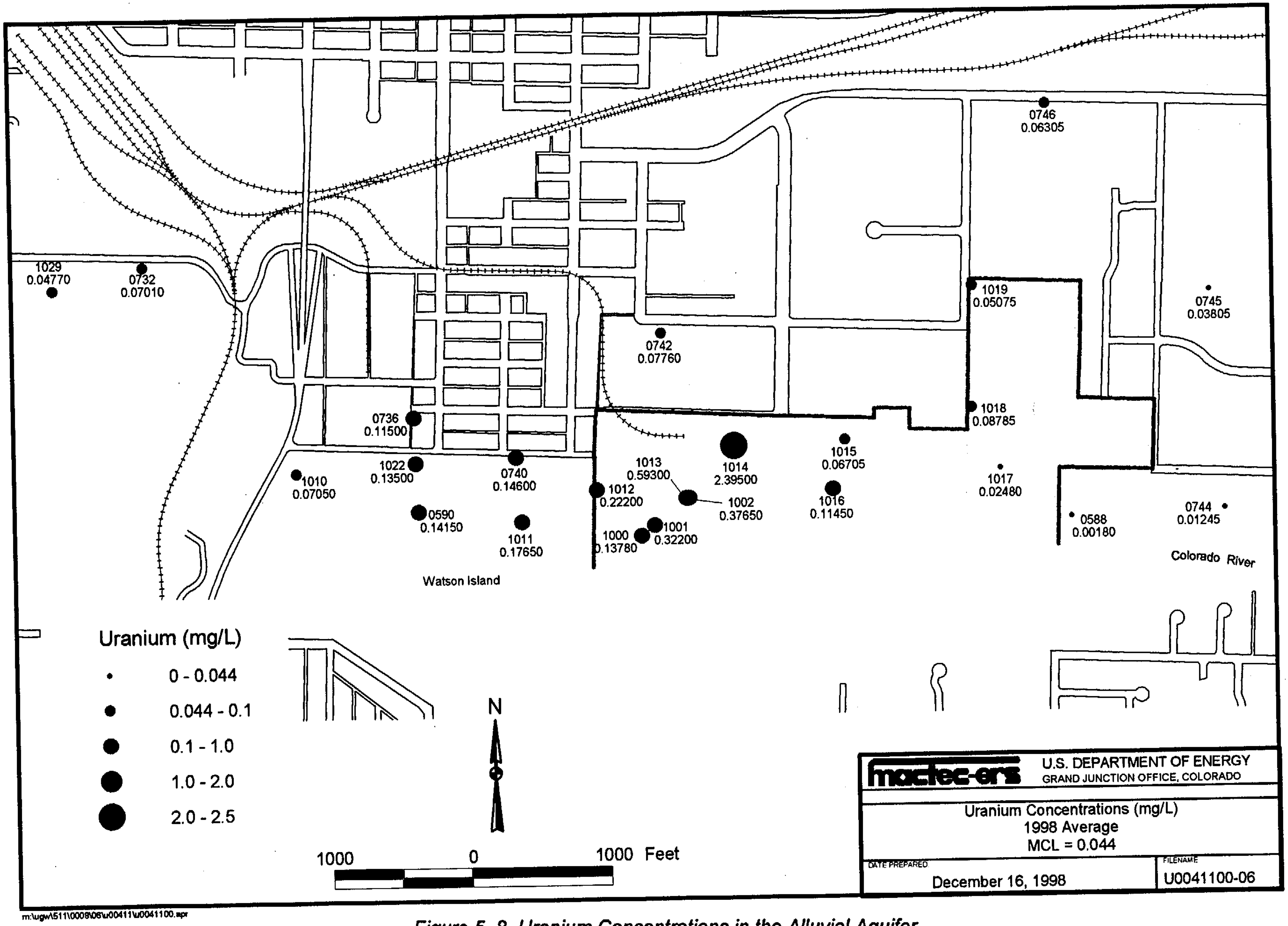

Figure 5–8. Uranium Concentrations in the Alluvial Aquifer

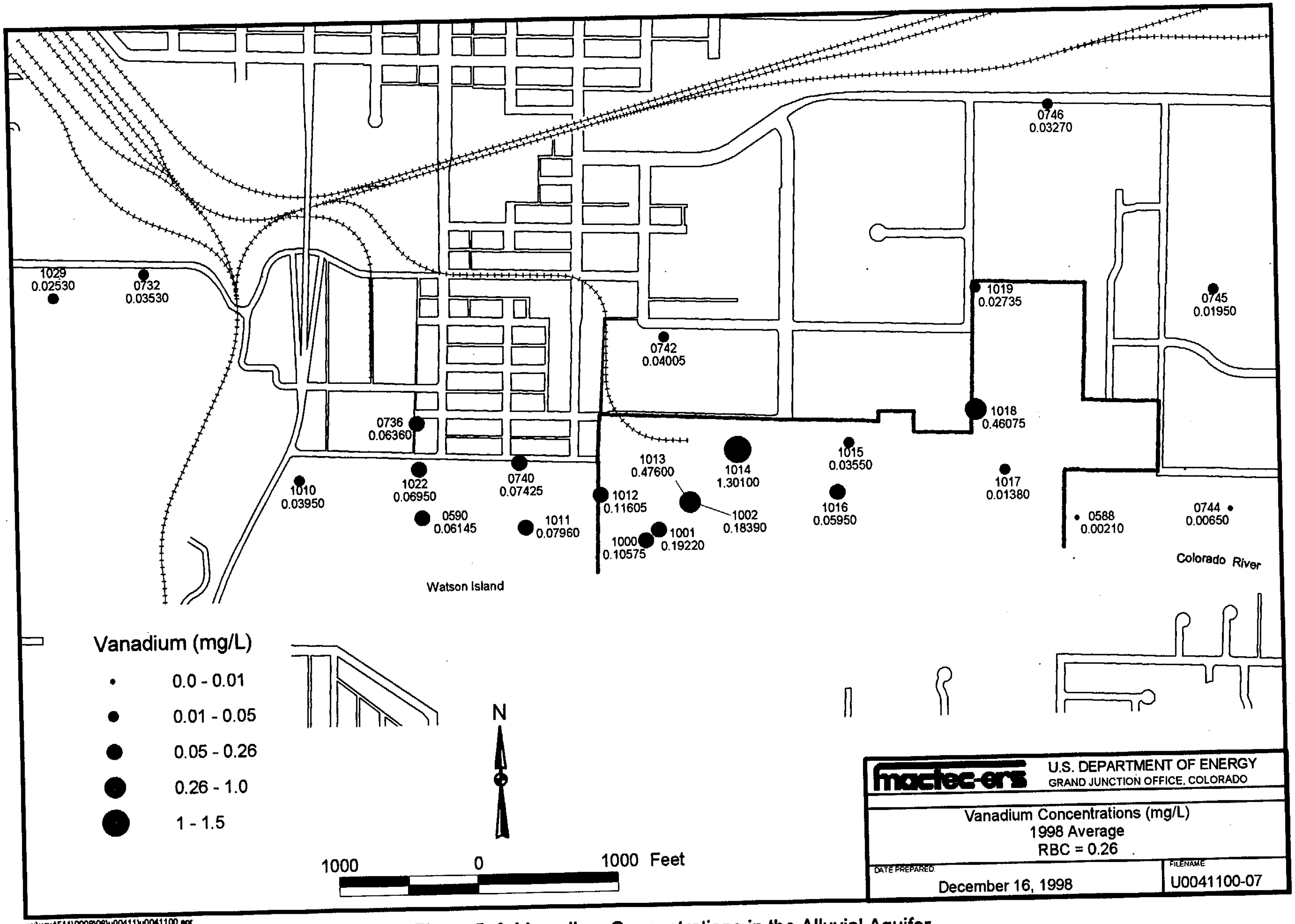

Figure 5–9. Vanadium Concentrations in the Alluvial Aquifer

probably downgradient from the millsite. Ammonia was used in the uranium milling process to neutralize acids used to leach ores in the early processing stage (Merritt 1971). Ammonia concentrations are elevated in downgradient wells to about 5th Street, then decrease to background (0.093 mg/L) beyond this point.

Arsenic. The highest concentrations of arsenic are in on-site wells, though all concentrations are below the MCL of 0.05 mg/L. Concentrations in nearly all the off-site wells, both upgradient and downgradient, are at or near the detection limit of 0.001 mg/L. The lack of significant off-site migration of the arsenic "plume" is consistent with the Kd calculated for arsenic (see Section 4.3.1), which indicated that arsenic should be relatively immobile.

Iron. In general, the most consistently high concentrations of iron are in on-site wells, and the spatial distribution of concentrations displays no well-defined pattern or trend. Downgradient well 1010 has one of the highest concentrations (16.2 mg/L) but is separated from the site by downgradient wells with very low iron concentrations.

Manganese. The most consistently high concentrations of manganese are in on-site wells and in wells directly downgradient of the site. Manganese concentrations generally decrease with distance from the site. However, it is difficult to actually define a "plume" that is attributable to site activities because of the relatively high concentrations of manganese in background wells (the average background concentration is 1.44 mg/L).

Molybdenum. The highest concentrations of molybdenum are from samples collected from on-site wells. A number of wells have concentrations exceeding the MCL of 0.1 mg/L. Off-site, molybdenum concentrations generally decrease, though two background wells have concentrations that exceed the MCL.

Sulfate. Sulfate concentrations show no well-defined pattern. Concentrations in on-site and off-site wells are generally high and exceed the secondary drinking water standard of 250 mg/L at all locations except in well 588.

Uranium. The highest concentrations of uranium are in on-site and downgradient wells. Concentrations in most of these wells exceed the MCL of 0.044 mg/L. Because of the high mobility of uranium predicted by measured Kds (see Section 4.3.1), it is reasonable to infer that wells immediately downgradient of the site are affected by site contamination. However, because of the high background concentrations of uranium (mean of 0.047 mg/L), it is difficult to accurately define the boundary of site-related contamination.

Vanadium. Highest vanadium concentrations are in the on-site wells, although these concentrations vary considerably. Vanadium concentrations generally decrease with distance downgradient. Significant differences in concentration (almost two orders of magnitude) exist between the most contaminated on-site wells and wells located off-site. Based on the high Kds calculated for vanadium, the relative immobility of vanadium is to be expected. Only on-site wells exceed risk-based concentrations for vanadium.

Historical Changes in Ground Water Chemistry

Figures 5–2 through 5–9 are updated plots of figures prepared for the characterization work plan for the site (DOE 1997), which were based on data collected from sampling events that took place from 1985 to 1996. Many of the highest contaminant concentrations, particularly for metals, were in some of the earliest samples collected and tended to be from one location (well 584). The 1998 sampling data indicates that many of these contaminant concentrations have decreased to levels below detection or are indistinguishable from background.

A comparison of average values and ranges of COPCs identified in the original SOWP (DOE 1996d) with averages and ranges of the same constituents detected in the 1998 sampling indicates that, qualitatively, nearly all COPCs have decreased in concentration. Only results for uranium and nitrate appear to be inconclusive. However, historical and 1998 data come from different wells, and historical data were collected over a number of years. Therefore, only a qualitative comparison of these data sets is made here.

Time-concentration plots for selected wells and contaminants are shown in Figures 5–10 through 5–15. Data from three sets of wells were examined in an attempt to discern any trends in concentration through time. Wells 590, 736, and 740 are generally downgradient of the site, and 742 is in a former ore-storage area; all have data going back to the early 1980s. These wells were selected to identify changes in the plume through time. Wells 745 and 746 have historically been regarded as upgradient wells and also have data collected as far back as the early 1980s. Wells 1000, 1001, and 1002 are on-site wells; these were installed following surface remediation and have data extending back to early 1995.

The older plume wells (Figures 5–10, 5–12a, 5–12b, 5–13, 5–14a, and 5–14b) do not show any clearly consistent upward or downward concentration trends through time. Concentrations show considerable fluctuation from 1990 through 1993, though inflection points for many wells appear to be coincident (though not consistently increasing or decreasing even for the same contaminant). These large fluctuations may be related to changing conditions associated with millsite surface remediation. Excavation of tailings piles and ponds, particularly in areas where the water table is shallow, would be expected to affect ground water chemistry.

A prominent inflection point in the 1992 time frame is present even for background wells. This suggests that changes in concentrations were related to an event more far-reaching than remediation activities.

Post-remediation on-site wells (Figures 5–11 and 5–15) indicate a generally decreasing trend for uranium and molybdenum (two contaminants that can be attributed to site activities). However, the limited range in concentration and the small number of data points available make this conclusion tentative.

Isotopic concentrations of ^{234}U and ^{238}U were measured for one round of samples from background and plume locations. Tables 5–5 and 5–6 show the results of background and plume analyses. Isotopic concentrations of combined ^{234}U and ^{238}U were converted to total uranium in milligrams per liter to compare with the 0.044 mg/L standard (which assumes secular equilibrium between the two isotopes). Ratios of ^{234}U: ^{238}U indicate that the two isotopes are not in equilibrium and that ^{234}U is the dominant radionuclide. No significant difference exists between the mean concentrations in plume and background wells, though the isotopic ratios for plume samples span a wider range. These data also indicate that a lower total elemental uranium standard would be applicable for the Grand Junction site than the 0.044 mg/L to adjust for disequilibrium conditions. An adjusted standard of approximately 0.037 or 0.038 mg/L would be

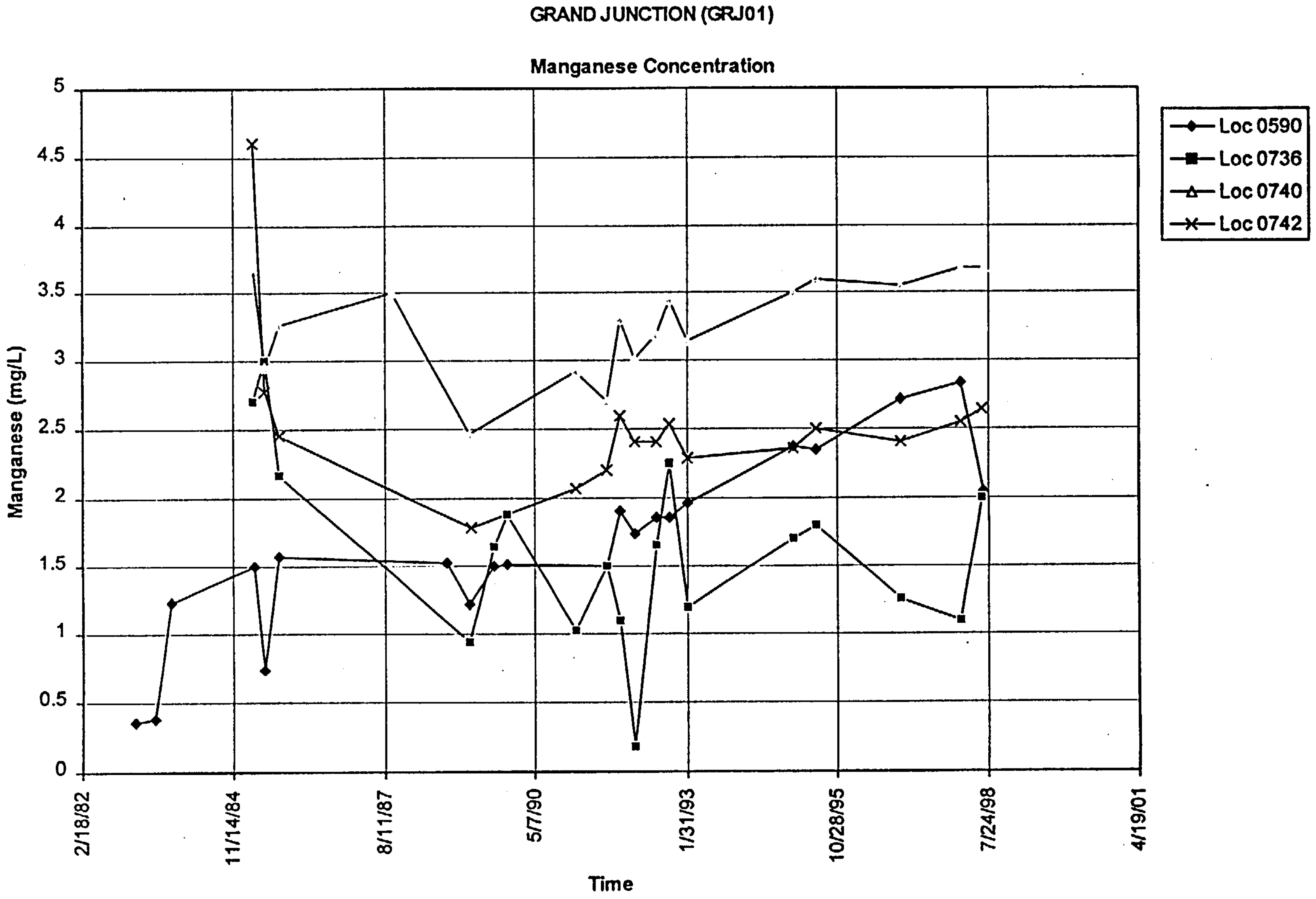

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Figure 5–10. Time Concentration Plot—Manganese in Old Wells

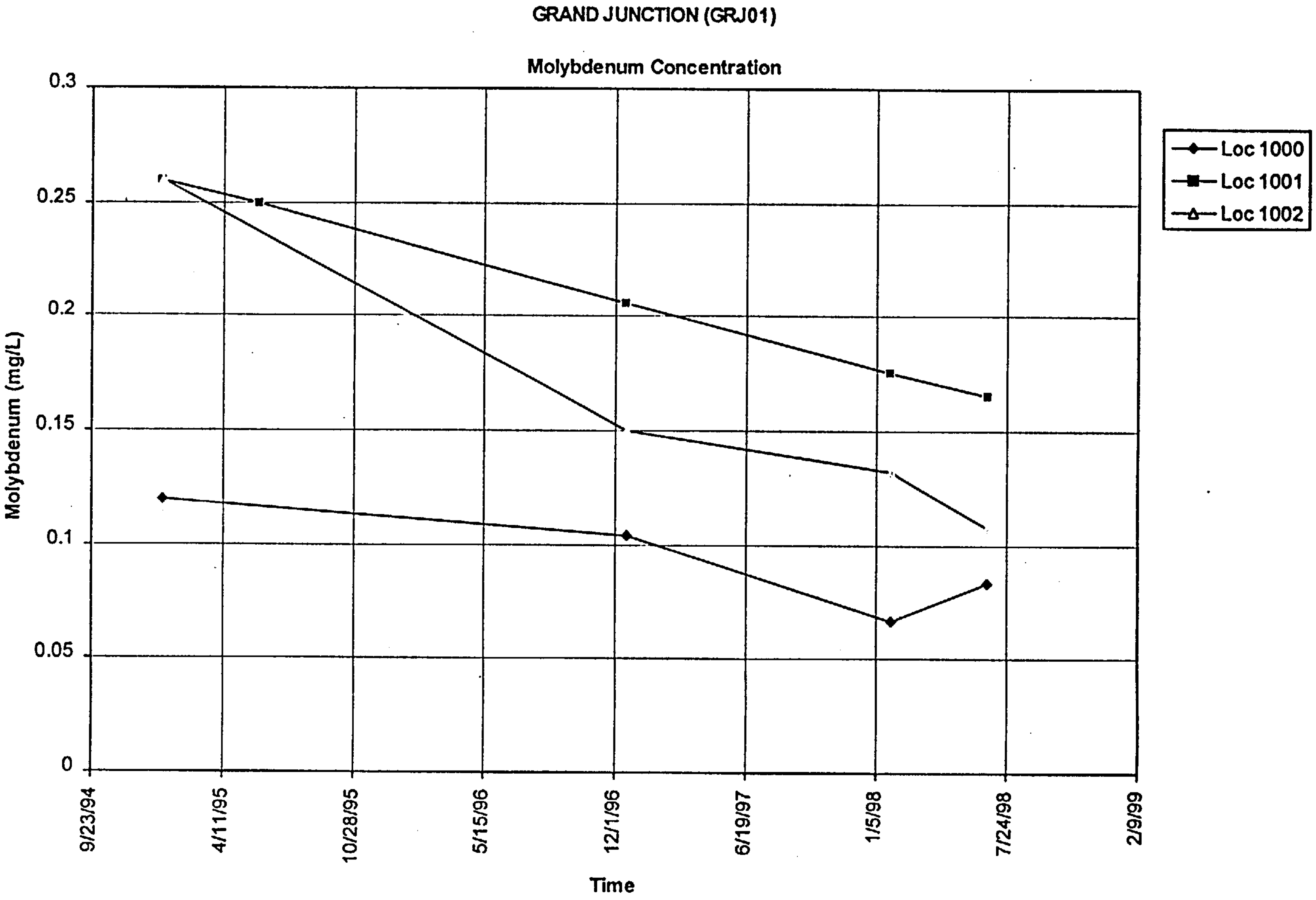

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Figure 5–11. Time Concentration Plot—Molybdenum in New Wells

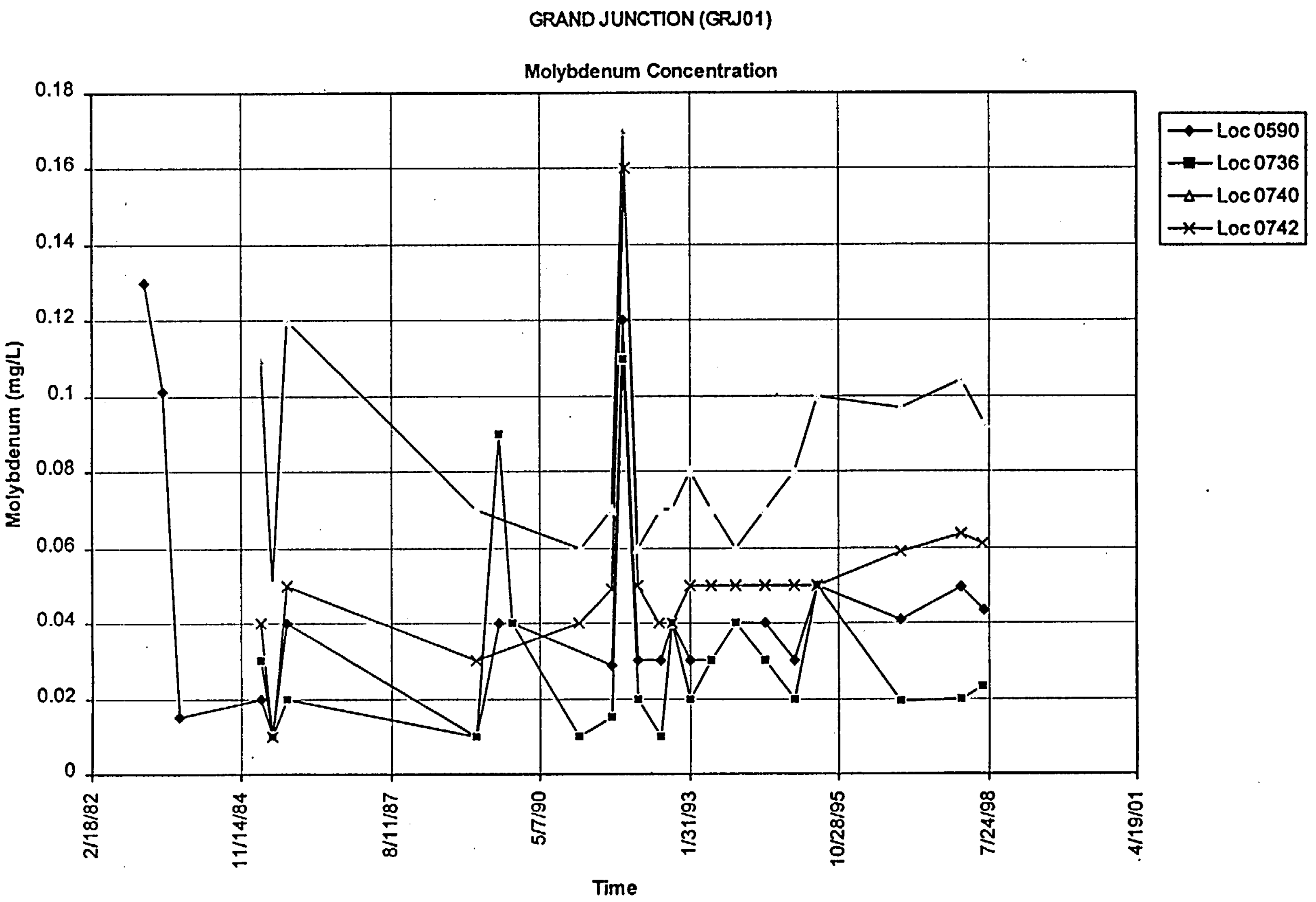

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Figure 5–12a. Time Concentration Plot—Molybdenum in Old Wells

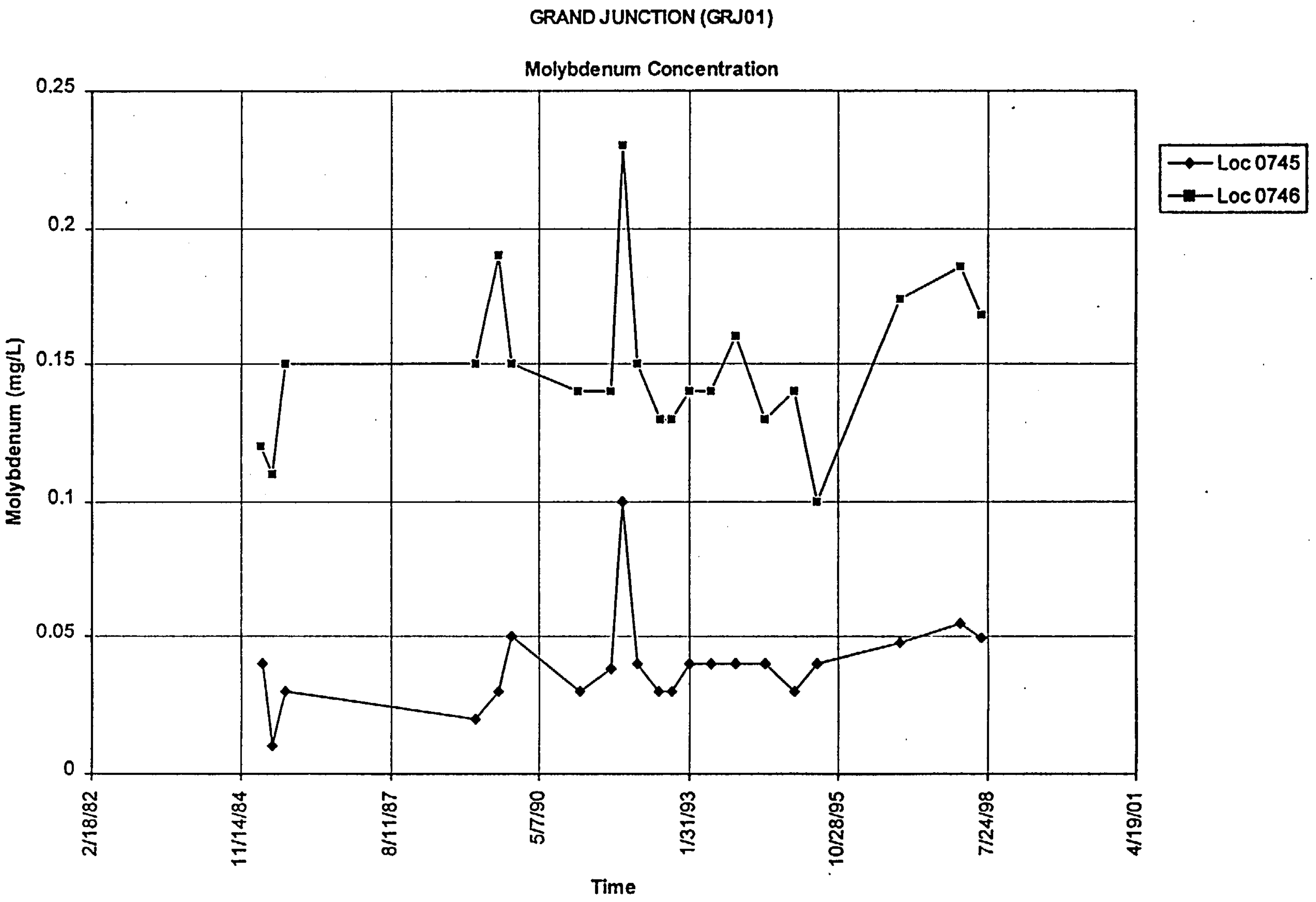

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Figure 5–12b. Time Concentration Plot—Molybdenum in Old Wells

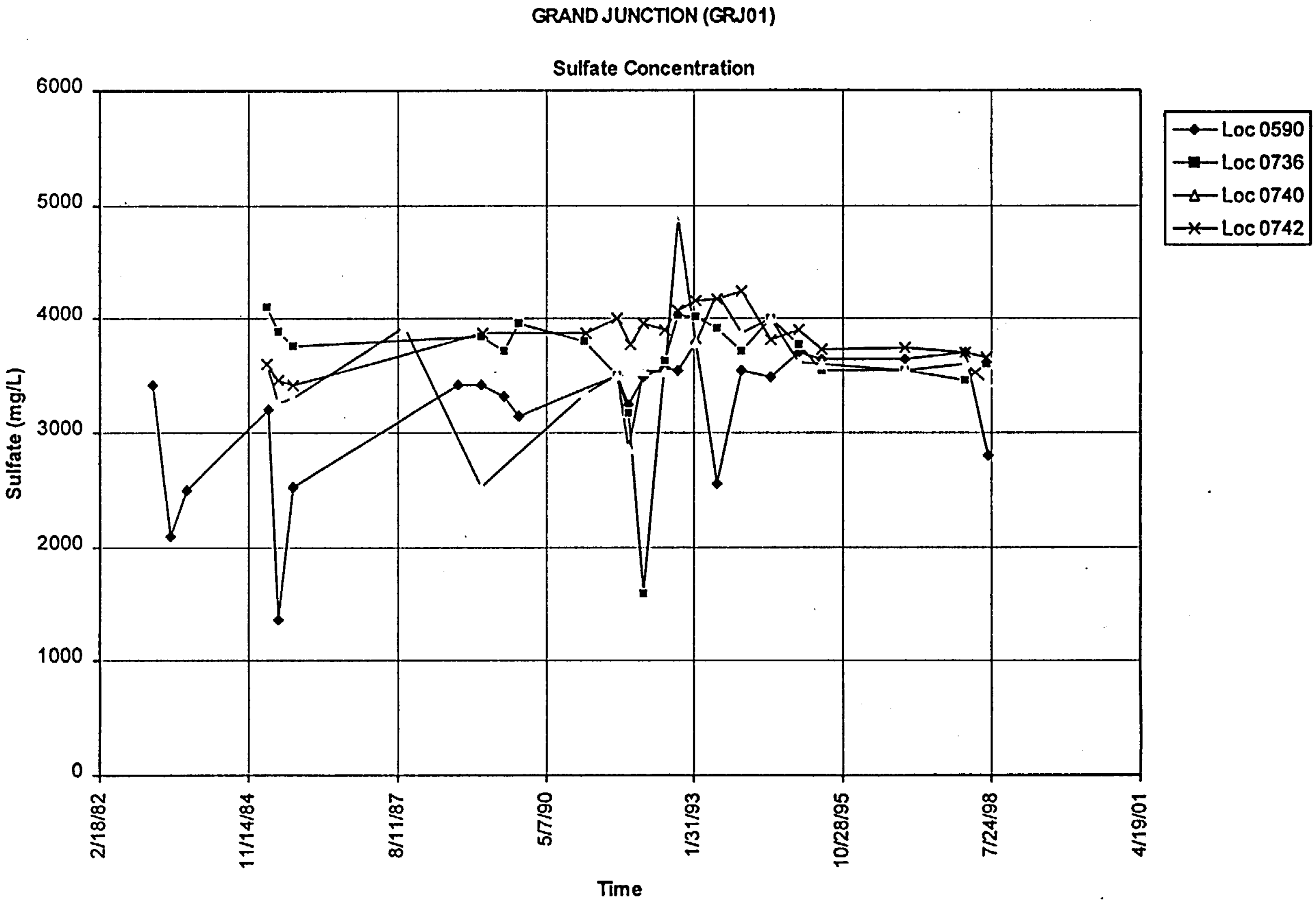

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Figure 5–13. Time Concentration Plot—Sulfate in Old Wells

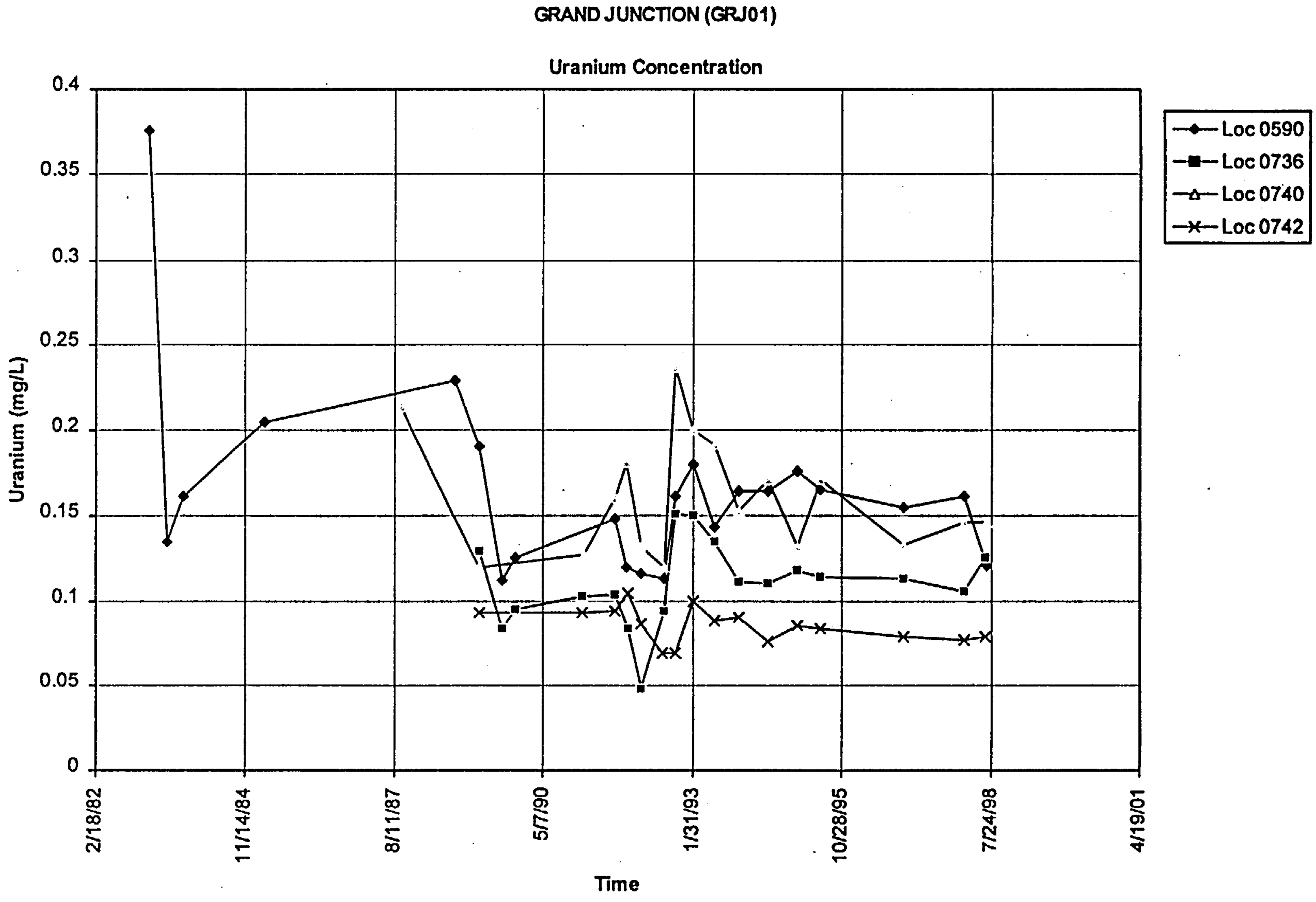

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Figure 5–14a. Time Concentration Plot—Uranium in Old Wells

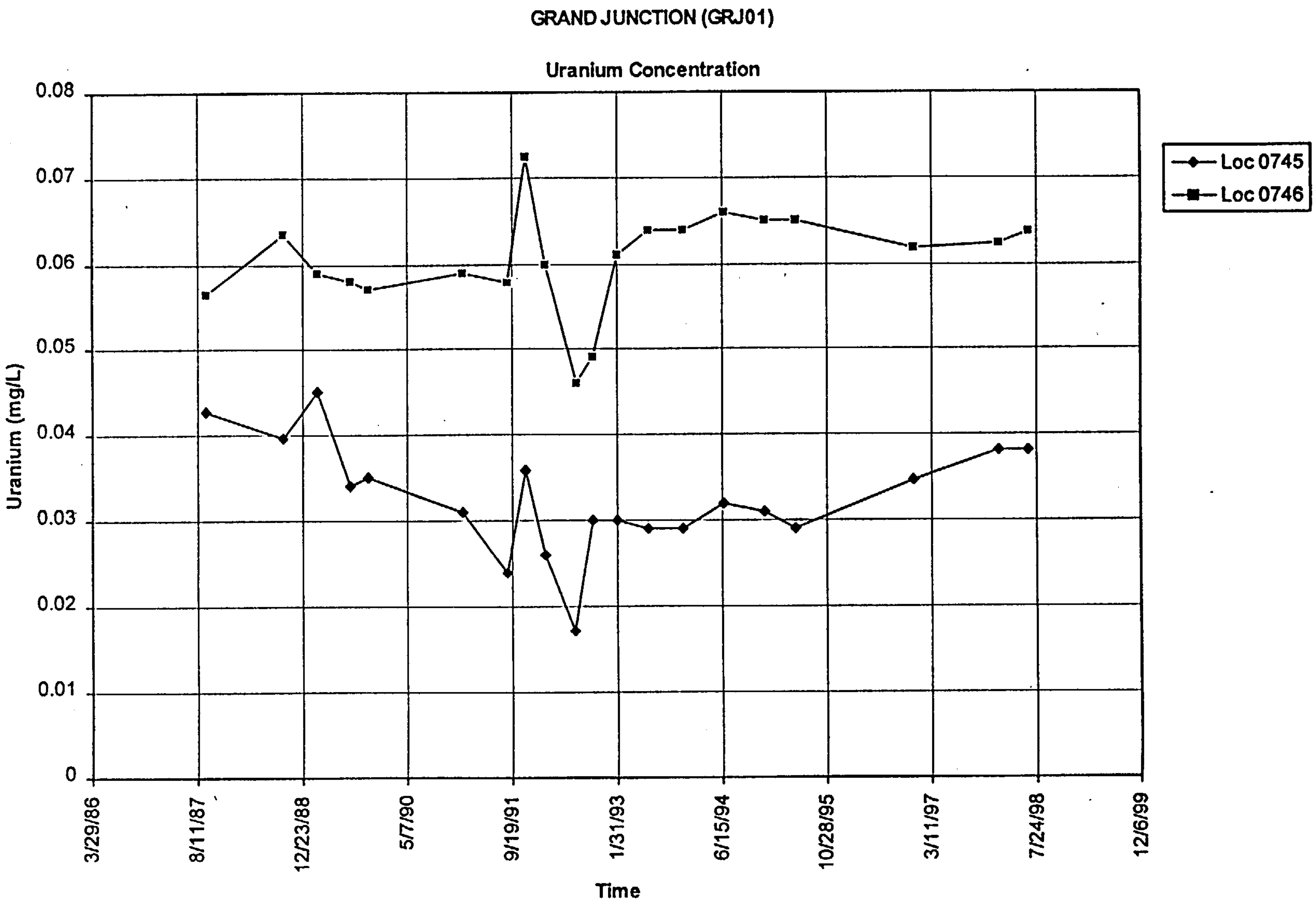

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Figure 5–14b. Time Concentration Plot—Uranium in Old Wells

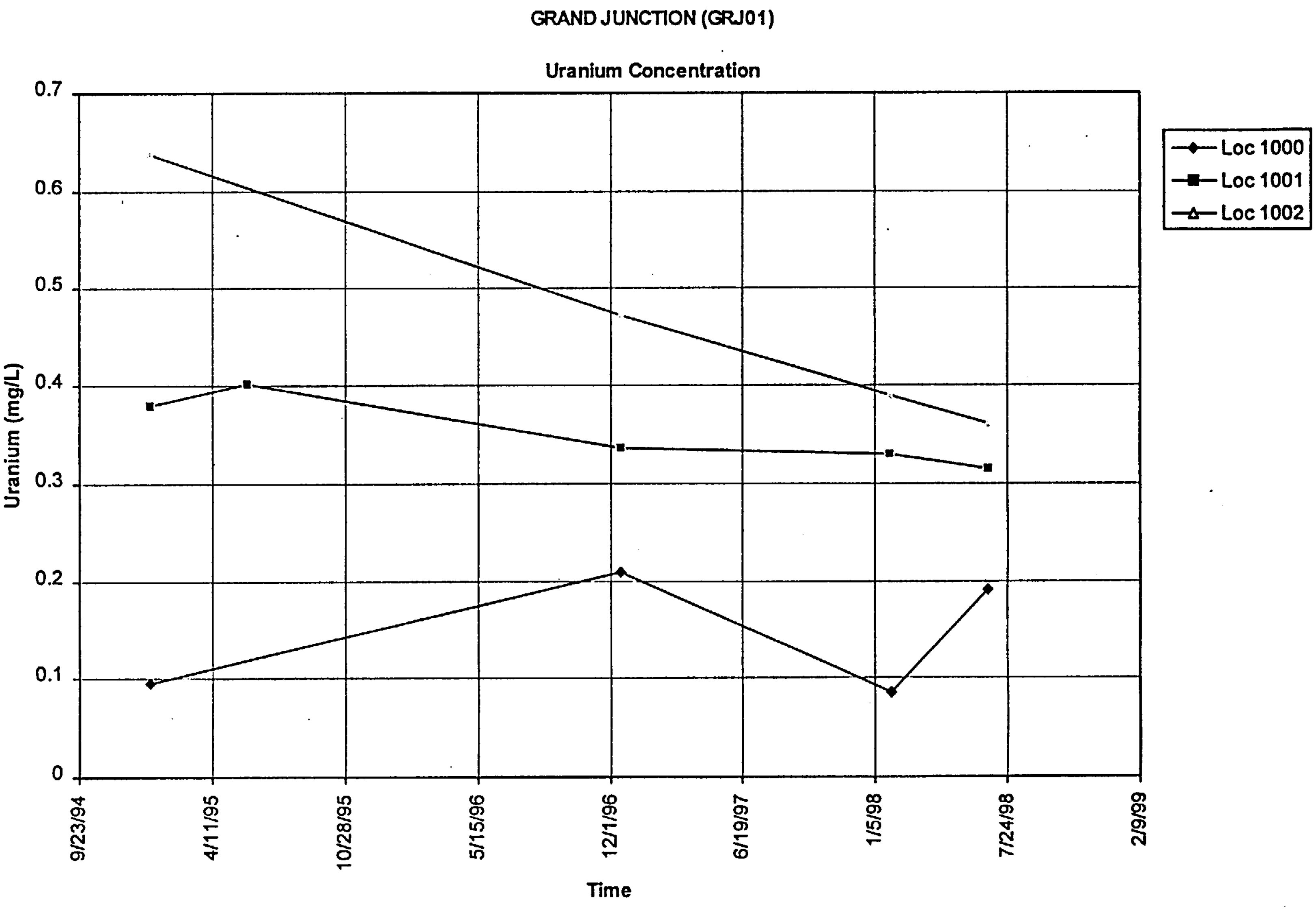

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Figure 5–15. Time Concentration Plot—Uranium in New Wells more appropriate to account for site-specific uranium concentrations and the higher proportion of ^{234}U.

5.3.4 COPC Fate and Transport

This section presents discussion of the evolution of the contaminated ground water system. Understanding the chemistry of the ground water will aid in making quantitive predictions or assessing general trends to be expected of the migration of the contaminant plume and the fate of contaminated sediments. Geochemical considerations that influence transport modeling and a general discussion of the fate of individual COPCs are also presented. The geochemical considerations presented below, together with knowledge of the milling history and the ground water flow characteristics, indicate that the average contaminant concentrations in the alluvial aquifer, surface water, and surface sediments should decrease over time. However, some areas may show interim increases as constituents migrate before eventual decreases occur.

5.3.4.1 Evolution of Ground Water Geochemistry After Uranium Milling

Because of its importance to regulatory compliance, this discussion focuses on uranium.

The milling process at the Grand Junction site used acids to extract uranium from the ores. The acids produced low pH and oxidizing conditions. Under these conditions, uranium forms a uranyl cation (UO_2^{2+}) that favors uranium partitioning to the aqueous phase. Probably much of this acidic solution was neutralized before it was released from the mill. However, when the mill was operating, remnant uranyl-bearing, acidic solution entered the ground water from tailings pond seepage. The water table would have been mounded at the site due to the elevated flux of water recharging from the ponds. The mounding would have caused the contamination to spread rapidly. Due to the high rate of ground water flow and the chemical conditions that favored partitioning to the aqueous phase, it is likely that much of the plume migration occurred during and shortly after the milling.

As the acidic solutions passed through the alluvial aquifer they interacted with aquifer minerals. Dissolution of carbonate minerals caused addition of carbonate to the aqueous phase and a rise in pH due to consumption of H^+. Mixing with carbonate-bearing ground water also caused the pH to increase. Reactions with silicate minerals such as feldspars and clays also caused neutralization of the acidic solutions but at a slower rate than reaction with carbonate minerals. The rates of neutralization were probably high for the milling fluids that had pH values less than 2 but decreased as pH increased. It is likely that pH values increased significantly before the milling fluids migrated more than a few hundred feet from the mill ponds. No pH value less than 6.43 is currently measured in the ground water, and the pH values are similar on site, upgradient, and downgradient.

Uranium chemistry evolved as contaminated, low-pH fluids entered the ground water and became neutralized. Dissolved carbonate has a strong tendency to form aqueous complexes with uranium. The dominance of the uranyl ion in the milling solutions was replaced by uranyl dicarbonate ions [$UO_2(CO_3)_2^{2-}$]. Uranyl dicarbonate currently dominates the dissolved uranium distribution in the alluvial ground water both at the site and in the upgradient area. As indicated by the low distribution coefficients (about 1 mL/g), uranium is still relatively mobile in the ground water. Without carbonate complexing, the mobility would be much lower.

Table 5–5. Isotopic Uranium Concentrations—Background Locations

Uranium Disequilibrium at Grand Junction - Background Locations

Easting	Northing	Location	Total U (mg/L) Lab	U-234 (pCi/L) Lab	U-234 (mg/L) Calculated	U-238 (pCi/L) Lab	U-238 (mg/L) Calculated	U-234 & 238 (pCi/L) Lab	U-234 & 238 (mg/L) Calculated	Ratio pCi/L 234/238
		715	0.0602	34.9	0.00000560	20.1	0.060	55	0.060	1.74
		713	0.0652	35.2	0.00000565	21.8	0.065	57	0.065	1.61
		1020	0.0566	29.2	0.00000469	18.9	0.056	48.1	0.056	1.54
		1023	0.0468	23.8	0.00000382	15.6	0.047	39.4	0.047	1.53
		1025	0.0436	21.5	0.00000345	14.5	0.043	36	0.043	1.48
		745	0.0381	18.8	0.00000302	12.7	0.038	31.5	0.038	1.48
		1021	0.0305	14.9	0.00000239	10.2	0.030	25.1	0.030	1.46
									average	1.55
		Disequilibrium factor	Ratio pCi/L (234/238)	U-234 MCL (pCi/L)	U-234 MCL (mg/L)	U-238 MCL (pCi/L)	U-238 MCL (mg/L)	U-234 & 238 (pCi/L)	U-234 & 238 (mg/L)	
example; assumes equilibrium at std			1.0	15.0	0.00000241	15.0	0.045	30	0.045	
		actual average	1.55	18.2	0.00000293	11.8	0.035	30	0.035	

Table 5–6. Isotopic Uranium Concentrations—Plume Locations

Uranium Disequilibrium at Grand Junction - Plume Locations

Easting	Northing	Location	Total U (mg/L) Lab	U-234 (pCi/L) Lab	U-234 (mg/L) Calculated	U-238 (pCi/L) Lab	U-238 (mg/L) Calculated	U-234 & 238 (pCi/L) Lab	U-234 & 238 (mg/L) Calculated	Ratio pCi/L 234/238
		1015	0.0641	37.8	0.00000607	21.4	0.064	59.2	0.064	1.77
		1017	0.0241	13.2	0.00000212	8.1	0.024	21.3	0.024	1.63
		1019	0.0486	25.7	0.00000412	16.2	0.048	41.9	0.048	1.59
		736	0.105	49	0.00000786	35.2	0.105	84.2	0.105	1.39
		1018	0.0862	39.1	0.00000627	28.8	0.086	67.9	0.086	1.36
		1010	0.0637	25.4	0.00000408	21.3	0.064	46.7	0.064	1.19
		1022	0.132	52.5	0.00000843	44.2	0.132	96.7	0.132	1.19
		740	0.146	57.3	0.00000920	48.7	0.146	106	0.146	1.18
		590	0.162	62.6	0.00001005	54.1	0.162	116.7	0.162	1.16
		1012	0.22	84.7	0.00001359	73.5	0.220	158.2	0.220	1.15
		1016	0.113	42.2	0.00000677	37.6	0.112	79.8	0.112	1.12
		1011	0.199	73.5	0.00001180	66.5	0.199	140	0.199	1.11
		1013	0.604	220	0.00003531	202	0.604	422	0.604	1.09
		1000	0.0816	30.6	0.00000491	28.2	0.084	58.8	0.084	1.09
		1001	0.33	115	0.00001845	110	0.329	225	0.329	1.05
		1002	0.391	136	0.00002183	131	0.392	267	0.392	1.04
		1014	2.5	833	0.00013368	835	2.496	1668	2.496	1.00
									average	1.24
		Disequilibrium factor	Ratio pCi/L (234/238)	U-234 MCL (pCi/L)	U-234 MCL (mg/L)	U-238 MCL (pCi/L)	U-238 MCL (mg/L)	U-234 & 238 (pCi/L)	U-234 & 238 (mg/L)	
example; assumes equilibrium at std			1.0	15.0	0.00000241	15.0	0.045	30	0.045	
		actual average	1.24	16.6	0.00000267	13.4	0.040	30	0.040	

After the mill closed, the infiltration of contaminated processing fluids ceased, which significantly reduced the amount of contaminants entering the ground water. At that time the only contribution to ground water contamination was percolation of water through the tailings. The percolating water was a combination of atmospheric precipitation and water applied to irrigate vegetation used to stabilize the tailings. During this period, some of the tailings pores probably still contained residual low-pH fluids. As water percolated through the tailings, these contaminated low-pH fluids were gradually swept into the ground water. After the removal of the tailings, the flux of contamination to ground water was essentially eliminated. As indicated by the soil-leaching tests, however, there is still some leachable uranium in the subpile soils. The contribution of contaminants from these soils is much less than from the former tailings. Residual uranium is also present in the aquifer solids and is gradually being leached out as cleaner water passes through.

The major-ion chemistry of the alluvial ground water at the millsite is similar to that of the upgradient area, as indicated by their similar locations on a Piper diagram (Figures 4–5 and 4–6). The chemical composition of the alluvial aquifer system at the millsite is apparently dominated by the same factors (e.g., interaction with the aquifer solids, irrigation practices, recharge and evaporation rates) that control its composition in the upgradient area. The entire alluvial aquifer is nearly at equilibrium with calcite and gypsum, indicating that these minerals are partially controlling the major-ion composition.

5.3.4.2 Fate and Transport of Individual COPCs

As contaminated ground water migrates through soils and rocks, some of the contaminants transfer between the solid and liquid phases. This phenomenon causes the contaminants to travel at a slower rate than the average ground water velocity. The chemical processes that cause this retardation include adsorption, absorption, precipitation, diffusion into immobile porosity, transfer to vapor phases, and accumulation in plants. Although it is generally not possible to differentiate among these processes, for many aquifer systems a bulk parameter (the distribution coefficient, or Kd) has been used with some success to describe the retardation of contaminant migration. Most numerical ground water models use the Kd concept to simulate contaminant transport. Thus, a laboratory study was conducted during this investigation to determine Kd values applicable to the alluvial aquifer.

Distribution coefficients (Kds) were determined for the regulated COPCs (As, Cd, Mo, and U). The Kd value is a measure of the degree of chemical interaction between the dissolved component and the aquifer solids. High values of Kd indicate more partitioning to the solid phases. Kd values give no direct indication of the chemical mechanisms responsible for the partitioning.

To use Kd values for ground water transport modeling, the following assumptions must be made: (1) the 24-hour shake time is sufficient to bring the system to chemical equilibrium, (2) the modeled system is always in chemical equilibrium, (3) an adequate portrayal of the areal and vertical distributions of Kd values is manifested in the model domain, (4) Kd values do not vary within the range of major-ion chemistry or pH values present (or expected) in the ground water, (5) processes such as mineral precipitation or preferential extraction by plant roots do not occur, and (6) Kd values do not vary with contaminant concentrations present in the ground water.

Some studies have shown that Kd values decrease as the concentration of adsorbate increases (assumption 6). At low concentrations this effect is usually minimal; that is, for low contaminant concentrations the adsorption isotherm is usually linear. If high concentrations are present a nonlinear isotherm such as the Freudlich isotherm is required for more accurate simulations. While the effect of nonlinearity of the isotherm is likely to exert only a small effect on plume migration compared to other factors (such as aquifer heterogeneity, dispersion, ground water flow velocities, or retardation by mechanisms other than adsorption), an isotherm for uranium was measured. Within experimental uncertainties the isotherm is linear, supporting the use of a Kd for transport modeling. Because other COPCs are present at lower concentrations than uranium, it is reasonable to use a Kd approach as a first approximation to simulate plume migration.

Mineral precipitation can occur if concentrations of the dissolved components increase to saturation. If COPCs transfer to or from the solid phases by precipitation/dissolution, the Kd modeling approach is unlikely to produce a realistic simulation of plume migration. Therefore, it is useful to examine conditions that may cause mineral precipitation. It was determined that calcite and gypsum are nearly at equilibrium with the aquifer. These minerals in part control the concentrations of Ca, HCO_3^-, and SO_4^{2-}, and the pH in the aquifer. Some of the COPCs, including U, will partition somewhat into calcite.

Although it is likely that sorption is the predominant retardation mechanism for the COPCs, other mechanisms may control migration under specific circumstances. All the COPCs except fluoride are sensitive to oxidation-reduction changes. A general discussion of retardation mechanisms that may exert control on the specific COPCs (As, Cd, Co, F, Fe, Mn, Mo, Ni, NO_3, Se, SO_4, U, V, and Zn) follows.

Arsenic. Arsenic occurs in ground water predominantly in two oxidation states: arsenite (As^{3+}) and arsenate (As^{5+}). The monovalent species $H_2AsO_4^-$ predominates between about pH 3 and 7, and the divalent species $HAsO_4^{2-}$ dominates at higher pH. Some metal arsenates have low solubilities, which may control arsenic concentrations in ground water. In particular, arsenic is able to coprecipitate with ferric iron. At low oxidation states, arsenic can precipitate as native As metal.

Adsorption to alluvial aquifer mineral grains, which are mostly quartz, feldspar, and clay, is expected to be relatively minor unless the grains have oxide or oxyhydroxide coatings. Arsenic, however, is known to adsorb to ferric oxyhydroxides in relatively high concentrations (Dzombak and Morel 1990). Arsenic adsorption would increase in those portions of the aquifer that have higher concentrations of iron and manganese oxides.

Cadmium. Cadmium is present in ground water as the uncomplexed cation Cd^{2+} or complexed with an anion (e.g., $CdSO_4^o$). Cadmium readily substitutes for Ca in carbonate minerals. Coprecipitation with calcite ([Ca, Cd]CO_3) is the most likely mechanism for removal of Cd from the alluvial ground water. Since the aquifer is saturated with calcite, this mechanism is likely to keep Cd concentrations low. Cadmium can precipitate as Greenockite (CdS) under sulfate-reducing conditions. Cadmium will also effectively adsorb to ferric oxyhydroxides.

Cobalt. Cobalt occurs in the 2+ and 3+ oxidation states in aqueous solution and readily coprecipitates with ferric iron and manganese oxyhydroxides. This coprecipitation is most likely the limiting mechanism for Co transport in the alluvial aquifer. Under sulfate-reducing conditions, Co can form CoS. Cobalt will also adsorb to ferric oxyhydroxides.

Fluoride. Fluoride exists mainly as the uncomplexed F^- in ground water. It is likely that the F^- concentrations in the alluvial aquifer are too low to form minerals; however, with high concentrations of Ca^{2+}, fluoride can form the mineral fluorite (CaF_2). Although some ion exchange may occur with the clay minerals in the aquifer, most of the fluoride probably remains in solution as a conserved species.

Iron. Iron occurs in two oxidation states in ground water: ferrous (Fe^{2+}) and ferric (Fe^{3+}). At the pH values in the alluvial aquifer, transport occurs as ferrous iron, which will complex with aqueous anions such as chloride (e.g., $FeCl_2^0$). Ferric iron forms insoluble oxyhydroxide precipitates. Thus, oxidizing conditions in the aquifer tend to immobilize iron. Ferric oxyhydroxides are believed to migrate in aquifers in colloidal suspension; however, there is limited evidence that this is a dominant transport mechanism. Reducing conditions in the aquifer will mobilize iron through dissolution of the oxyhydroxide phases. Ferric oxyhydroxides are capable of adsorbing many of the COPCs; thus, the iron cycle is likely to be important in understanding the migration behavior of many of these contaminants. Under sulfate-reducing conditions, iron can form insoluble sulfide minerals such as FeS and FeS_2.

Manganese. Manganese occurs in the 2+ and 4+ oxidation states in the alluvial aquifer. In the dissolved state it is present mainly as the Mn^{2+} ion. Its redox chemistry is similar to that of iron in that oxidation will promote the precipitation of hydroxide or oxide minerals. Manganese will substitute readily for Ca in calcite. Because the alluvial aquifer is saturated with calcite, this mechanism could be important at the Grand Junction site. Like iron, manganese minerals are effective scavengers of many COPCs.

Molybdenum. Molybdenum occurs naturally in the 4+ and a 6+ oxidation states, but the 6+ state is most likely present in the Grand Junction ground water because of the high oxidation potential. Dissolved molybdenum species are dominated by the molybdate anion (MoO_4^{2-}) in the pH range of interest. At low pH, $HMoO_4^-$ or $H_2MoO_4^0$ may become important. High concentrations of sodium and calcium can form sodium and calcium molybdate complexes (e.g., $NaMoO_4^-$ and $Ca\ MoO_4^0$).

Because of the low concentrations in ground water at the site, no molybdenum minerals are expected to form unless reducing conditions are present in the aquifer. At low redox states, Mo can precipitate as ferrous molybdate ($FeMoO_4$) or under sulfate-reducing conditions as molybdenite (MoS_2). Adsorption to alluvial aquifer mineral grains, which are mostly quartz, feldspar, and clay, is expected to be relatively minor unless the grains have oxide or oxyhydroxide coatings. Molybdenum, is known to adsorb to ferric oxyhydroxides in relatively high concentrations (Morrison and Spangler 1993). Molybdenum adsorption would increase in those portions of the aquifer that have higher concentrations of iron and manganese oxides.

Nickel. Nickel is present in ground water mainly as the uncomplexed Ni^{2+} species. Nickel can coprecipitate with calcite and form sulfide minerals under sulfate-reducing conditions. Nickel can also adsorb to ferric oxyhydroxides.

Nitrate. Nitrate (NO_3^-) does not complex significantly with other ions under ground water conditions. It is transported without significant interaction with the rock matrix. If appropriate nitrate-reducing microbiota and nutrients are present, nitrate can undergo reduction to nitrogen gas (N_2). Significant denitrification is not expected to occur without a suitable organic nutritional source such as acetate. Therefore, nitrate probably transports nearly conservatively through the aquifer. Concentrations decrease by mixing with other ground water and by dispersion. If the aquifer is within about 50 feet of the ground surface, plants will remove nitrate from the ground water.

Selenium. Aqueous selenium occurs predominately as selenate (SeO_4^{2-}) or selenite (SeO_3^{2-}); selenate is probably favored under the oxidized conditions of the alluvial aquifer. Concentrations of selenium are not high enough to precipitate selenium minerals. Selenium can substitute for sulfur in sulfur-bearing minerals and can precipitate as ferroselite ($FeSe_2$) or coprecipitate with pyrite (FeS_2) under reducing conditions. Plants, such as the genus *Astragalus*, common to the Grand Junction area, can preferentially utilize Se if the ground water is shallow.
Selenium is not likely to adsorb appreciably to the mineral grains. Both selenite and selenate, however, will adsorb to ferric oxyhydroxides (Dzombak and Morel 1990). Selenate adsorption requires low pH and is not likely to be significant in the alluvial aquifer. Thus, selenium is likely to remain in solution with concentration gradients developed mainly by advection and dispersion.

Sulfate. In alluvial ground water, dissolved sulfur occurs mainly as the unassociated sulfate ion (SO_4^{2-}). The only mechanism likely to partition significant amounts of sulfate into the solid phase is the precipitation of gypsum. The amount that precipitates is likely to be relatively minor compared to the high concentrations of sulfate in solution. Therefore, most of the concentration gradient is produced by mixing with other ground water and dispersion. Under reducing conditions brought about by microbial stimulation, sulfate can form sulfide minerals.

Uranium. Most naturally occurring uranium is either in the uranyl (6+) or uranous (4+) oxidation state. The uranyl form is predominant in oxidized ground water. The uranyl ion forms strong aqueous complexes with carbonate, and uranyl dicarbonate [$UO_2(CO_3)_2^{2-}$] is the dominant aqueous uranium species at the Grand Junction site.

Uranyl concentrations in the alluvial aquifer are too low to form uranium minerals. Uranous minerals would precipitate if the aquifer were to become reduced. Adsorption of uranyl to mineral grains in the alluvial aquifer is likely to be insignificant. However, uranyl is known to adsorb to ferric oxyhydroxide in relatively high concentrations (Morrison et al. 1995). It is likely that adsorption to ferric or manganese minerals is the principal mode that retards uranium migration at the site.

Vanadium. Vanadium exists in the 3+ and 5+ oxidation states in aquifers. Dissolved vanadium exists mainly as vanadate (VO_4^{3-}) oxyanions such as $H_2VO_4^-$. Vanadate can combine with cations to form minerals such as $Ca_3(VO_4)_2$. Under reducing conditions it forms insoluble minerals such as paramontroseite (V_2O_4). Vanadate adsorbs effectively on ferric oxyhydroxides. Vanadium can combine with uranium to form low-solubility uranyl vanadates such as carnotite [$K_2(UO_2)_2(VO_4)_2$].

Zinc. Zinc is present in ground water as Zn^{2+} and readily complexes with many anions such as chloride. Zinc substitutes for Ca^{2+} in calcite, which is a likely retardation mechanism in the alluvial aquifer. Under sulfate–reducing conditions, zinc forms sphalerite (ZnS). Zinc also effectively adsorbs on ferric oxyhydroxides.

5.4 Ecological Risk Assessment Model

The purpose of the ecological risk assessment (ERA) is to identify and characterize adverse effects, if any, on the ecosystem at the Grand Junction site. For ecological risks to occur at the Grand Junction site, pathways must exist for exposure of biological receptors to biotic and abiotic media contaminated by ground water. The Grand Junction ERA is based on EPA guidance provided in *Guidelines for Ecological Risk Assessment* (EPA 1998) and *Framework for Ecological Risk Assessment* (EPA 1992). A screening-level assessment of ecological risks at the site, the BLRA (DOE 1995), evaluated COPCs, potential pathways, receptors, and adverse effects. This section presents a conceptual ecological risk model. Section 6.2 is an update of the BLRA based on this conceptual model and the results of the 1998 field investigations (Section 4.4). The risk assessment methodology and calculations are presented in Appendix I.

Conceptual models for ecological risk assessments are developed from information about stressors, potential exposure, and predicted effects on an ecological entity (the assessment endpoint). Conceptual models consist of two principal components (EPA 1998):

- A set of risk hypotheses that describe predicted relationships among stressor, exposure, and assessment endpoint response, along with the rationale for their selection.
- A diagram that illustrates the relationships presented in the risk hypotheses.

5.4.1 Risk Hypothesis

Milling operations at the Grand Junction site have resulted in low levels of ground water contamination. Hydrogeologic information regarding plume migration suggests that contamination might be present in the Colorado River adjacent to and downgradient of the Grand Junction site. This could result in contaminant exposure directly or indirectly to wildlife and plant receptors that use or inhabit the site. Figure 5–16 illustrates current and potential exposure pathways based on all the available data.

An exposure pathway is the mechanism by which a contaminant in an environmental medium (i.e., the source) contacts an ecological receptor. A complete exposure pathway includes

- Contaminant source
- Release mechanism that allows contaminants to become mobile or accessible
- Transport mechanism that moves contaminants away from the release
- Ecological receptor
- Route of exposure (e.g., dermal or direct contact, inhalation, or ingestion).

Ecological receptors that could potentially be exposed to COPCs were identified in the BLRA (DOE 1995) and included mammalian and avian species. A food web for the Grand Junction site (Figure 5–17) illustrates the significant dietary interactions between the terrestrial and aquatic receptors.

- The food web also depicts the major trophic-level interactions and describes nutrient flow and transfer of matter and energy through these levels. It was developed from the species lists and consideration of the exposure pathways. The food web diagram was used to portray potential

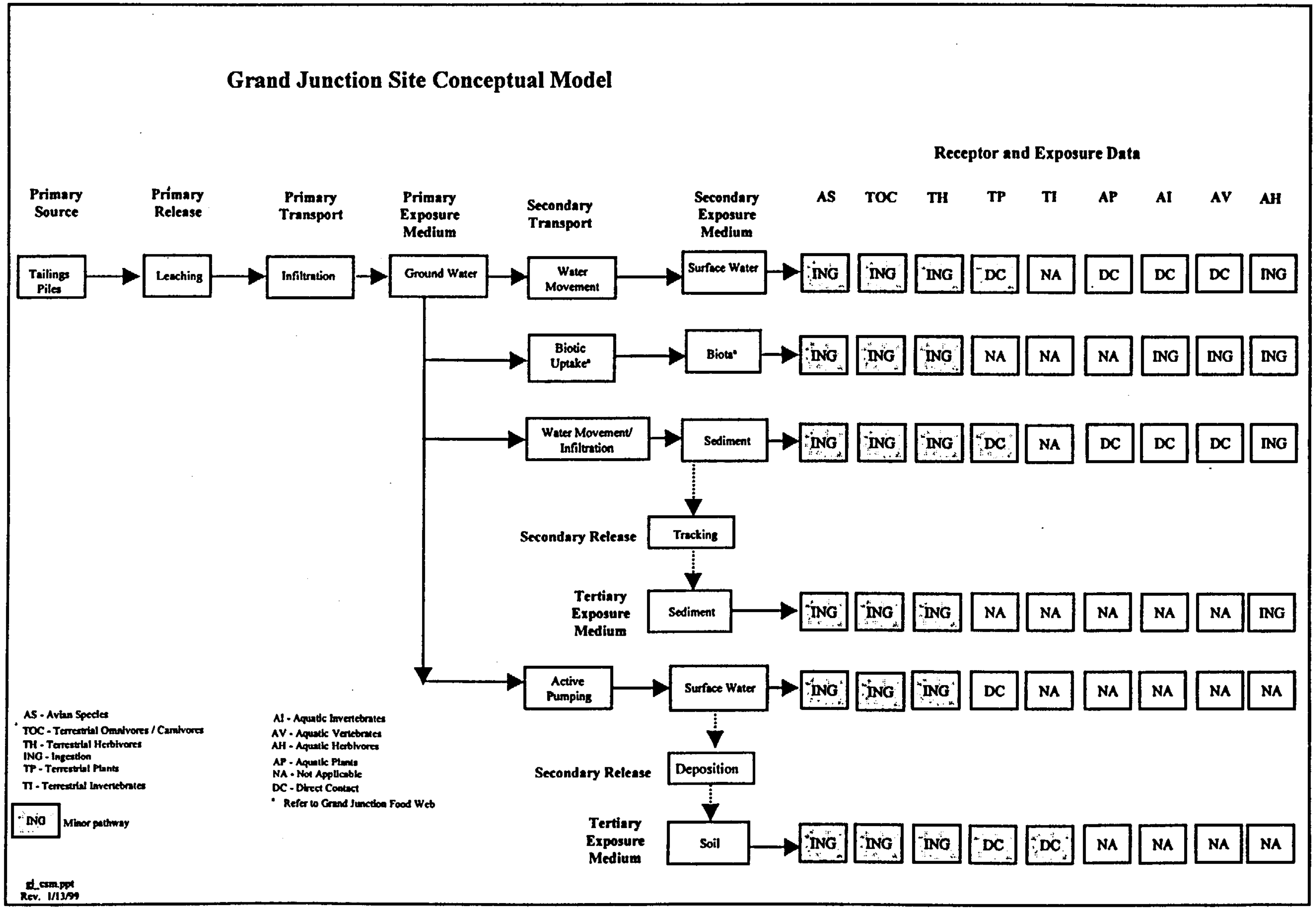

Figure 5–16. Grand Junction Site Conceptual Model

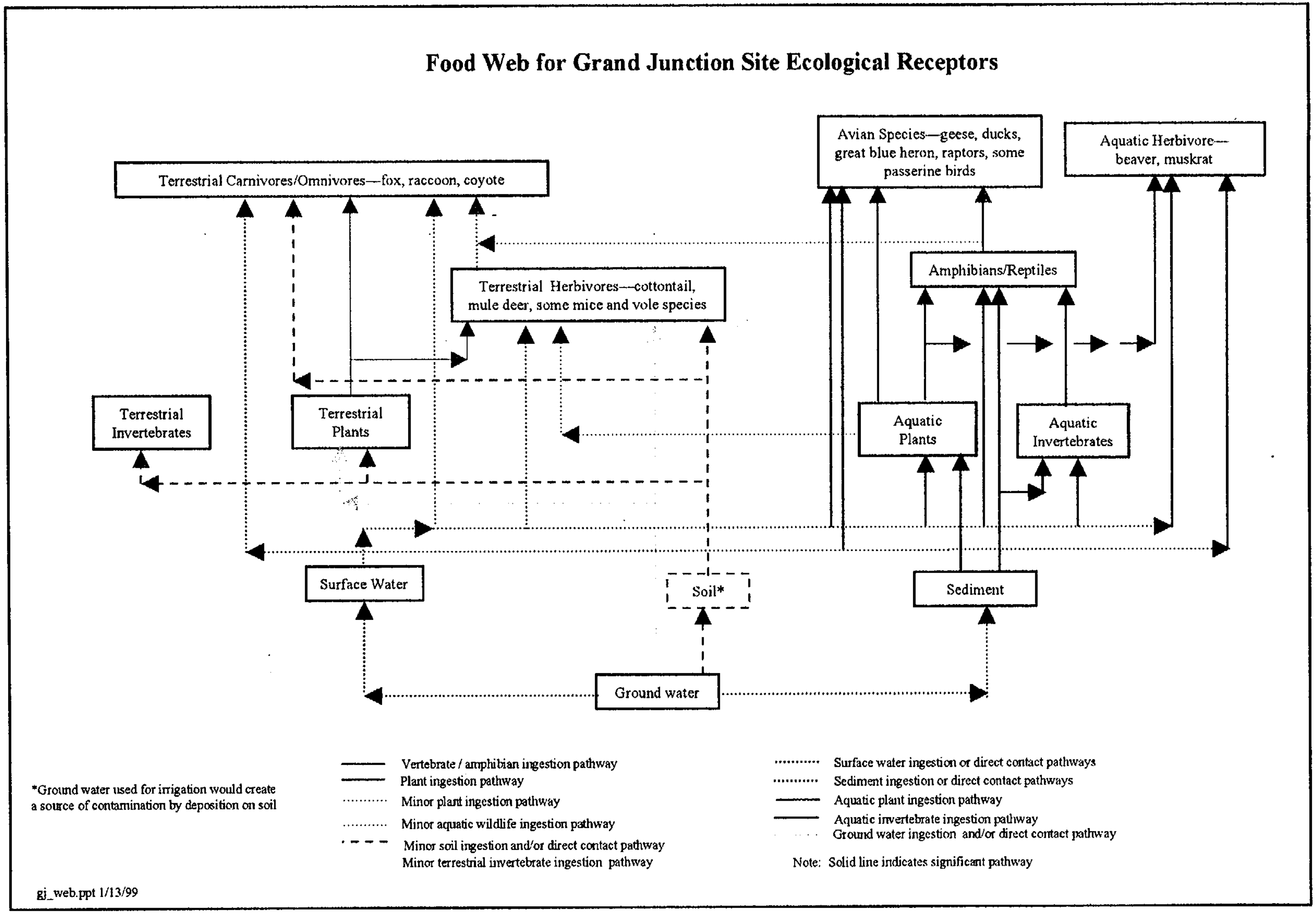

Figure 5–17. Grand Junction Site Food Web

habitat at the site is a storm-water discharge canal on the western property boundary. Consequently, surface water ingestion was not evaluated for the terrestrial habitat.

The riparian and aquatic habitats associated with the Colorado River at the Grand Junction site represent the areas of significant potential exposure. Contaminated ground water associated with the former milling operations discharges into the Colorado River where COPCs may be deposited in sediment or may be present in the surface water as well as downstream of the site. Phreatophytes rooted in sediment may uptake contaminants through their root systems. Such species include sandbar willow (*Salix exigua*), cattail (*Typha sp.*), cottonwood (*Populus fremontii*), common reed (*Phragmites communis*), bulrushes, tamarisk (*Tamarix ramosissima*), and reed canarygrass (*Phalaris arundinaceae*). As mentioned in the characterization work plan (DOE 1997), elevated concentrations of some constituents were present in the wetlands mitigation ponds.

Although the prominent boundaries of these ponds no longer exist, remnants of these ponds may still contain some elevated concentrations of COPCs. In addition, the sediments may act as sinks for COPCs in ground water discharging into the area, and thus represent potential sources of contamination.

Terrestrial receptors such as foxes, coyotes, skunks, raccoons, deer, and rodents are likely to use the riparian corridor for food items and as a drinking water source. Consequently, they are also exposed to potentially contaminated sediments. These terrestrial receptors typically do not spend most of their time in the riparian or aquatic areas.

Aquatic receptors living in the riparian and aquatic habitats adjacent to and downstream from the millsite have the potential to ingest contaminated sediment, surface water, and vegetation. These species have the potential for the greatest exposures. Larger herbivores prefer to browse on leafy material; smaller mammals and birds seek plant seeds and roots. Field observations in the reference area found evidence of wildlife browsing on cattails. Beaver (an herbivore) and muskrat (an omnivore that feeds chiefly on aquatic plants) forage on the types of vegetation found along the river banks. Higher trophic receptors such as coyotes, eagles, and hawks may in turn feed on small mammals or birds that have ingested contaminated food items. Aquatic avian species such as the great blue heron, ducks, geese, and killdeer frequent the Colorado River and represent ecological receptors with significant exposure potential. Aquatic invertebrates, amphibians, reptiles, and fish are also in direct contact with potentially contaminated sediment, surface water, and aquatic vegetation. These receptors can also serve as prey for eagles, herons, and other wildlife.

5.4.2 Future Hypothetical Exposure Scenario

Because no significant habitat changes from the present scenario are expected, the future exposure scenario includes all of the current exposure scenarios associated with the riparian and aquatic habitats on the Colorado River. Localized flooding will likely continue to erode the vestiges of the wetlands mitigation ponds and reshape the river banks.

Without institutional controls, ground water could possibly be pumped and used for irrigation and livestock watering or other industrial uses. This would create a source for ground water and surface water ingestion, direct contact with terrestrial vegetation, and deposition of ground water and surface water on the soil. The soil would then represent an additional source medium for ingestion and direct contact. At present, both of these secondary exposure routes are considered incomplete since ground water is not currently used for these purposes, nor is ground water likely to be pumped in the future. Large-scale irrigation with ground water is not considered a likely future pathway because surface water is the main source of irrigation water in the Grand Junction area. As long as there is the possibility of pumping ground water for agricultural purposes, it is assumed that the potential exists for these two hypothetical exposure pathways.

The land use plans for the Grand Junction site have not been made final. One possible use is the construction of a recreation area, which would likely include the planting of various tree species. Since the potential exists for phreatophytes (e.g., cottonwood, willow, and greasewood) to inhabit the terrestrial portion of the site, contaminants in ground water could be taken up by those plants through extensive root systems. Contaminants could possibly bioaccumulate in various plant parts and exert a range of influences, depending on the specific COPC. Plant uptake rates and toxicities vary greatly among species and are affected by factors such as soil characteristics (e.g., pH, redox potential, organic matter), plant sensitivity, input-output balance, and cumulative effects. Foraging wildlife could be indirectly exposed to contaminants in ground water by ingesting plants that have bioaccumulated certain contaminants.

6.0 Summary of Human Health and Ecological Risk

6.1 Human Health Risk Assessment

A baseline risk assessment was previously prepared for the Grand Junction site (DOE 1995) according to methods provided in the *Final Programmatic Environmental Impact Statement for the Uranium Mill Tailings Remedial Action Ground Water Project* (DOE 1996c). Much of the data used in that risk analysis were collected before completion of surface remediation (data for characterizing the contaminant plume were collected from 1983 to 1989). As described in Section 5.3.3, additional wells were installed during the 1990s and more recent samples were collected. Many contaminants have shown significant changes, mainly decreases, in concentration since completion of the original BLRA. This necessitates a reevaluation of COPC identification and assessment of associated risks. The intent of this BLRA update is to use those earlier results and conclusions as a starting point from which to evaluate the more recent data.

6.1.1 Summary of 1995 Risk Assessment Methodology and Results

The 1995 BLRA identified 19 contaminants associated with the Grand Junction site as being at levels statistically above background concentrations for the area. This initial list of contaminants was screened first to eliminate contaminants in concentrations within nutritional ranges and then to eliminate contaminants of low toxicity and high dietary ranges. These two steps eliminated three contaminants each, resulting in the following COPC list: arsenic, cadmium, cobalt, fluoride, iron, manganese, molybdenum, nickel, ^{226}Ra, sulfate, uranium, vanadium, and zinc. These contaminants were retained for further risk analysis.

A number of potential routes of exposure were evaluated: ingestion of ground water as drinking water in a residential setting, dermal contact with ground water while bathing, ingestion of garden produce irrigated with ground water, ingestion of milk/livestock watered with ground water, ingestion of fish from the Colorado River, and recreational exposure to Colorado River water. Results indicated that adverse toxic responses from exposure to contaminants from routes other than drinking water would not be expected. Therefore, it was determined that ingesting ground water as drinking water would be the primary contributor to total exposure. Consequently, the use of ground water as drinking water in a residential setting was evaluated probabilistically. For additional information on other potential exposure routes and for the probabilistic methodology, see the BLRA (DOE 1995).

Results of the BLRA showed that the most severe noncarcinogenic health effects could occur from the water's sulfate and manganese content and to a lesser extent from fluoride, vanadium, cadmium, iron, arsenic, molybdenum, zinc, and nickel. Refer to the BLRA for specific toxicological effects (DOE 1995). The estimated risk levels for maximum detected concentrations of the carcinogens arsenic, $^{234+238}$U and ^{226}Ra each exceeded the highest EPA-recommended excess lifetime cancer risk of 1×10^{-4}.

Potential public health effects from using background water as drinking water were also assessed in the BLRA by calculating point-exposure doses and comparing the exposure doses to toxic effect levels observed for the COPCs. Background exposure doses were calculated for all plume-related COPCs. Maximum concentrations of the constituents in the upgradient and regional background wells were used in these calculations. Selenium was also evaluated because it is detected in high concentrations in regional ground water (as discussed in Section 5.3.1). The potential receptors assessed were infants, children, and adults. The exposure dose calculations followed UMTRA Ground Water Project methodology (DOE 1996c).

The results of the assessment indicated that, if the regional alluvial ground water were ingested as drinking water, sulfate, selenium, manganese, sodium, chloride, and fluoride have the potential to cause adverse health effects. The individual excess lifetime cancer risk calculated for the upgradient background ground water shows that the cancer risk for arsenic (8×10^{-4}) exceeds the upper end EPA-recommended risk level of 1×10^{-4}. The point-exposure dose evaluation and comparison to standards of upgradient and regional background water substantiates the conclusion that the background water quality in the Grand Junction area is poor. That is, drinking the background alluvial ground water could cause adverse health effects. In addition, the water is unpalatable because of high levels of sulfate, TDS, manganese, iron, fluoride, and chloride.

6.1.2 BLRA Update

6.1.2.1 COPC List Update

This BLRA update uses the COPC list from the original BLRA as a starting point to evaluate current data. Table 6–1 lists the COPCs identified in the 1995 BLRA along with a summary of historical plume data (from the 1996 SOWP and BLRA) and current (1998) plume and background data. In addition to the 13 COPCs from the original BLRA, nitrate also is included at the request of CDPHE; ammonia is included as it is present in significantly elevated concentrations at the site and was an important constituent in the ecological risk evaluation. MCLs and risk-based concentrations (RBCs) are also included for comparison of data to benchmarks. Background locations were determined as described in Section 5.3.1 of this document. Plume data include on-site wells and wells immediately downgradient of the site that can reasonably be assumed to be influenced by site activities. Table 6–1 lists wells included in both plume and background groupings for 1998 data.

The risk-based concentration presented in Table 6–1 for a given contaminant represents a concentration in drinking water that would be protective of human health provided that

- A residential exposure scenario is appropriate.
- Ingestion of contaminated drinking water is the only exposure pathway. [Note: Does not apply to ammonia. See discussion in Section 6.1.2.2.]
- The contaminant contributes nearly all of the health risk.
- EPA's risk level of 1×10^{-6} for carcinogens and a hazard index of 1 for noncarcinogens is appropriate.

If any of these assumptions is *not* true, contaminant levels at or below RBCs cannot automatically be assumed to be protective. For example, if multiple contaminants are present in drinking water, a single contaminant may be below its RBC but still be a significant contributor to the total risk posed by drinking the water. However, if an RBC is exceeded, it is an indication that further evaluation of the contaminant is warranted. RBCs are intended to be used in screening-level evaluations.

Table 6–1. Grand Junction Site Data Summary

Contaminant	No.	Minimum (mg/L)	Maximum (mg/L)	Mean (mg/L)	MCL (mg/L)	RBC[a] (mg/L)	% exceeding benchmark[b]
Ammonia (as NH_4)						0.2N (as NH_3)	
Background	8/8	0.014	0.321	0.093		43 (as NH_4)[d]	0
Current Plume	17/17	0.017	233	71.4			65
Historical Plume[c]	N/A	N/A	N/A	N/A			
Arsenic					0.05	0.011N	
Background	3/15	0.001	0.0014	N/A		0.000045C	0
Current Plume	18/34	0.001	0.0349	0.005			0
Historical Plume		0.007	0.18	0.007			
Cadmium					0.01		
Background	0/15	0.001	0.001	N/A			0
Current Plume	2/34	0.001	0.0013	N/A			0
Historical Plume		0.073	0.42	1.2			
Cobalt						2.2N	
Background	0/15	0.006	0.008	N/A			0
Current Plume	6/34	0.006	0.0162	N/A			0
Historical Plume		0.05	0.66	0.14			
Fluoride					4	2.2N	
Background	15/15	0.453	1.62	0.895			0
Current Plume	34/34	0.335	7.57	1.93			9/24
Historical Plume		4.3	4.8	4.6			
Iron						11N	
Background	10/15	0.003	3.13	0.552			0.00
Current Plume	29/34	0.003	21.2	3.88			12
Historical Plume		1.3	16	11			
Manganese						1.7N	
Background	15/15	0.233	2.22	1.4			53
Current Plume	34/34	0.436	4.54	2.82			97
Historical Plume		1.8	10	4.1			
$^{234+238}$U (pCi/L)					30 pCi		
Background	7/7	25.1	57	42			86
Current Plume	17/17	21.3	1668	215.3			94
Historical Plume							
Molybdenum					0.1	0.18	
Background	15/15	0.0158	0.124	0.0587			13
Current Plume	34/34	0.0147	0.299	0.101			38
Historical Plume		0.13	0.53	0.28			
Nickel						0.73	
Background	10/15	0.0074	0.0281	0.015			0
Current Plume	28/34	0.01	0.111	0.035			0
Historical Plume		0.28	0.38	0.32			
Nitrate					44		
Background	15/15	0.0579	71.4	21.85			20
Current Plume	31/34	0.011	65	5.43			3
Historical Plume		<.01	50				
^{226}Ra (pCi/L)					5 pCi		
Background	7/15	0.04	0.34	N/A			0
Current Plume	17/34	0.04	0.62	0.167			0
Historical Plume		0	29	2.1			

Table 6–1 (continued). Grand Junction Site Data Summary

Contaminant	No.	Minimum (mg/L)	Maximum (mg/L)	Mean (mg/L)	MCL (mg/L)	RBC[a] (mg/L)	% exceeding benchmark[b]
Sulfate					N/A	N/A	
Background	15/15	416	3720	2566			
Current Plume	34/34	1650	3700	3154			
Historical Plume		3100	4900	3945			
Uranium					0.044		
Background	15/15	0.0228	0.0662	0.0469			53
Current Plume	34/34	0.0241	2.5	0.304			94
Historical Plume		0.29	0.45	0.3			
Vanadium						0.26N	
Background	10/15	0.001	0.0049	0.0019			0
Current Plume	16/34	0.001	0.832	0.0857			18
Historical Plume		5.2	14	7.1			
Zinc						11N	
Background	1/17	0.004	0.0051	N/A			0
Current Plume	19/34	0.004	0.352	0.0349			0
Historical Plume		2.6	6.7	4.5			
Background Wells: 713, 715, 745, 1020, 1021, 1023, 1025, CW21							
Plume Wells: 590, 736, 740, 1000-1002, 1010-1019, 1022							

MCL=maximum concentration limit
RBC = risk based concentration
[a] N—noncarcinogenic risk, C—carcinogenic risk
[b] Benchmark = MCL if available; risk-based concentration (RBC) used if no MCL.
[c] Historical data were collected 1983 to 1989.
[d] Site-specific value determined through geochemical modeling; inhalation pathway.

For contaminants with MCLs, it is interesting to compare these with calculated RBCs. For example, the MCL for arsenic, is 0.05 mg/L, the RBCs are 0.001 and 0.000045 mg/L for noncarcinogenic and carcinogenic effects, respectively. Thus the MCL was set at a level higher than that believed to result in some adverse health effect. On the other hand, the MCL for molybdenum is 0.1 mg/L and the RBC is 0.18 mg/L. Therefore, the MCL is more protective than the RBC. There are a variety of contaminant-specific reasons for differences between MCLs and RBCs, and that discussion is beyond the scope of this document. However, for purposes of risk management and decision-making, it is necessary to have some appreciation of what these benchmarks mean.

A comparison of historical and current plume data indicates that concentrations of many constituents have decreased. This is true for all COPCs except uranium and nitrate, though maximum plume concentrations for iron and fluoride are higher compared to historical data. A comparison of current background and plume data indicates that plume concentrations for nitrate and ^{226}Ra + ^{228}Ra (which is mostly ^{226}Ra) are within the range obtained for background. Mean plume concentrations of nitrate are far below the average background mean; plume and background mean concentrations for ^{226}Ra + ^{228}Ra are essentially the same. Therefore, on the basis of a comparison to background, it is possible to eliminate nitrate and ^{226}Ra + ^{228}Ra from further consideration as COPCs.

The presence of fluoride in elevated levels associated with the site is problematic. Although fluoride is a process-related contaminant at other uranium milling sites, research of milling operations at the Grand Junction site gave no indication that fluoride was used in any form.

However, the maximum and mean concentrations of fluoride in plume-related wells are four-times and two-times that of background, respectively. Although process knowledge would seem reason to eliminate fluoride as a site-related contaminant, it is retained for further analysis pending some explanation for its elevated concentrations in alluvial ground water at the site.

Sulfate is present in alluvial ground water throughout the Grand Valley in relatively high concentrations, though concentrations are higher, on average, in association with the Grand Junction site. Sulfuric acid was used in processing operations at the site, and some of the ores processed were known to contain sulfide minerals. Therefore, sulfate is a site-related contaminant. However, the highest background concentration of sulfate exceeds any values detected in plume-related wells. Also, sulfate in ground water near the site shows no distribution, such as decreasing concentrations with distance from the site, as would be expected for a plume that is clearly associated with site practices. In terms of risk to human health, there is still no consensus regarding what levels of sulfate intake are detrimental. A secondary drinking water standard of 250 mg/L has been established on the basis of aesthetic concerns, though significantly higher concentrations are believed to produce no ill effects in humans. Because of the lack of an established risk-based benchmark for sulfate, it is not carried through the risk calculations presented in this section. However, because of the elevated levels that are present in plume-related ground water, it is retained as a COPC.

Through a qualitative evaluation, all the other COPCs are deemed to be present in concentrations sufficiently elevated above background to be retained for further consideration in the update of risk calculations.

6.1.2.2 Risk Assessment Methodology

As mentioned previously, the original BLRA considered several potential routes of exposure to contaminants and eliminated all but one, ingestion of ground water in a residential setting, as insignificant. Therefore, the ground water ingestion pathway is the only route of exposure considered in this BLRA update (with the exception of ammonia as discussed below). Note that all risks discussed in this document are hypothetical with respect to human health. Based on current ground water use, no risks are present as no exposure pathways are complete. Thus this assessment concerns only potential risks that could exist in the future if land and water usage changes.

Risk calculations presented here follow EPA's *Risk Assessment Guidance for Superfund Methodology* (EPA 1989a), which involves determining a point estimate for excess cancer risk from current or potential carcinogenic exposures and a hazard quotient (HQ; ratio of exposure intake to an acceptable intake) for noncarcinogenic exposures. It is assumed that the receptors for ground water are residents who use alluvial ground water as their primary source of drinking water. This is an unlikely scenario because of current land use in the vicinity of the site and because of the institutional controls in place (see Section 7.2) but is consistent with the scenario evaluated in the original BLRA. However, for the purposes of making risk management decisions, results of these risk calculations are based on very conservative assumptions.

The original BLRA calculated noncarcinogenic risks using a probabilistic approach. Essentially, this means that instead of using a single value for each parameter required in the risk calculations (e.g., ground water concentration, body weight, frequency of exposure), a range of values with a given probability distribution was used. By performing numerous iterations of the standard risk calculations, with a value selected at random from each parameter distribution, a range of exposures and associated risks results. The original BLRA reported results for the most sensitive receptor population modeled—children.

In this update, which uses point-exposure doses, single values are used for each parameter required in the risk calculations. Calculations to determine contaminant intakes use standard exposure factors for the adult population (EPA 1989b). Ground water concentrations used to calculate risks associated with ingestion of plume-related ground water are the maximum concentrations detected during the 1998 sampling events, most of which were from on-site wells. Although use of adult exposure data is probably less conservative than use of the exposure data for children, use of maximum ground water concentrations and point-exposure dose calculations is probably more conservative; the net effect is to produce comparably conservative results. For purposes of making risk management decisions, results of both methodologies are usable and both have their advantages and limitations.

Risks associated with ammonia were generally calculated as described above for other noncarcinogens with one important exception. For all contaminants except ammonia, risks were determined for ingestion of contaminated ground water (i.e., an oral exposure route) in a residential setting. The major risk concern ammonia is not through oral ingestion in groundwater, but rather from inhalation of ammonia in the gaseous form through volatilization from ground water. Risks were calculated using default inhalation exposure parameters for a residential setting (EPA 1991). The volatilization factor for ammonia and the fraction of ammonia actually present as the dissolved gas, NH_3, were determined through site-specific geochemical modeling with the PHREEQC modeling code (see Section 4.3.3.1 and Appendix I for more details).

Note that risks associated with ammonia for a residential setting requires that exposure occurs within a closed structure (i.e., a residence) in which volatilized ammonia is trapped through its use for all other purposes (drinking, bathing, laundry, etc.). For exposure scenarios where a closed structure is absent (e.g., irrigation and agricultural), volatilized ammonia would quickly dissipate to the atmosphere and risks would be negligible (at least at the concentrations present in ground water at the Grand Junction site). Therefore, exposure to ammonia is only evaluated here for a residential setting.

The same methodology was used to calculate carcinogenic risks for this BLRA update as was used in the original BLRA (i.e., receptors are adults with exposure averaged over 70 years). For all risk calculations, benchmarks for acceptable contaminant intakes (e.g., reference doses, slope factors) are best available data from standard EPA sources (e.g., Integrated Risk Information System, Region III Risk-Based Concentration Table).

6.1.2.3 Results

Results of the risk calculations are included in Tables 6–2 and 6–3. Table 6–2 shows risk calculations for maximum and mean plume concentrations for both noncarcinogenic and carcinogenic contaminants. Values for ammonia represent concentrations present as NH_3 as determined through geochemical modeling. Table 6–3 shows the same calculations for maximum background concentrations. The tables also show the percentage that each noncarcinogenic contaminant contributes to the total HI (or overall risk).

Table 6–2. Risk Calculations for 1998 Maximum and Mean Plume Concentrations

Non-Carcinogens - Groundwater Ingestion Only (Adults)

Contaminant	CW-MAX	HQ-MAX	%Risk	CW-MEAN	HQ-MEAN	%Risk
	mg/L			mg/L		
Arsenic	0.0349	3.187	8.13	0.005	0.4566	6.42
Cadmium	0.0013	0.071	0.18	0.001	0.0548	0.77
Cobalt	0.0162	0.007	0.02	0.007	0.0032	0.04
Fluoride	7.57	3.457	8.81	1.93	0.8813	12.39
Iron	21.2	1.936	4.94	3.88	0.3543	4.98
Manganese	4.54	2.646	6.75	2.82	1.6438	23.12
Molybdenum	0.299	1.638	4.18	0.101	0.5534	7.78
Nickel	0.111	0.152	0.39	0.035	0.0479	0.67
Uranium	2.5	22.831	58.22	0.304	2.7763	39.05
Vanadium	0.832	3.256	8.30	0.0857	0.3354	4.72
Zinc	0.352	0.032	0.08	0.0349	0.0032	0.04
	HI=	39.215		HI=	7.1103	

Non-carcinogens - Inhalation through water use in residential setting*

Contaminant	CW-MAX	HQ-MAX	%Risk	CW-MEAN	HQ-MEAN	%Risk
Ammonia	0.655	4.706	100	0.201	1.444	100

*IR = 15 m^3/d of air default; concentration in air = water concentration x site-specific volatilization factor x conversion factor

For Grand Junction, volatilization factor = .000595; conversion factor is 1000L/m3

Maximum NH3 in Grand Junction ground water is 1.1 mg/L, mean is .337 mg/L

Contaminant		CW	Risk
Arsenic	max	0.0349	6.15E-04
mg/L	mean	0.005	8.81E-05
U234+238	max	1668	1.86E-03
pCi/L	2nd	422	4.71E-04
	mean	2.15E+02	2.41E-04

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Table 6–3. Risk Calculations for 1998 Maximum Background Concentrations

Non-Carcinogens - Background Groundwater Ingestion Only (Adults)

Contaminant	CW	HQ	%Risk
	mg/L		
Arsenic	0.0014	0.128	2.82
Selenium	0.137	0.751	16.53
Fluoride	1.62	0.740	16.29
Iron	3.13	0.286	6.30
Manganese	2.22	1.294	28.50
Molybdenum	0.124	0.679	14.96
Nickel	0.0281	0.038	0.85
Uranium	0.0662	0.605	13.32
Vanadium	0.0049	0.019	0.42
Zinc	0.0051	0.000	0.01
	HI=	4.540	

Carcinogens - Groundwater Ingestion Only (Adults)

Contaminant		CW	Risk
Arsenic	mg/L	0.0014	2.47E-05
U234+238	pCi/L	57	6.37E-05

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The following major observations are based on these results:

- Risks associated with maximum concentrations of contaminants in plume ground water greatly exceed the acceptable HI of 1 for noncarcinogens. Risks calculated using mean contaminant concentrations are significantly lower, though still unacceptable.

- Uranium is the main risk contributor to noncarcinogenic risks posed by plume ground water (58 percent contribution to the HI using maximum concentrations).

- All carcinogenic risks calculated for $^{234}U + ^{238}U$ associated with plume ground water exceed the upper end of EPA's acceptable risk range (1×10^{-4} to 1×10^{-6}). Carcinogenic risks calculated for background ground water are within EPA's risk range.

- Noncarcinogenic risks posed by background ground water (calculated using maximum detected contaminant concentration) exceed the acceptable HI of 1.

It was noted previously that several metals identified as COPCs in the original BLRA have decreased significantly in concentration since that time, though they still were somewhat above background. These metals include cadmium, cobalt, nickel, and zinc. The relative contribution of these contaminants to overall noncarcinogenic risk indicates that they are insignificant, both individually and collectively. These four metals make up less than 1 percent of the total risk considering maximum plume concentrations and less than 2 percent for mean concentrations. Therefore, these contaminants can be eliminated from further consideration as final COPCs for the site.

As mentioned above, the major risk contributor for ground water ingestion is uranium. Other significant risk contributors (4 percent or greater) are the same for maximum and average calculations, though relative contributions vary. Those other contaminants are arsenic, fluoride, iron, manganese, molybdenum, and vanadium. Risks associated with inhalation of ammonia exceed acceptable levels. In terms of carcinogenic risk, maximum plume concentrations of arsenic exceed EPA's acceptable risk range, though the mean risk values lie within this range. All levels of $^{234}U + ^{238}U$, from mean to maximum, exceed EPA's acceptable risk range.

Several of the contaminants included as significant risk contributors do not exceed their individual RBCs. However, they cannot be eliminated from further consideration because, in terms of collective risk posed by ground water, they are important. Likewise, although arsenic does not exceed its MCL, from a risk perspective it is still a significant contributor to site risks.

The greatest contributors to background risks through ground water ingestion are manganese selenium, floride, and molybdenum; uranium is of lesser importance. However, those contaminants collectively responsible for the majority of background and plume risks are the same, with two exceptions. Vanadium makes up a significant amount of risk for plume ground water but is unimportant in terms of background. Selenium, which is essentially nondetectable in plume wells, is a significant contributor to background risk. Other than these two constituents, the majority of risk in both instances is made up of arsenic, fluoride, iron, manganese, molybdenum, and uranium. (Risks were not determined for inhalation of ammonia because of insignificant concentrations of actual NH_3.)

To summarize, ingestion of either site-related or background ground water as the sole source of drinking water would result in unacceptable human health risks. Site-related ground water may pose both carcinogenic and noncarcinogenic risks, both of which are primarily attributed to uranium (in isotopic and chemical forms). The other significant contributors to risk are ammonium (through inhalation), arsenic, fluoride, and vanadium, and to a lesser extent iron, manganese, and molybdenum. Background water quality is a threat to human health from a noncarcinogenic standpoint; carcinogenic risks are within the EPA acceptable range. Noncarcinogenic risks for background ground water are primarily due to manganese, molybdenum, selenium, and fluoride, and to a lesser extent iron and arsenic. A summary of the updated evaluation of COPCs is presented in Table 7–2.

Although risks posed by sulfate were not assessed due to lack of acceptable toxicity data, sulfate concentrations are high in both plume and background ground water. Sulfate should be considered a potential threat to human health for plume and background ground water pending additional guidance on assessing sulfate-related risks.

All risk estimates are based on the assumption that contaminated ground water will be used as the primary source of drinking water in a residential setting. This is a worst case assumption because of the poor water quality of the alluvial aquifer and the availability of a municipal water supply. No human health risks are currently posed by contaminated ground water, nor are any expected, as water is not currently or likely to be used for residential purposes. As long as ground water use is prohibited for this use, no exposure pathway is complete and no risks exist.

6.2 Ecological Risk Assessment

The BLRA prepared for the Grand Junction site (DOE 1995) included a screening-level assessment of ecological risks. The BLRA identified ecological COPCs and potential exposure pathways, receptors, and adverse effects. During the 1998 investigation (Section 4.4) additional field data were collected to evaluate risks associated with the exposure pathways. Results were used to update the BLRA. The approach used for the BLRA update was based on guidance in *Guidelines for Ecological Risk Assessment* (EPA 1998) and *Framework for Ecological Risk Assessment* (EPA 1992).

This section summarizes the 1995 BLRA and the results of the 1998 BLRA update. Appendix I__ contains the complete BLRA update.

6.2.1 Summary of 1995 Risk Assessment

The 1995 BLRA (DOE 1995) evaluated potential exposure of terrestrial and aquatic organisms to contaminated ground water and to surface water or sediment contaminated by ground water. Known concentrations of ecological COPCs in ground water, surface water, and sediment were compared to toxicity standards and guidelines for various ecological receptors.

6.2.1.1 Potential Receptors

The 1995 BLRA identified ecological receptors that could be exposed to site-related contaminants. The information was derived from qualitative surveys and observations made before tailings were removed and, therefore, is not necessarily indicative of current conditions or future land use.

Before tailings were removed, the ecology of the site consisted of an interspersion of riparian and aquatic habitats. Riparian vegetation dominated by salt cedar thickets covered several small islands and shorelines formed by Colorado River side channels and back waters. Cottonwood, Russian olive, and willow, which broke up the salt cedar thickets in some places, were less abundant. The understory vegetation consisted of several dense, open stands of reed canary grass, spotted knapweed, and giant reed with rushes, sedges, spikerushes, bullrush, and arrowhead common along the shores of side channels and in small wetlands on the islands. Yellow warbler, mourning dove, song sparrow, and black-billed magpie were observed in the salt cedar and willow stands. Mallard and great blue heron were common on the water or on the shore. Evidence of beaver, muskrat, raccoon, and skunk was also common, as was evidence of bull frog and leopard frog. Bald eagles, the only endangered terrestrial species potentially exposed to site contaminants, are known to winter in the area.

The following aquatic organisms were observed in the vicinity of surface water sampling locations in the Colorado River: mayfly nymphs, damselfly nymphs, dragonfly nymphs, water striders, backswimmers, and Cyprindae minnows. Game fish known to inhabit the area include green sunfish, bluegill, largemouth bass, black crappie, black bullhead, and channel catfish. Bluehead sucker, flannelmouth sucker, common carp, roundtail chub, red shiner, sand shiner, and fathead minnow also inhabit the area. Threatened or endangered fish potentially exposed to site contaminants include the humpback chub, bonytail chub, Colorado squawfish, and razorback sucker.

After the removal of tailings in 1994, the site was seeded with a mixture of grasses, forbs, and shrubs, and eight ponds were constructed along the southern boundary of the site between the flood control levee and the Colorado River. The ponds were constructed as part of a U.S. army Corps of Engineers effort to reestablish wetland habitat destroyed as a consequence of site remediation. The ponds were fed by contaminated ground water from the site. Colorado River flooding during the late spring and early summer of 1995 mostly destroyed the eight ponds.

6.2.1.2 Ecological Chemicals of Potential Concern

Ecological COPCs were defined in the 1995 BLRA as those constituents that exceeded background concentrations (Table 6–4). The water quality of upgradient wells was considered to be representative of background conditions (DOE 1995). Two categories of surface water were defined: Colorado River water and water in ponds constructed as part of a wetlands mitigation project. Colorado River COPCs were those constituents with higher concentrations downstream of the millsite than upstream. COPCs in the wetlands mitigation ponds were determined by comparing concentrations in the ponds and in the upgradient ground water wells (DOE 1996d). Sediment COPCs were determined by comparing data from Colorado River sediment sampled upstream, downstream, and adjacent to the site (DOE 1995).

6.2.1.3 Potential Adverse Effects

The 1995 BLRA evaluated the following potential exposure using data available at the time:

- Plant uptake of ground water
- Use of ground water to water livestock or irrigate crops
- Exposure of aquatic life in Colorado River water and sediments

- Livestock and terrestrial wildlife ingestion of surface water from ponds fed by site ground water
- Exposure of aquatic life in ground-water-fed ponds
- Use of pond water for crop irrigation

Table 6–4. Summary of Ecological Chemicals of Potential Concern in Ground Water, Surface Water, and Sediments

Constituents Above Background in Ground Water	COPC in Ground Water	Ecological COPC in Colorado River Water	Ecological COPC in Water in Wetlands Mitigation Ponds	Ecological COPC in Colorado River Sediment
Ammonium		X		
Arsenic	X		X	
Cadmium	X		X	
Cobalt	X		X	
Copper		X		
Fluoride	X		X	
Iron	X	X	X	
Manganese	X		X	
Molybdenum	X		X	X
Nickel	X		X	
^{226}Ra	X	X	X	
Selenium				X
Strontium	X			X
Sulfate	X		X	X
Uranium	X	X	X	X
Vanadium	X	X	X	
Zinc	X		X	

Phreatophytes, plants that have the potential to root into contaminated ground water, were not sampled. Concentrations of COPCs in plant tissue were estimated using published soil-to-plant concentration ratios (DOE 1995). The potential for adverse effects was evaluated by comparing the tissue estimates to published benchmark concentrations that can result in phytotoxicity (Will and Suter 1994). Hazard indices (HIs) were calculated by dividing the plant tissue concentration by the benchmark concentration; an HI greater than one indicates a possible phytotoxic effect. HIs for arsenic, manganese, vanadium, and zinc ranged from 3.5 to 34. HIs for cobalt and copper were only slightly greater than one (DOE 1996d).

Ground water pumped from the most contaminated area of the plume may be toxic if used to water livestock or wildlife or to irrigate crops. Sulfate and TDS concentrations exceed levels that may be toxic if ingested by livestock or wildlife. Comparisons of ground water concentrations with toxicity benchmarks indicate that cobalt, fluoride, iron, manganese, molybdenum, vanadium, and zinc exceed levels that may have adverse effects on irrigated crops.

Contaminant concentrations in the two wetlands mitigation ponds at the southwestern edge of the site were higher than concentrations in nearby upgradient ground water wells (DOE 1996d). For example, in 1995 the uranium concentration in surface water of the westernmost pond was 0.473 mg/L, and the concentration in ground water 200 ft (60 m) upgradient (well 1000) was

0.096 mg/L. The higher concentration in the pond was attributed to evaporation. Water chemistry data for samples taken from the wetlands mitigation ponds before they were destroyed by floods, when compared to water quality standards, indicate that cadmium, manganese, and vanadium concentrations exceeded chronic toxicity benchmarks for aquatic life and manganese, molybdenum, sulfate, and vanadium concentrations exceeded toxicity benchmarks for livestock watering, crop irrigation, and ingestion by wildlife.

6.2.2 BLRA Update

The 1998 ecological investigation (Section 4.4) was conducted to provide the following data to update the 1995 BLRA:

- Characterization of current plant communities overlying contaminated ground water and projections of the future plant ecology of the area given land-use scenarios.
- Selection and characterization of the plant ecology of a reference (background) area.
- Comparison of ecological COPC concentrations in vegetation, sediment, and surface water, on site and in the reference areas, with ecotoxicity benchmarks.
- Screening assessment of ecological risks associated with irrigation ponds constructed at the botanical gardens since publication of the BLRA.

The results of the 1998 ecological sampling and analyses (Appendix I) indicate generally low levels of a few COPCs in sediment, surface water, and plant tissues. The occurrences of significantly elevated concentrations coincide with sampling locations that are known to be either remnants of the wetlands mitigation ponds or ponded areas that receive little or no regular surface water flushing.

Based on sample size and variability, the strongest line-of-evidence factors for basing risk conclusions are the surface water and sediment results. In spite of necessarily smaller sample sizes, the biota data serve as an additional but significant line of evidence. Tissue results show that for the majority of the analytes, Grand Junction site concentrations are the same as or less than the reference area concentrations.

The majority of the data indicate no significant differences between Grand Junction site and reference area mean analyte concentrations in both abiotic and biotic media. To maintain a conservative approach, the following constituents were retained as COPCs even though their occurrences appear to be isolated. In most cases, the occurrences coincide with Grand Junction site location 1228. On the basis of an initial evaluation of the analytical data for the 1998 ecological sampling, it is recommended that the following COPCs be retained:

- Ammonia in surface water
- Nickel in surface water
- Uranium in surface water
- Vanadium in surface water
- Arsenic in reed canarygrass stems
- Vanadium in reed canarygrass stems
- Manganese in cattail stems

- Molybdenum in cattail stems
- Molybdenum in cattail roots

One of the objectives of the 1998 field investigation was to collect data from areas that might have the highest contaminant levels. The highest values were obtained from ponded areas (locations 1226, 1228, and 1235, see Figure 4–15) where the Colorado River provides little or no natural flushing.

Because the occurrences are localized, elevated concentrations of ammonia and some metals in surface water and vegetation at these locations probably do not present an unacceptable ecological risk. Although unlikely, the possibility remains that an isolated effect or mortality could be associated with these locations; however, no negative ecological effects have been observed.

Location 1226 (Figure 4–15) is located at the Botanical Gardens pond. This pond is small, fenced, and provides no significant ecological habitat. The ecological sampling for surface water at this location did not include all parameters listed on the State of Colorado agricultural standards (Colorado Department of Health, Water Quality Control Commission, *The Basic Standards for Ground Waters*, Section 3.11.0, amended April 1996). For those analytes that were included on this list, only the pH value of 9.07 was elevated over the recommended maximum value of 8.5. Based strictly on the surface water results for the ecological sampling event, there is no indication that this pond should not be used to irrigate the plants in the arboretum. It is recommended that the surface water be analyzed for the complete list of agricultural parameters to ensure compliance.

The other ponded areas (Figure 4–15, locations 1228 and 1235) are very small and are located on a braided portion of the river. Their small size (estimated to be no more than 1,000 square feet each) restricts the numbers and types of ecological receptors that rely solely on them for surface water, forage, or prey species. In addition, wildlife receptors typically utilize a variety of prey or forage items.

Manganese concentrations in cattail stems averaged 860 mg/kg at the Grand Junction site and 300 mg/kg at the reference area. Before the bioaccumulation factors for manganese were calculated, the plant tissue concentrations were plotted against the sediment concentrations to detect a linear correlation. A correlation coefficient of 0.77 was obtained for the manganese data, and an r^2 of 0.6 was calculated for the linear regression trend line. Bioaccumulation factors were obtained by dividing the maximum co-located tissue concentration by the minimum co-located sediment concentration. Bioaccumulation factors calculated for manganese were approximately equal for the Grand Junction site and reference area (4.5 and 3.9, respectively). The manganese sediment concentrations for the Grand Junction site and reference area locations did not differ significantly and were all between 200 and 300 mg/kg. The screening benchmark for terrestrial plant phytotoxicity is given as 500 mg/kg in soil (ORNL 1996). A mature leaf tissue manganese concentration range of 200 to 1,000 mg/kg (dry weight) was cited as toxic in the BLRA (Kabata-Pendias and Pendias 1992, cited in DOE 1995). Manganese appears to bioaccumulate in cattail stems to a significant level at both the millsite locations and the reference area.

According to Kabata-Pendias and Pendias (1992), "the Mn compounds are known for their rapid oxidation and reduction under variable soil environments, and thus oxidizing conditions may greatly reduce the availability of Mn and associated micronutrients, whereas reducing conditions may lead to the ready availability of these elements even up to the toxic range."

Therefore, it is possible that under stagnant conditions manganese may become highly bioavailable to cattails, thereby producing a high concentration such as that observed at Location 1226 (914 mg/kg wet weight). Reducing conditions at the other two Grand Junction site locations (1231 and 1235) might also account for the elevated manganese concentrations in cattails. It is noteworthy that most elevated concentrations of metals in biota occurred at generally stagnant ponded areas that represent the remnants of the mitigation wetlands ponds, especially locations 1228 and 1235.

Since the data evaluation did not indicate an unacceptable ecological risk at the Grand Junction site, the ecological risk assessment concludes with the analysis phase (See Appendix I). Exposure estimates and stress-response profiles were not calculated, and no risk characterization was performed.

Some residual milling-related constituents apparently persist at the Grand Junction site, as shown by the occasional elevated concentrations of metals and ammonia in surface water and biota. Based on a review of the analytical data and screening criteria, these isolated occurrences are not likely to present significant ecological risks.

Natural flushing is expected to diminish ground water COPC concentrations to negligible levels and prevent bioaccumulation of contaminants through phreatophytes growing in the terrestrial habitat. This situation depends on the future land use at the millsite.

Elevated concentrations of COPCs in surface water, sediment, and biota are expected to diminish over time as a result of natural ground water flushing. The sediment concentrations do not indicate site-related contamination, although elevated concentrations in some of the biota suggests that some degree of bioaccumulation is occurring. Constituent concentrations in sediment and biota are likely to persist for a longer period of time. Periodic flooding of the Colorado River adjacent to the site will tend to disperse these contaminants and remove the remaining boundaries of the mitigation wetlands ponds.

7.0 Ground Water Compliance Strategy

7.1 Process

The proposed ground water compliance strategy for the Grand Junction site is illustrated in Figure 7–1; the figure is based on the compliance strategy selection framework described in Section 2.1 of the *Final Programmatic Environmental Impact Statement for the Uranium Mill Tailings Remedial Action Ground Water Project* (DOE 1996c).

Three compliance strategies are available in the selection framework:

- **No remediation**. Application of the no-remediation strategy would mean that compliance with EPA ground water protection standards would be met for a particular constituent without altering the ground water or cleaning it up in any way. This strategy could be applied at sites where chemicals of potential concern are below the MCL or background, or at sites that have contamination above MCLs or background levels but qualify for supplemental standards or ACLs.

- **Natural flushing**. Natural flushing relies on natural ground water movement and geochemical processes to decrease contaminant concentrations to levels within regulatory limits in a given time period. This strategy could be applied at sites where ground water compliance would be achieved with natural flushing in 100 years, where effective monitoring and institutional controls could be maintained, and where the ground water is not currently and is not projected to be a drinking water source.

- **Active ground water remediation**. Active ground water remediation requires the application of engineered ground water remediation methods such as gradient manipulation, ground water extraction and treatment, and in situ ground water treatment to achieve compliance with EPA ground water protection standards.

7.2 Site-Specific Compliance

To achieve compliance with Subpart B of 40 CFR 192 at the Grand Junction site, the DOE proposed action is no remediation and application of supplemental standards based on the criteria for limited use ground water (40 CFR 192.21[g]). For ground water to be classified as limited use, at least one of three criteria must be met:

- TDS concentrations are at least 10,000 mg/L.

- Widespread ambient contamination not due to ore-processing activities exists that cannot be cleaned up using treatment methods reasonably employed in public water supply systems.

- The quantity of water reasonably available for sustained continuous use is less than 150 gallons per day.

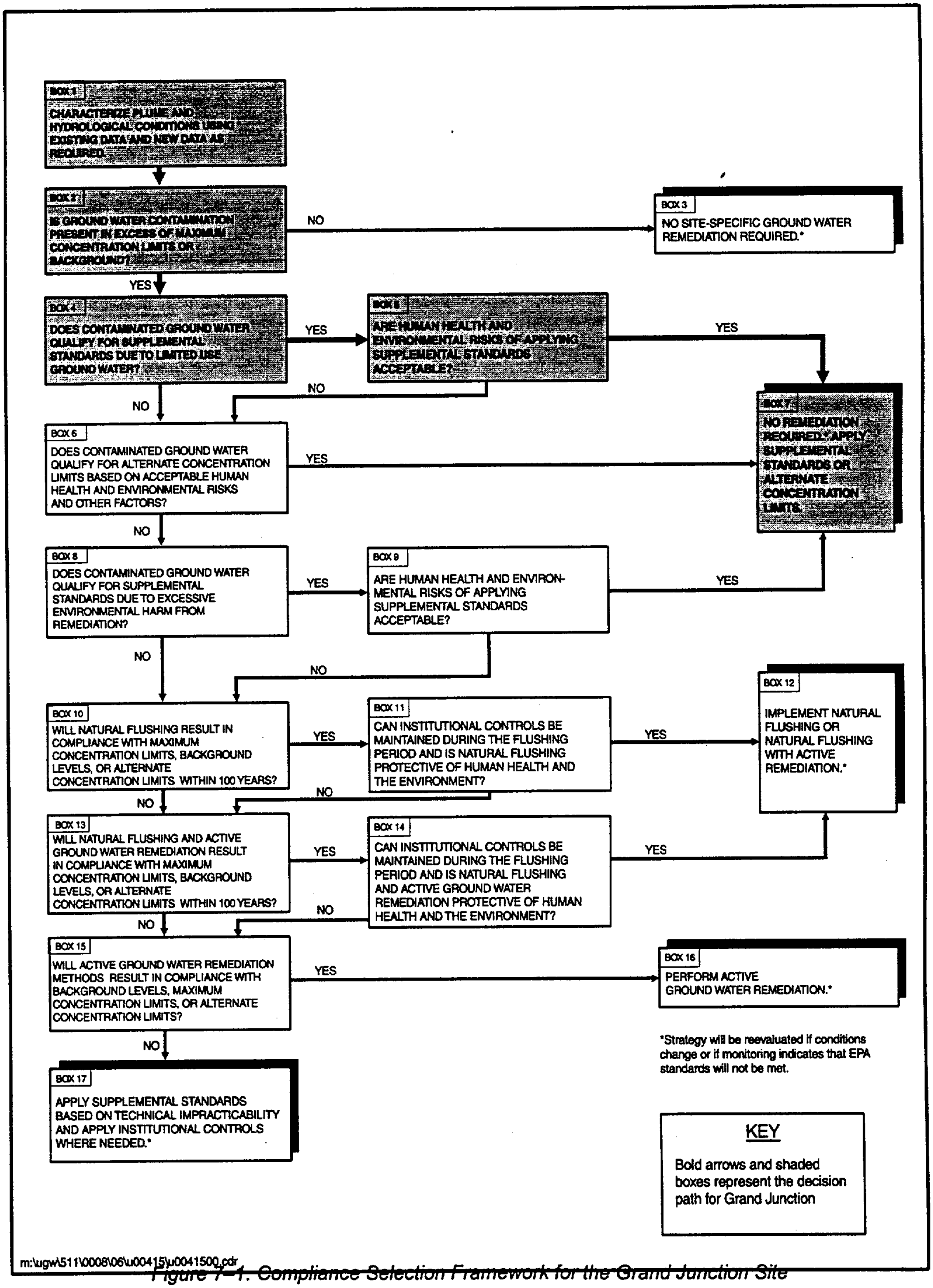

Figure 7–1. Compliance Selection Framework for the Grand Junction Site

The second criterion applies to alluvial ground water at the Grand Junction site and is the basis for the classification of limited use. Ground water in the uppermost aquifer is not a current or potential source of drinking water.

The applicability of supplemental standards at the Grand Junction site is described in this section, and the potential risk to human health and the environment was addressed in the BLRA (DOE 1995); updated risk information is presented in Section 6 of this document. This proposed action was determined by applying the compliance strategy selection framework shown in Figure 7–1.

7.2.1 Assessment of Environmental Data

7.2.1.1 Background

The original SOWP (DOE 1996d) indicated that the criterion of widespread ambient contamination in the alluvial aquifer of the Grand Valley might be justified. This premise was based on the following evidence from the original SOWP.

- Naturally occurring levels of molybdenum, selenium, and uranium in upgradient and regional ground water exceed UMTRA Project MCLs or national primary drinking water standards. A study of northwestern Colorado municipal water systems, which did not include Grand Junction specifically, concluded that ground water with types and levels of contamiants similar to those in the alluvial aquifer would not be adequately cleaned up for human consumption using reasonably available treatment systems. From discussions with U.S. Bureau of Reclamation personnel, it was learned that water would continue to leak out of unlined canals upgradient of the site and leach naturally occurring constituents from the Mancos Shale, further contributing to widespread ambient contamination.

- The BLRA concluded that alluvial ground water quality in the area is naturally poor, was not currently being used, and that local institutional controls required new developments to hook up to city water. Water that was being discharged into the Colorado River did not appear to represent unacceptable risks to human health or the environment.

7.2.1.2 Hydrologic Assessment

The first step in the decision process was an assessment of both historical and new environmental data collected to characterize hydrogeologic conditions and the extent of ground water contamination related to uranium processing at the site. The three main hydrogeologic units beneath the Grand Junction site are the unconfined alluvial aquifer, the underlying aquitard composed primarily of shale units in the Cretaceous Dakota Sandstone, and the confined aquifer in sandstones of the Dakota Sandstone. The alluvial aquifer is considered the uppermost aquifer at the site. Surface components of the hydrologic system in the area include the Colorado River along the south boundary of the site and irrigation canals and ditches north of the site.

The alluvial aquifer is composed of unconsolidated clays, silts, sands, gravels, and cobbles. Ground water is unconfined in the alluvial aquifer; depth to the water table ranges from zero near the river to approximately 20 ft at the northern end of the site. The saturated thickness of the aquifer ranges from 5 to 20 ft. Ground water generally flows to the southwest toward the Colorado River at a horizontal gradient of approximately 0.004. The alluvial aquifer is recharged by infiltration of precipitation directly on the site, leakage from upgradient irrigation canals and ditches in the area, and infiltration of river water during spring runoff in the Colorado River. Seasonal fluctuations in water levels beneath the site range from 2 to 5 ft in response to changes in river stage. Limited amounts of recharge also occur as upward leakage of ground water from the underlying Dakota Sandstone aquifer. Ground water discharge is primarily limited to drainage into the river during low stage. Some discharge also occurs as evapotranspiration from vegetation growing in areas of shallow ground water depth near the Colorado River. Hydraulic conductivity in the alluvial aquifer ranges from 20 to over 200 ft/day, based on aquifer pumping tests in several monitor wells. The variability is a result of lateral and vertical facies changes typically found in an alluvial depositional environment and from other boundary conditions in the vicinity. The average linear ground water velocity beneath the site is 2.0 ft/day, based on an estimated average hydraulic conductivity of 100 ft/day, a hydraulic gradient of 0.004, and an effective porosity of 0.20.

Underlying the alluvial aquifer is a shale aquitard composed of low-permeability shale units in the Dakota Sandstone. Thickness of the shale aquitard in the Dakota may be as much as 50 ft; depths to the top of the aquitard range from less than 10 ft to more than 75 ft below the ground surface. Although the shale unit is regarded as an aquitard, wells completed within the unit indicate that it is saturated with ground water. Horizontal hydraulic conductivity for the aquitard is variable depending on the degree of weathering of the unit, but the lower end of the range for unweathered material may be as low as 0.02 ft/day. Previously collected data indicate that vertical hydraulic gradients are generally upward, with a few exceptions noted during high water levels in the alluvial aquifer associated with high river stages.

The confined aquifer in sandstones of the Dakota Sandstone underlies the shale aquitard. This aquifer has not been extensively characterized during site investigations because of the presence of the overlying aquitard and vertical upward hydraulic gradients that minimize the potential for any infiltration of contamination from the alluvial aquifer. Recharge to the Dakota Sandstone occurs as infiltration of precipitation on outcrops to the south. Ground water flow direction in the Dakota beneath the site likely follows regional gradients, which vary between a northwest and a northeast orientation. Sparse information on hydraulic conductivity for this unit indicates a range from 0.02 to 0.13 ft/day.

7.2.1.3 Ground Water Contaminants

The second step in the decision process was to compare the list of ground water contaminants to MCLs or to concentrations in background ground water. A modified list of COPCs identified in the 1995 BLRA was evaluated using 1998 sampling data. Potential risks calculated using the recent data for a residential scenario indicated that the major risk contributors were uranium, ammonia, iron, manganese, molybdenum, and vanadium. Although there is no consensus as to what concentration of sulfate is acceptable in drinking water, concentrations detected in the site ground water are sufficiently high to be of probable concern. A discussion of COPCs is presented in section 6.1.2, and data are presented in Table 6–1.

7.2.1.4 Applicability of Supplemental Standards

The third step in the decision process determines whether contaminated ground water qualifies for supplemental standards on the basis of limited use ground water. Ground water in the unconfined alluvial aquifer is of limited use because of widespread, elevated concentrations of naturally occurring uranium and selenium.

Background Concentrations

Uranium values for background ground water average 0.047 mg/L (the MCL is 0.044 mg/L). Activity concentrations for $^{234}U + ^{238}U$ average 42 pCi/L, well above the 30 pCi/L MCL. Analytical data for the background ground water quality is shown in Table 7–1 and Appendixes D and H.

Selenium values average 0.04 mg/L; the UMTRA MCL is 0.01 mg/L. Selenium concentrations are high in some wells and not detected in others. The population is bimodal; if the nondetect values are assumed to be the detection limits, the average of 0.04 mg/L is above the MCL of 0.01 mg/L. Previous studies by the U.S. Geological Survey found concentrations of selenium in valley ground water up to 0.88 mg/L (Butler et al. 1994).

The source of uranium and selenium in background ground water is thought to be the dark marine shales in the Mancos Shale (discussed in Section 5.1.2.2). Black shales are known to contain unusually high concentrations of uranium (Levinson 1974), and Late Cretaceous marine shales, such as the Mancos, are known to have high concentrations of selenium (USGS 1997). These shales underlie most of the valley and are leached by ground water moving to the south and southwest.

Other constituents in background ground water that have concentrations above the secondary drinking water standards in the Safe Drinking Water Act include chloride, iron, manganese, sulfate, and TDS (Table 7–1). Although the secondary drinking water standards are not enforceable, they do indicate that the background ground water is of poor quality. The mean TDS concentration for background ground water is 5,238 mg/L, which is below the 10,000 mg/L that defines a limited-use aquifer, but still elevated. The data for uranium and selenium concentrations support the use of the criterion of widespread ambient contamination in the alluvial aquifer.

Reasonableness of Ground Water Treatment

Ground water from the alluvial aquifer is not a current or potential source of drinking water. Potable water is readily available from the municipal water system in the vicinity of the site. Ground water from the alluvial aquifer has no current use, and there is no historical record of wells completed in this unit beneath or downgradient of the site. Future use of ground water from the alluvial aquifer is unlikely based on historical information and the planned future development of a park and recreational facilities in the area. Therefore, the current and reasonably projected uses of site-affected ground water would be preserved with the application of supplemental standards.

Table 7–1. Summary of Grand Junction 1998 Water Quality

Contaminant	Maximum mg/L	Mean mg/L	MCL mg/L	SMCL mg/L	RBC mg/L
Ammonia (as NH_4)					
Plume	233	71.4			0.20 (as NH_3)
Background	0.321	0.093			
Arsenic					
Plume	0.0349	0.005	0.05		0.001N
Background	0.0014	n/a			0.000045C
Chloride					
Plume	1,160	796		250	
Background	991	437			
Fluoride					
Plume	7.57	1.93	4	2	2.2N
Background	1.62	0.895			
Iron					
Plume	21.2	3.88		0.3	11N
Background	3.13	0.552			
Manganese					
Plume	4.54	2.82		0.05	1.7N
Background	2.22	1.4			
Molybdenum					
Plume	0.299	0.101	0.1		0.18
Background	0.124	0.0587			
Selenium					
Plume	0.016	n/a	0.01		0.18
Background	0.137	0.036			
Sulfate					
Plume	3,700	3,154		250	
Background	3,720	2,566			
^{234}U & ^{238}U					
Plume	1,668	215.3	30 pCi/L		
Background	57	42			
Uranium (total)					
Plume	2.5	0.304	0.044		
Background	0.0662	0.0469			
Vanadium					
Plume	0.832	0.0857			0.26
Background	0.0049	0.0019			
Total Dissolved Solids					
Plume	7,840	6,525		500	
Background	7,400	5,238			

NOTE: SMCL—secondary maximum contaminant level
RBC—risk based concentration (human health)
N—noncarcinogenic risk
C—carcinogenic risk

Even though ground water has no current or projected use, a study was performed to test how reasonable the costs would be to treat contaminated ambient ground water for municipal potable use. The study addressed the criterion in 40 CFR 192.11(e)(2) that the water cannot be treated by "methods reasonably employed in public water systems." Appendix J describes the results of this study, which was based on information provided by contractor personnel and guidance in *Guidelines for Ground-Water Classification Under the EPA Ground-Water Protections Strategy* (EPA 1988). The study shows that the cost of producing potable water from the alluvial aquifer is conservatively estimated at $680 per household per year. This value exceeds the threshold of $300 per household per year provided by the EPA 1988 guidelines; adjusted for inflation of 3 percent per year, which results in a current threshold of $400 per year, the cost is still well above the threshold. The three sources of municipal water in the Grand Valley are Grand Junction city water, Clifton water, and Ute water. Mr. Terry Franklin, Grand Junction Water Superintendent, provided average private household domestic costs for local water. The average household uses about 8,000 gallons per month; therefore the cost for each is

- Grand Junction: $222 per year per household
- Clifton water: $222 per year per household
- Ute water: $216 per year per household

These amounts are about one-third the estimated cost of treating alluvial ground water.

7.2.1.5 Human Health and Ecological Risks

The fourth step in the decision process considers whether the human health and environmental risks of applying supplemental standards are acceptable. Assessment of site conditions and consideration of potential effects on environmental resources indicate that supplemental standards will be protective of human health and the environment.

The BLRA (DOE 1995) and the update presented in this SOWP indicate that residential use of ground water, mainly as drinking water, presents the only unacceptable pathway for exposure to ground water at the site. If site ground water were used exclusively for residential consumption, risks would exceed EPA's acceptable level of 1×10^{-6} for carcinogens and a total HI of 1 for noncarcinogens. The largest contribution to noncarcinogenic risks from site ground water would be from uranium, ammonium, arsenic, fluoride, iron, manganese, molybdenum, and vanadium. Uranium would also produce the largest carcinogenic risk (see Table 6–2). Table 7–2 lists the COPCs discussed in the 1995 BLRA and presents a summary of the rationale for retaining them in or deleting them from the 1998 update.

Although risks calculated for use of site ground water in a residential setting are unacceptably high, no risks currently exist at the site because no pathways for human use of ground water are complete at this time. Risks associated with ground water at the site will continue to be acceptable in the future as long as no significant changes in ground water use occur. Because institutional controls on site ground water are in place and are likely to continue (see Section 7.3.1), current and future human health risks are acceptable.

Table 7–2. Human Health and Ecological Risk COPC Update Summary

COPC	UMTRA MCL mg/L	Updated COPC for Human Health Risk[a]	Update COPC for Ecological Risk[b]	Comments and Rationale for Retaining as a COPC HR: Human Health Risk ER: Ecological Risk
Ammonia[c]		Y	Y	HR: HI[d] > 1 for inhalation in residential setting ER: One surface water concentration exceeded RBC[e]
Arsenic	0.05	Y	N	HR: Risks higher than acceptable; MCL not exceeded
Cadmium	0.01	N	N	HR: Insignificant contribution to total risk
Cobalt		N	N	HR: Insignificant contribution to total risk
Fluoride		N	N	HR: No evidence of use at millsite
Iron		Y	N	HR: HQ[f] > 1
Manganese		Y	Y	HR: HQ > 1
Molybdenum	0.10	Y	Y	HR: HQ > 1 ER: Concentration in cattail stems 2 to 3 times greater in site area than in reference area
Nickel		N	N	HR: Insignificant contribution to total risk
Nitrate	44	N	N	HR: Plume concentrations are within background range
^{226}Ra	5 pCi/g	N	N	HR: Plume concentrations are within background range
Sulfate		Y	N	HR: Toxicity data are currently under evaluation by EPA, but concentrations are high enough to be of probable concern
Uranium	0.044	Y	Y	HR: Primary carcinogenic and noncarcinogenic risk contributor ER: Concentration in one surface water sample exceeded EPA's Ecotox threshold and lowest chronic value
Vanadium		Y	Y	HR: Concentrations exceed RBC but have decreased two orders of magnitude from historical values ER: Concentration in one surface water sample exceeded EPA's Ecotox threshold and lowest chronic value
Zinc		N	N	HR: Insignificant contributor to total risk

NOTE: Boldface type indicates COPCs that were retained in 1998 update of BLRA

[a] Identified as a COPC if concentrations exceeded the calculated acceptable risk for a hypothetical residential exposure scenario.
[b] Identified as a COPC if concentrations exceeded an ecological benchmark or threshold.
[c] Screened out as a COPC in the original BLRA through evaluation of ground water ingestion only; retained here for evaluation through inhalation pathway.
[d] HI = Hazard index
[e] RBC = Risk-based concentration
[f] HQ = Hazard quotient

Ecological Risk

Ecological risk assessments evaluate the likelihood that adverse ecological effects are occurring or might occur as a result of exposure to a physical, chemical, or biological entity. Section 6.2 and Appendix I describe the collection and evaluation of information from surface water, sediment, and vegetation to determine risks to the environment. Samples were collected from the plume area and from a reference area located in an ecologically similar environment about 3 miles (5 km) east (upgradient) along the Colorado River.

Results of this sampling indicate generally low levels of a few COPCs in sediment, surface water, and plant tissues. Some residual levels of millsite-related constituents still remain in ponded areas along the Colorado River that receive little or no regular surface water flushing. Nearly all the data indicate no significant differences between the Grand Junction site and the reference area for concentrations of COPCs in biotic and abiotic media. Because isolated maximum values for some constituents exceeded threshold values, it is recommended that ammonia in water, uranium in surface water, vanadium in surface water, vanadium in reed canarygrass stems, manganese in cattail stems, and molybdenum in cattail stems be retained as COPCs. Because data evaluation did not indicate an unacceptable ecological risk for the Grand Junction site, no further ecological risk assessment was performed. Table 7–2 lists the COPCs discussed in the 1995 BLRA and presents a summary of the rationale for retaining them in or deleting them from the 1998 update.

7.2.1.6 Compliance Strategy Selection

The fifth and final step in the decision process is the selection of an appropriate compliance strategy to meet the EPA ground water protection standards. The selected strategy is no remediation and application of supplemental standards based on the criterion of limited use ground water (40 CFR 192.21[g]). Ground water in the uppermost aquifer is not a current or potential source of drinking water because “widespread, ambient contamination not due to activities involving residual radioactive materials from a designated processing site exists that cannot be cleaned up using treatment methods reasonably employed in public water systems…” (40 CFR 192.11[e][2]).

7.3 Implementation of Supplemental Standards

7.3.1 Institutional Controls

7.3.1.1 On-Site Controls

The State of Colorado, through the Colorado Department of Public Health and Environment (the Grantor), transferred the Climax millsite property to the City of Grand Junction (the Grantee) via two quitclaim deeds recorded in the Mesa County Courthouse, Book 2320, pages 882 to 886, on March 29, 1997. As part of the agreement, the City agrees “not to use ground water from the site for any purpose, and not to construct wells or any means of exposing ground water on the property unless prior written approval of construction plans, designs and specifications is given by the Grantor and the U.S. Department of Energy.”

7.3.1.2 Downgradient Controls

Several controls are in place for private landowners downgradient of the millsite. The question of institutional controls has been investigated in the past.

Considerable research found no evidence that anyone was drinking water from the alluvial aquifer in the area of the millsite (see Appendix J). This conclusion resulted from inquiries with the Colorado State Engineer's Office for well permits, the City of Grand Junction water service records, visual physical inspections, and contact with about 40 percent of the landowners in the affected area.

As of 1998 the State Engineer's Office has no records of wells installed in the alluvial aquifer on or downgradient of the site. The nearest alluvial wells are south of the Colorado River on Orchard Mesa, which is not in the flow path of ground water from the alluvial aquifer.

Although the City of Grand Junction will not prevent someone from drilling a well, it does require citizens to hook up to municipal water lines for potable water.

The Western Colorado Botanical Gardens has a sump near the Colorado River for pumping water to the ponds on the western side of their property. Water from the lowermost and largest pond is used for watering the gardens but not for human consumption. The pond is lined to prevent surface water from contacting ground water and is fenced to prevent access. Analysis of pond water indicates uranium levels are below the MCL.

7.3.1.3 Public Involvement Plan

A Public Involvement Plan (MAC-GWGRJ 11.6.2) was prepared for the Grand Junction site. The plan describes the history of the UMTRA Project legislation and scope, a brief history of the Climax mill, Phase I (surface remedial action) at the site, the reasons for soliciting public involvement, and a summary of results from information gathered for this study. It also describes the types of public responses that were recorded at the public meeting conducted June 22, 1995. The public comments received at the meeting are included in Volume II of the PEIS (DOE 1996c).

A meeting is scheduled for March 1999 with the City Council, other representatives from the city and county, the State Engineer's Office, CDPHE, and the public (see Table 7–3). Discussions will include information gathered for this study, risks to human health and the ecology, and the supplemental standards compliance strategy based on the classification of limited use ground water. The purpose of the meeting is to inform the public about decisions that affect the community and to solicit comments for consideration during planning of the final compliance strategy.

Table 7–3. Public Participation Activities To Be Conducted Before Completion of the Environmental Assessment, SOWP, and Compliance Strategy

Activity	Scheduled Date
Send letter describing the proposed compliance strategy to: City Council County Commissioners Planning Commission State Engineer's Office	February 19, 1999
Send letter to adjacent property owners	February 26, 1999
Make presentation to City Council during regularly scheduled meeting. (D. Metzler, DOE-GJO)	March 3, 1999
Press releases (as needed)	July 15, 1999
Publish public notice in the Daily Sentinel twice a week for two months before issuing the Finding of No Significant Impact (FONSI)	July 15, 1999
Public meeting	To Be Determined

The Public Involvement Plan also provides a schedule for producing the Environmental Assessment, the Finding of No Significant Impact, and any meetings deemed necessary during this process (see Table 7–4). These documents are planned for completion in fiscal year 1999.

Table 7–4. Scheduled Public Participation Activities for Preparing the Environmental Assessment of Ground Water Compliance at the Grand Junction UMTRA Project Site

Activities	Scheduled Date
Review of draft Environmental Assessment by the State of Colorado	April 1999
Notification of Environmental Assessment availability : • News Release • Federal Register notice (not required)	May 1999
Transmit draft Environmental Assessment to interested stakeholders, other agencies, public (upon request)	June 1999
Place copies of Environmental Assessment in public locations: • Mesa County Library • DOE-GJO Reading Room • Other	June 1999
Hold Public Meetings	As Needed
Comments received from stakeholders	July 1999
Comments addressed	July 1999
News release of Finding of No Significant Impact (FONSI) approval	August 1999
Final Environmental Assessment and Finding of No Significant Impact issued to the public, stakeholders, and agencies	September 1999
Place copies of Environmental Assessment in public locations: • Mesa County Library • DOE-GJO Reading Room • Other	September 1999

7.4 Future Activities and Contingencies

Future activities for the site will include verification of institutional controls to ensure continued protection of human health and the environment. Verification will be conducted annually for the next 5 years and will consist of consultation and documentation of discussions with the Grand Junction City Engineering Department, the State Engineer's Office, and the local office of the Colorado State Water Quality Division. If no changes are found or if no issues arise that might compromise established institutional controls, contacts will subsequently be made every 5 years for the next 20 years. Documentation of the contacts will consist of telephone logs sent to the UMTRA Ground Water Project file for the Grand Junction site. All future activities will be conducted through the Long-Term Surveillance and Monitoring Program.

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End of current text

Appendix A

Monitoring Well Locations and Information

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MONITOR WELL REPORT (USEE300) FOR SITE GRJ01, GRAND JUNCTION
REPORT DATE: 2/11/1999 8:47 am

LOCATION CODE	NORTH COORD. (FT STATE-PLANE)	EAST COORD. (FT STATE-PLANE)	GROUND ELEV. (FT NGVD)	BORE HOLE DEPTH (FT BLS)	BORE HOLE DIA. (INCHES)	TOP OF CASING ELEV. (FT NGVD)	CASING LENGTH (FT)	CASING DIAMETER (INCHES)	SCREEN DEPTH (FT BLS)	SCREEN LENGTH (FT)	FLOW CODE	ZONE OF COMPL.
0588	459315	1135627	4570.6	16.1	6.6	4570.3	16.8	4.0	7.1	10.0	U	AL
0590	459399	1130965	4564.2	15.5	6.6	4566.7	18.0	4.0	7.2	8.3	D	AL
0713	462539	1149188	4611.9	39.0	4.0	4611.9	37.6	-	-	-	U	AL
0715	465065	1149497	4632.7	59.0	4.0	4633.1	59.4	-	-	-	U	AL
0724	459762	1131040	4563.9	142.0	6.0	4565.8	142.8	2.0	129.0	10.0	U	KD
0726	459261	1130926	4566.7	140.0	6.3	4568.6	141.9	4.0	109.5	30.0	U	KD
0732	461158	1129019	4564.6	21.0	6.0	4566.7	23.1	2.0	14.0	1.0	D	AL
0735	460079	1130930	4563.8	50.0	6.0	4565.7	39.9	2.0	26.0	10.0	D	KD
0736	460066	1130939	4564.1	15.5	6.0	4565.9	16.8	2.0	8.0	5.0	D	AL
0740	459776	1131670	4565.3	18.0	6.0	4567.9	19.5	2.0	10.0	5.0	D	AL
0741	460664	1132717	4573.7	55.5	6.0	4574.0	45.4	2.0	33.0	10.0	C	KD
0742	460642	1132716	4573.7	23.0	6.0	4574.2	23.5	2.0	16.0	5.0	C	AL
0743	459359	1136737	4574.1	50.0	6.0	4576.1	37.0	2.0	23.0	10.0	U	KD
0744	459360	1136718	4573.9	15.0	6.0	4576.2	17.2	2.0	8.0	5.0	U	AL
0745	460907	1136625	4578.8	22.0	6.0	4580.8	21.9	2.0	13.0	5.0	U	AL
0746	462232	1135474	4585.8	25.0	6.0	4587.9	27.0	2.0	18.0	5.0	U	AL
1000	459213	1132560	4564.6	9.2	8.0	4566.8	10.9	4.0	3.7	5.0	O	AL
1001	459288	1132654	4567.2	12.1	8.0	4569.7	14.1	4.0	6.6	5.0	O	AL
1002	459477	1132900	4570.2	13.3	8.0	4572.6	15.8	4.0	8.3	5.0	O	AL
1010	459680	1130096	4567.5	23.9	12.3	4570.1	25.4	4.0	12.4	10.0	D	AL
1011	459320	1131707	4565.4	15.0	12.3	4567.7	16.9	4.0	6.4	8.0	D	AL
1012	459540	1132242	4566.2	13.3	12.3	4568.6	15.5	4.0	4.9	8.0	O	AL
1013	459476	1132880	4570.7	16.3	12.3	4573.6	18.9	4.0	5.8	10.0	O	AL
1014	459839	1133223	4572.3	18.5	12.3	4574.3	20.0	4.0	7.8	10.0	O	AL
1015	459873	1134015	4571.8	17.3	12.3	4573.5	18.4	4.0	8.4	8.0	O	AL

MONITOR WELL REPORT (USEE300) FOR SITE GRJ01, GRAND JUNCTION
REPORT DATE: 2/11/1999 8:47 am

LOCATION CODE	NORTH COORD. (FT STATE-PLANE)	EAST COORD. (FT STATE-PLANE)	GROUND ELEV. (FT NGVD)	BORE HOLE DEPTH (FT BLS)	BORE HOLE DIA. (INCHES)	TOP OF CASING ELEV. (FT NGVD)	CASING LENGTH (FT)	CASING DIAMETER (INCHES)	SCREEN DEPTH (FT BLS)	SCREEN LENGTH (FT)	FLOW CODE	ZONE OF COMPL.
1016	459525	1133926	4569.4	15.0	12.3	4571.9	16.8	4.0	6.1	8.0	O	AL
1017	459663	1135119	4570.5	13.3	12.3	4572.7	15.2	4.0	7.7	5.0	O	AL
1018	460091	1134921	4573.9	15.1	12.3	4575.9	16.5	4.0	6.2	8.0	O	AL
1019	460949	1134933	4579.0	27.0	12.3	4581.0	28.9	4.0	6.7	20.0	O	AL
1020	459638	1139021	4580.9	17.0	12.3	4582.9	18.2	4.0	5.9	10.0	U	AL
1021	458331	1143968	4586.3	10.7	12.3	4586.4	10.5	4.0	5.0	5.0	U	AL
1022	459743	1130948	4563.0	19.0	12.3	4562.8	17.5	4.0	7.4	10.0	D	AL
1023	461340	1161786	4628.5	22.0	12.3	4630.2	23.4	4.0	8.5	13.0	U	AL
1024	463785	1168175	4638.3	15.3	12.3	4640.2	16.7	4.0	6.5	8.0	U	AL
1025	461546	1152752	4615.2	35.0	12.3	4617.6	34.7	4.0	12.0	20.0	U	AL
1026	462343	1140482	4593.7	27.0	12.3	4593.8	26.6	4.0	9.4	16.8	U	AL
1027	462389	1140321	4593.2	33.0	12.3	4593.3	29.9	4.0	9.4	20.0	U	AL
1028	462559	1140584	4594.9	34.0	12.3	4595.0	31.9	4.0	11.5	20.0	U	AL
1029	460999	1128375	4556.2	23.5	12.3	4558.6	24.6	4.0	7.0	15.0	D	AL
1030	464340	1125985	4555.6	30.5	12.3	4555.9	28.9	4.0	8.2	20.0	D	AL
1031	464433	1126303	4550.8	12.0	12.3	-	-	-	-	-	D	AL
1032	464844	1126056	4552.2	13.0	12.3	-	-	-	-	-	D	AL
1034	459478	1132919	4569.9	18.0	9.3	4571.7	19.8	4.0	7.7	10.0	O	AL
1035	459509	1132921	4570.6	19.5	9.3	4572.2	19.6	4.0	7.7	10.0	O	AL
CW21	467031	1170549	4646.0	10.0	4.8	4647.8	11.8	2.0	5.0	4.8	U	AL

LOCATION CODE	NORTH COORD. (FT STATE-PLANE)	EAST COORD. (FT STATE-PLANE)	GROUND ELEV. (FT NGVD)	BORE HOLE DEPTH (FT BLS)	BORE HOLE DIA. (INCHES)	TOP OF CASING ELEV. (FT NGVD)	CASING LENGTH (FT)	CASING DIAMETER (INCHES)	SCREEN DEPTH (FT BLS)	SCREEN LENGTH (FT)	FLOW CODE	ZONE OF COMPL.

RECORDS: SELECTED FROM USEE300 WHERE site_code='GRJ01' AND location_code in('0588','0590','0732','0735','0736','0740','0741','0742','0743','0744','0745','0746','0713','0715','0724','0726','1000','1001','1002','1007','1008','1010','1011','1012','1013','1014','1015','1016','1017','1018','1019','1020','1021','1022','1023','1024','1025','1026','1027','1028','1029','1030','1031','1032','1034','1035','CW21')

FLOW CODES:							
C	CROSS GRADIENT	D	DOWN GRADIENT	O	ON-SITE	U	UPGRADIENT

ZONES OF COMPLETION:

AL	ALLUVIUM	KD	DAKOTA SANDSTONE

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Appendix B

Lithologic/Well Completion Logs

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MONITORING WELL COMPLETION LOG GRJ01-0590

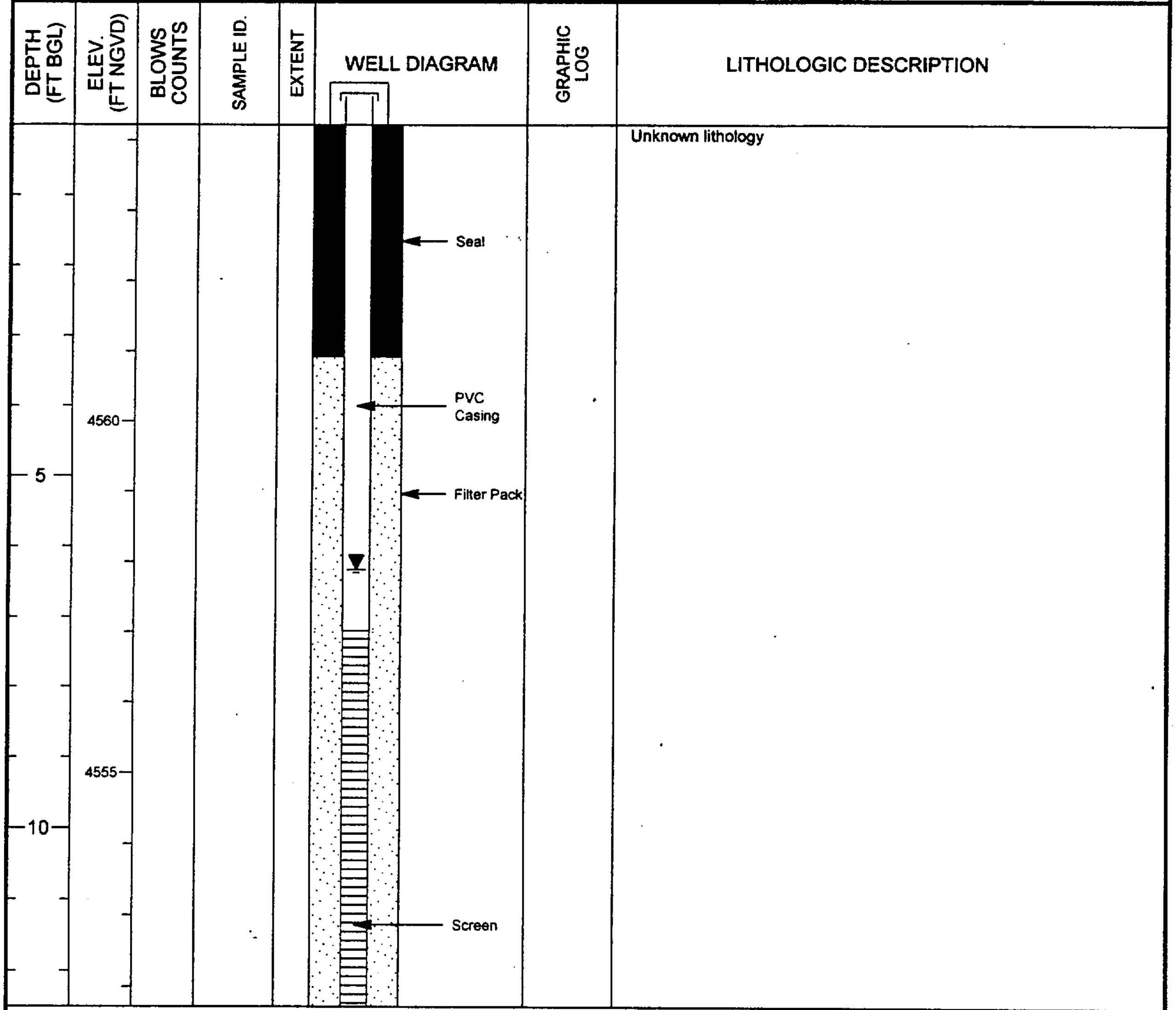
PROJECT UMTRA GROUND WATER
LOCATION GRAND JUNCTION, CO
SITE GRAND JUNCTION
WELL NUMBER 0590

NORTH COORD. (FT) 459398.60
EAST COORD. (FT) 1130964.95
HOLE DEPTH (FT) 15.50
WELL DEPTH (FT) 15.50

DATE DRILLED 1/4/83
SURFACE ELEV. (FT NGVD) 4564.22
TOP OF CASING (FT) 4566.69
MEAS. PT. ELEV. (FT) 4566.69
SLOT SIZE (IN)
BIT SIZE(S) (IN) 6.63

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Casing	-2.47	to	7.2
WELL SCREEN:	4 in. Screen	7.2	to	15.5
SUMP/END CAP:				
SURFACE SEAL:				
GROUT:				
SEAL:	Seal	0.0	to	3.3
UPPER PACK:				
LOWER PACK:	Filter Pack	3.3	to	15.5

DRILLING METHOD
SAMPLING METHOD
DATE DEVELOPED
WATER LEVEL (FT BMP) 8.8
LOGGED BY
REMARKS



Unknown lithology

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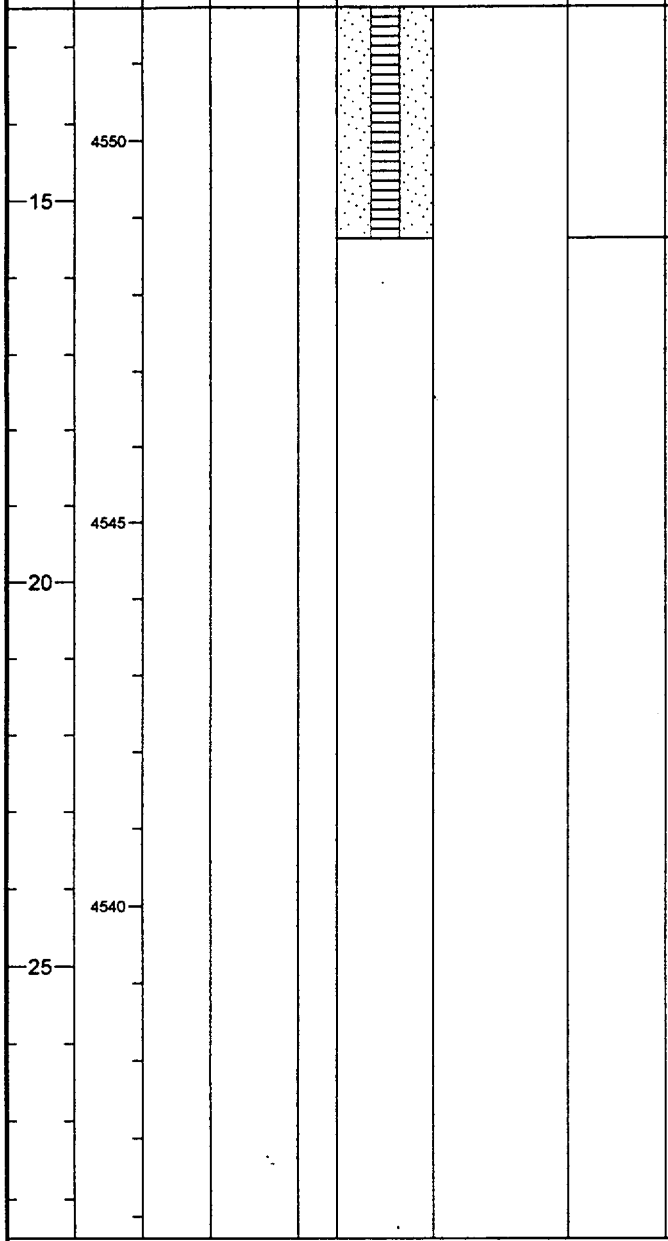
PAGE 1 OF 2 1/28/99

MONITORING WELL COMPLETION LOG GRJ01-0590

PROJECT	UMTRA GROUND WATER	**WELL NUMBER**	0590
SITE	GRAND JUNCTION	**DATES DRILLED**	1/4/83

Continued from Previous Page

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOWS COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							Bottom of boring at 15.5 ft



MONITORING WELL COMPLETION LOG GRJ01-0713

PROJECT UMTRA GROUND WATER
LOCATION GRAND JUNCTION, CO
SITE GRAND JUNCTION
WELL NUMBER 0713

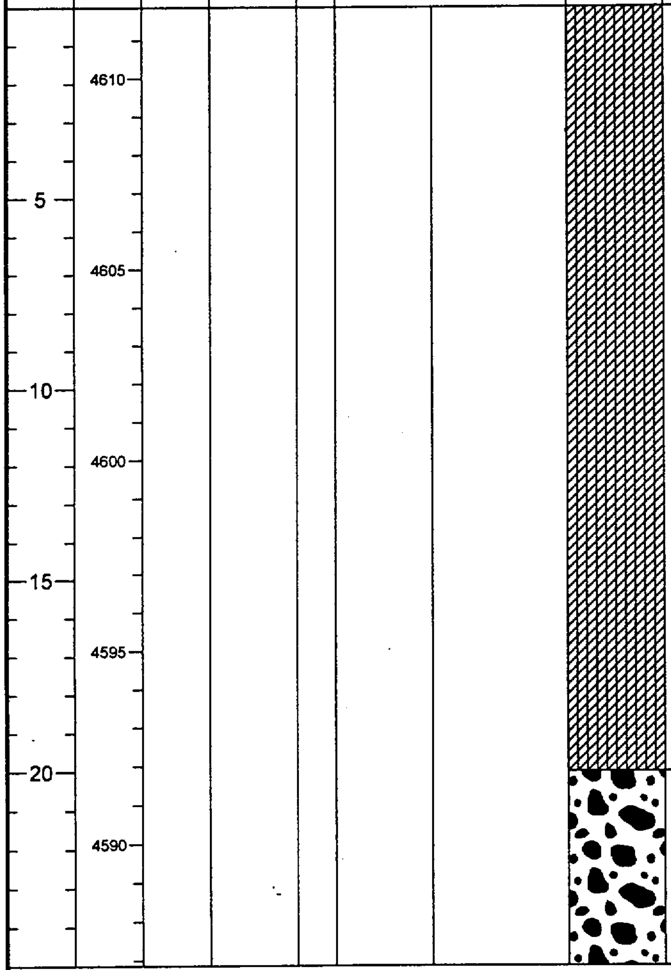
NORTH COORD. (FT) 462539.06
EAST COORD. (FT) 1149187.61
HOLE DEPTH (FT) 39.00
WELL DEPTH (FT) 37.50

DATE DRILLED 9/14/77
SURFACE ELEV. (FT NGVD) 4611.86
TOP OF CASING (FT) 4611.92
MEAS. PT. ELEV. (FT) 4611.92
SLOT SIZE (IN)
BIT SIZE(S) (IN) 4.0

	WELL INSTALLATION	INTERVAL (FT)
SURFACE CASING:		
BLANK CASING:	PVC	
WELL SCREEN:		
SUMP/END CAP:		
SURFACE SEAL:		
GROUT:		
SEAL:		
UPPER PACK:		
LOWER PACK:		

DRILLING METHOD CONTINUOUS FLIGHT AUGER
SAMPLING METHOD
DATE DEVELOPED
WATER LEVEL (FT BMP)
LOGGED BY W. Phillips
REMARKS No Well Construction Information.

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOWS COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION



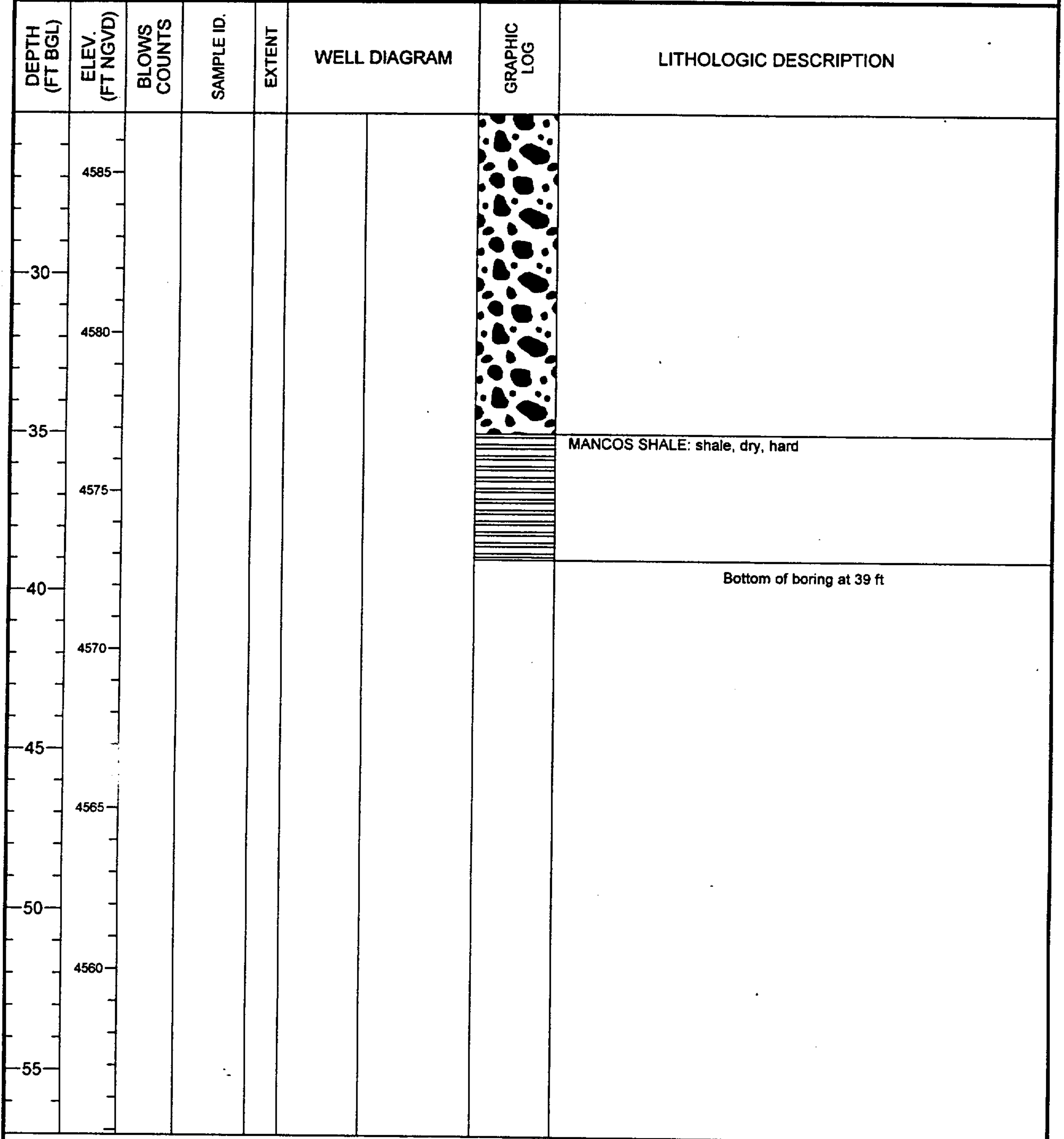
Silty clay, dry to wet, soft light brown CL-ML

Gravel GW

MONITORING WELL COMPLETION LOG GRJ01-0713

PROJECT UMTRA GROUND WATER
WELL NUMBER 0713
SITE GRAND JUNCTION
DATES DRILLED 9/14/77

Continued from Previous Page



MANCOS SHALE: shale, dry, hard

Bottom of boring at 39 ft

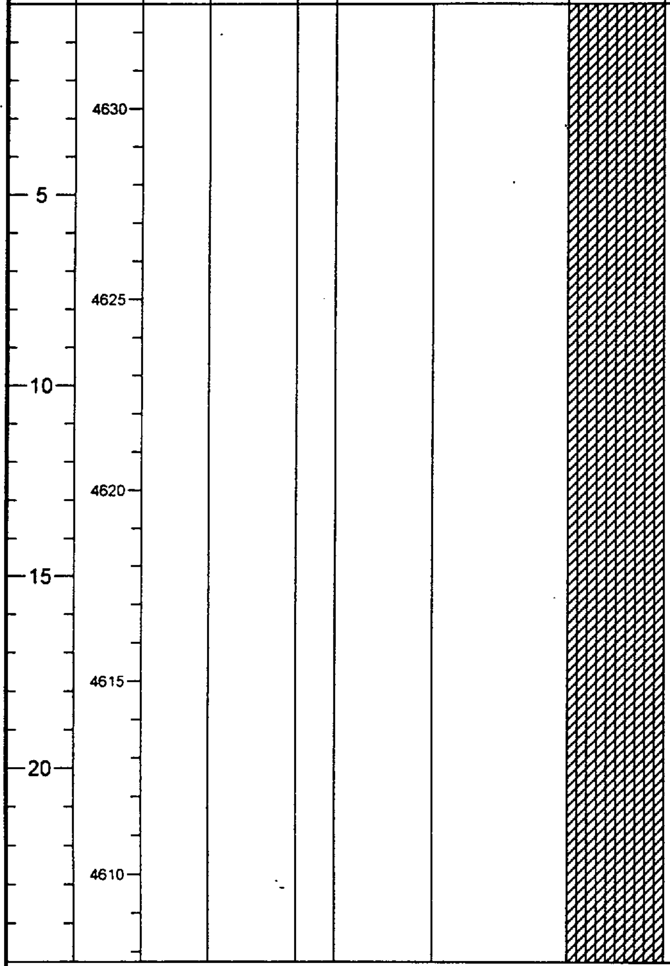
MONITORING WELL COMPLETION LOG GRJ01-0715

PROJECT	UMTRA GROUND WATER	**NORTH COORD. (FT)**	465064.64	**DATE DRILLED**	9/19/77
LOCATION	GRAND JUNCTION, CO	**EAST COORD. (FT)**	1149497.00	**SURFACE ELEV. (FT NGVD)**	4632.74
SITE	GRAND JUNCTION	**HOLE DEPTH (FT)**	59.00	**TOP OF CASING (FT)**	4633.12
WELL NUMBER	0715	**WELL DEPTH (FT)**	59.00	**MEAS. PT. ELEV. (FT)**	4633.12
				SLOT SIZE (IN)	
				BIT SIZE(S) (IN)	4.0

	WELL INSTALLATION	**INTERVAL (FT)**
SURFACE CASING:		
BLANK CASING:	PVC	
WELL SCREEN:		
SUMP/END CAP:		
SURFACE SEAL:		
GROUT:		
SEAL:		
UPPER PACK:		
LOWER PACK:		

DRILLING METHOD CONTINUOUS FLIGHT AUGER
SAMPLING METHOD
DATE DEVELOPED
WATER LEVEL (FT BMP)
LOGGED BY W. Phillips
REMARKS No Well Construction Information.

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOWS COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION



Silty clay, damp to wet,soft, brown CL-ML

Note: Free water in mud/grading to more clay below 20.0 and more firm

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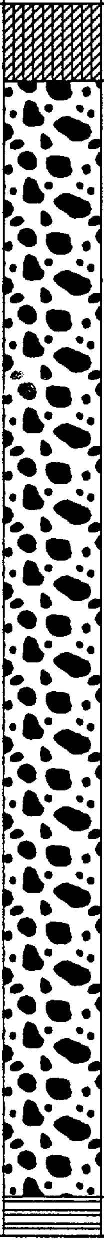
MONITORING WELL COMPLETION LOG GRJ01-0715

PROJECT	UMTRA GROUND WATER	**WELL NUMBER**	0715
SITE	GRAND JUNCTION	**DATES DRILLED**	9/19/77

Continued from Previous Page

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOWS COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
						▨	
							Gravel GW
	4605						
30							
	4600						
35							
	4595						
40							
	4590						
45							
	4585						
50							
	4580						
55							
							MANCOS SHALE: shale,dry hard



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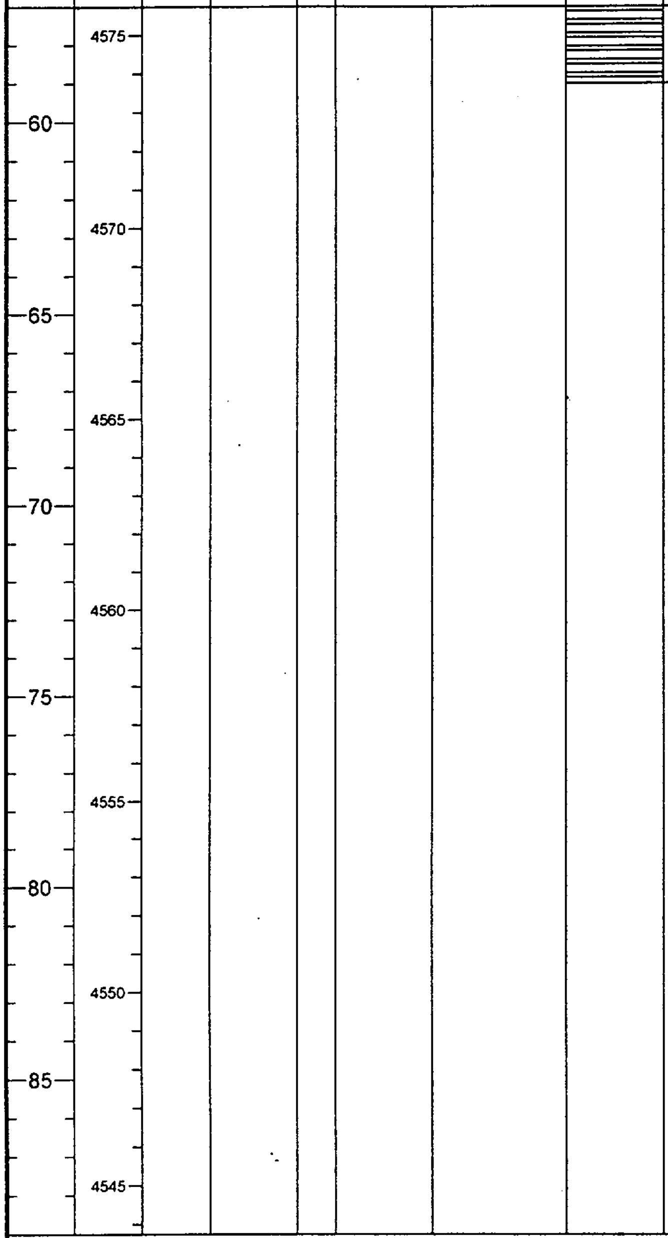
MONITORING WELL COMPLETION LOG GRJ01-0715

PROJECT UMTRA GROUND WATER
WELL NUMBER 0715
SITE GRAND JUNCTION
DATES DRILLED 9/19/77

Continued from Previous Page

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOWS COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							Bottom of boring at 59 ft



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MONITORING WELL COMPLETION LOG GRJ01-0724

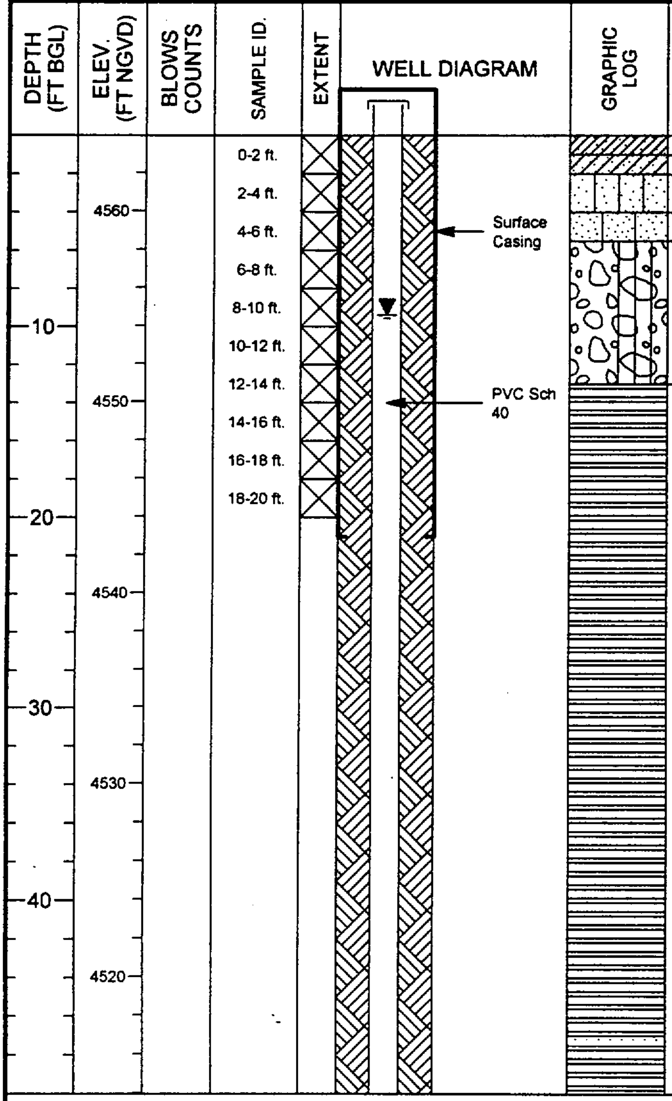
PROJECT UMTRA GROUND WATER
LOCATION GRAND JUNCTION, CO
SITE GRAND JUNCTION
WELL NUMBER 0724

NORTH COORD. (FT) 459762.41
EAST COORD. (FT) 1131040.16
HOLE DEPTH (FT) 142.00
WELL DEPTH (FT) 141.00

DATE DRILLED 2/17/85 to 3/8/85
SURFACE ELEV. (FT NGVD) 4563.93
TOP OF CASING (FT) 4565.75
MEAS. PT. ELEV. (FT) 4565.75
SLOT SIZE (IN) 0.01
BIT SIZE(S) (IN) 6.0 / 6.0 / 6.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:	6 in. Steel	-2.0	to	21.0
BLANK CASING:	2 in. PVC Sch 40	-2.0	to	129.0
WELL SCREEN:	2 in. Machine Slotted PVC	129.0	to	139.0
SUMP/END CAP:	2 in. PVC Sch 40	139.0	to	141.0
SURFACE SEAL:				
GROUT:	Cement - Bentonite	0.0	to	124.0
SEAL:	Bentonite Pellets	124.0	to	126.5
UPPER PACK:				
LOWER PACK:	1/4" Pea Gravel	126.5	to	142.0

DRILLING METHOD ROTARY CORE (NX)
SAMPLING METHOD SPLIT SPOON
DATE DEVELOPED 3/12/85
WATER LEVEL (FT BMP) 11.2
LOGGED BY W. Wood
REMARKS



LITHOLOGIC DESCRIPTION

Fill, sandy clay, medium plasticity, grayish brown CLS

Fill, clayey sand, fine grained, low-medium plasticity, brown SC

Sandy silt, no plasticity, brown MLS

Silty sand, fine, no plasticity, brown SM

Silty sravel with cobbles, porly graded to 0.7', subrounded, no plasticity, light brown. Note: occasional seam with sandy clay. GP-GM

DAKOTA SANDSTONE; Shale, extremely weathered, very soft, very light grey to dark gray.

Begin coring at 22'

Note: 6" sandstone seam at 47' occasional thin seams throughout

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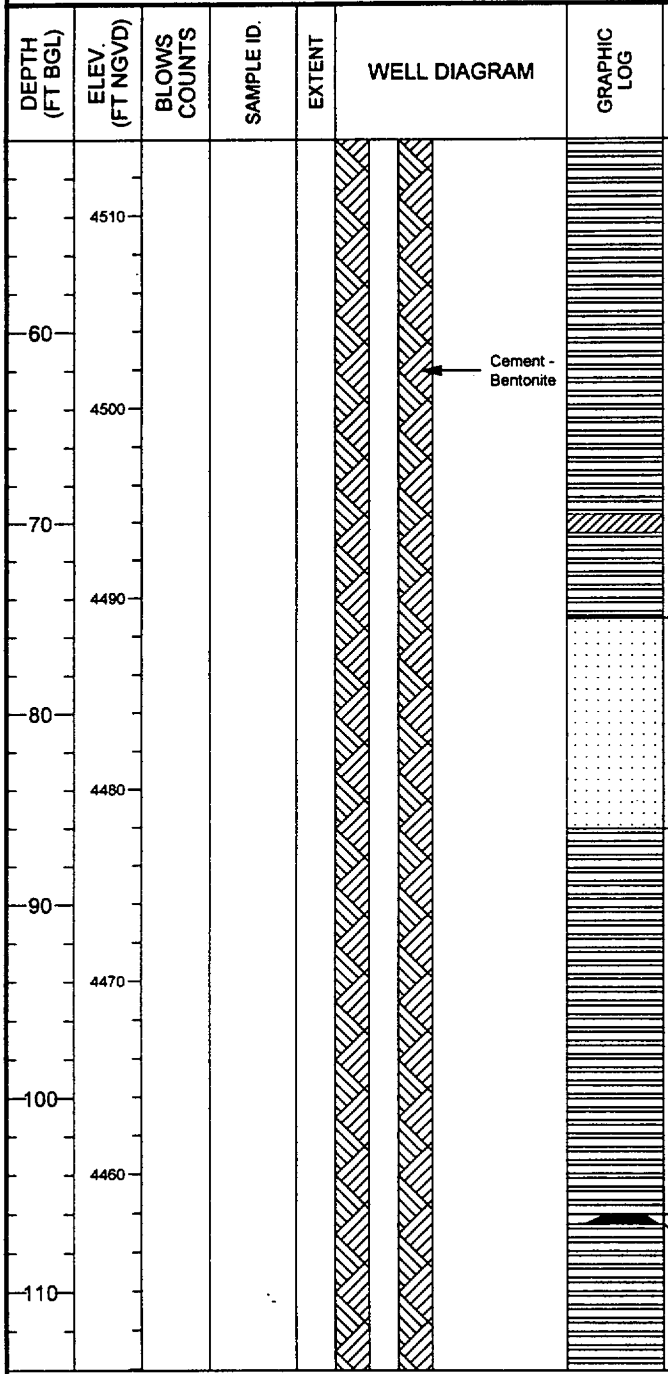
MONITORING WELL COMPLETION LOG GRJ01-0724

PROJECT	UMTRA GROUND WATER	**WELL NUMBER**	0724
SITE	GRAND JUNCTION	**DATES DRILLED**	2/17/85 to 3/8/85

Continued from Previous Page



LITHOLOGIC DESCRIPTION

Seam of soft, white claystone (benttonite) 1' thick.

Intercalated sandstone and shale lenses, Lt. grey to mottled dark grey

Shale, carbonaceous, black. Occasional seam of hard, lt. grey sandstone

Coal

Shale, grey.

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MONITORING WELL COMPLETION LOG GRJ01-0724

PROJECT UMTRA GROUND WATER
WELL NUMBER 0724
SITE GRAND JUNCTION
DATES DRILLED 2/17/85 to 3/8/85

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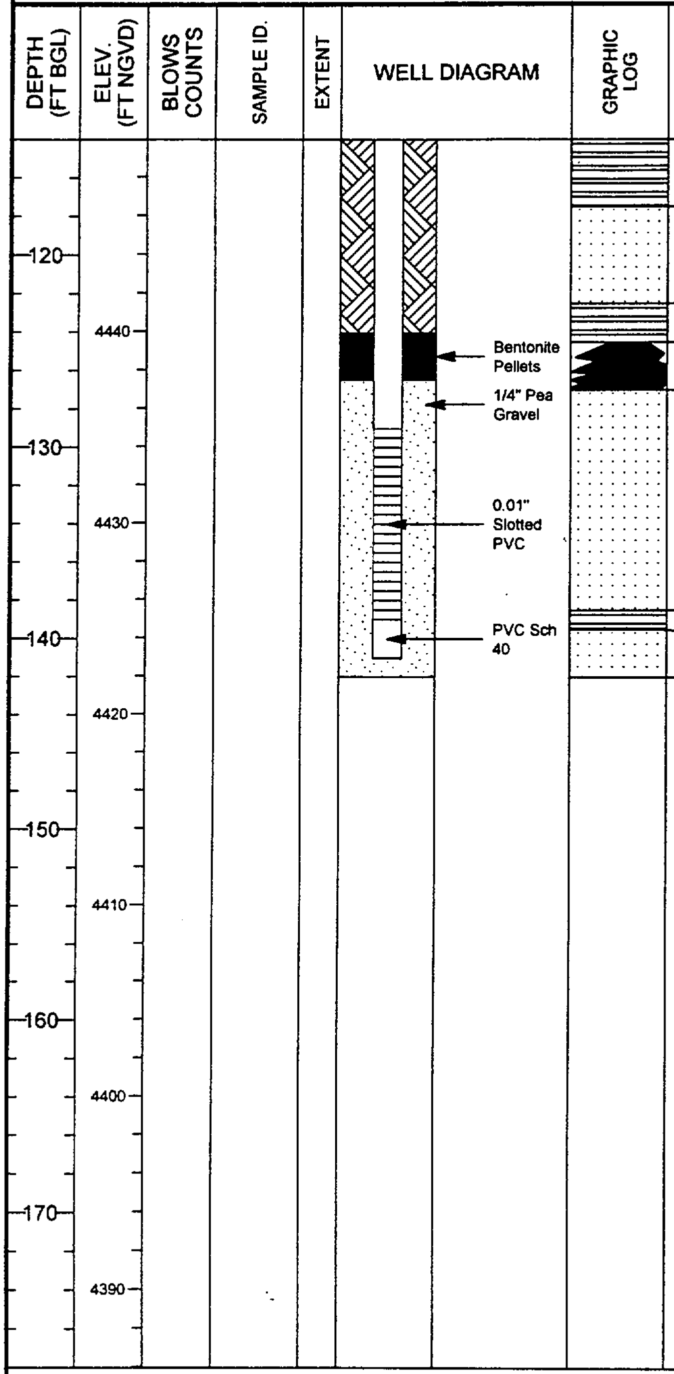

LITHOLOGIC DESCRIPTION

Note: light grey seam from 115.5 to 117.5 ft

Sandstone, lt, grey

Shale, dark grey

Coal, black

Sandstone, lt. grey Note: Occasional shale seam.

Shale, lt. grey

Sandstone, lt. grey

Bottom of boring at 142 ft

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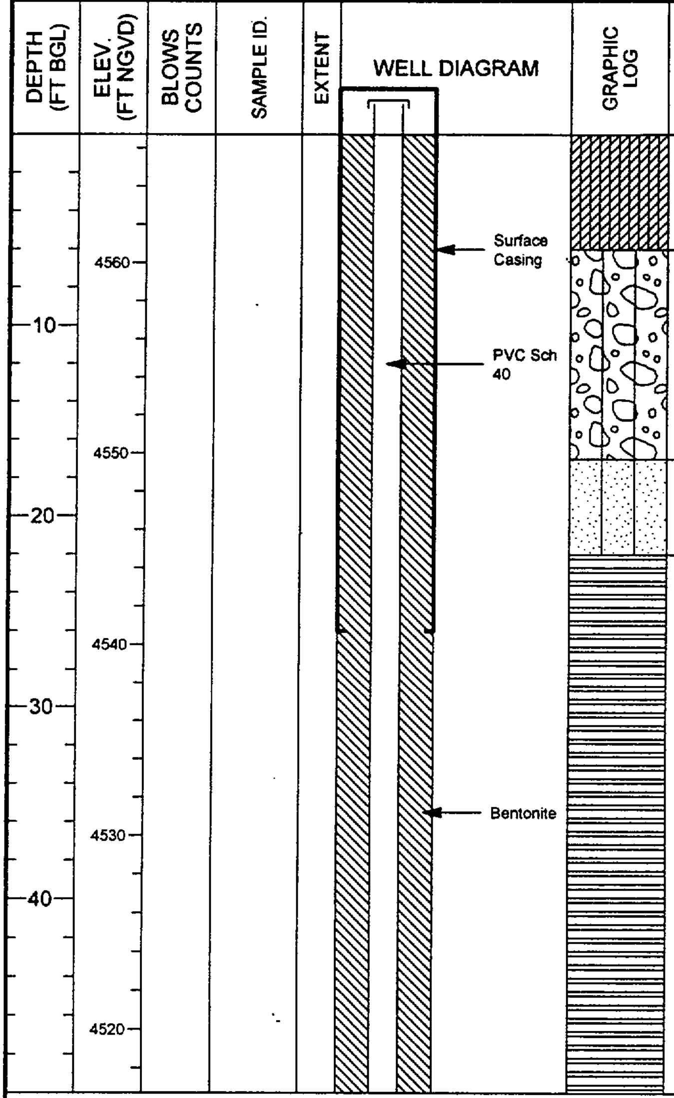
MONITORING WELL COMPLETION LOG GRJ01-0726

PROJECT	UMTRA GROUND WATER	**NORTH COORD. (FT)**	459261.07	**DATE DRILLED**	2/14/85 to 3/7/85
LOCATION	GRAND JUNCTION, CO	**EAST COORD. (FT)**	1130925.88	**SURFACE ELEV. (FT NGVD)**	4566.72
SITE	GRAND JUNCTION	**HOLE DEPTH (FT)**	140.00	**TOP OF CASING (FT)**	4568.59
WELL NUMBER	0726	**WELL DEPTH (FT)**	140.00	**MEAS. PT. ELEV. (FT)**	4568.59
				SLOT SIZE (IN)	0.01
				BIT SIZE(S) (IN)	7.0 / 6.25 / 4.25

	WELL INSTALLATION	**INTERVAL (FT)**		
SURFACE CASING:	7 in. Steel	-1.0	to	26.0
BLANK CASING:	4 in. PVC Sch 40	-1.0	to	110.5
WELL SCREEN:	4 in. Machine Slotted PVC	109.5	to	139.5
SUMP/END CAP:	4 in. PVC Sch 40	139.5	to	140.0
SURFACE SEAL:				
GROUT:	Bentonite	0.0	to	71.0
SEAL:	Bentonite Pellets	71.0	to	73.0
UPPER PACK:				
LOWER PACK:	1/4" Pea Gravel	73.0	to	109.5

DRILLING METHOD ROTARY WITH GEAR BIT
SAMPLING METHOD
DATE DEVELOPED 3/10/98
WATER LEVEL (FT BMP)
LOGGED BY W. Wood
REMARKS



LITHOLOGIC DESCRIPTION

FILL; Silty clay, high plasticty, occasional lens of sitlty sand, light brown CL-ML

Silty gravel-sand and cobbles, poorly graded, subrounded to rounded, nonplastic, brown. Occasional thin seam of silty clay. GM

Silty sand, fine,some gravel, nonplastic, dark grey. SM

DAKOTA SANDSTONE; Shale, very weathered, soft, dark grey.

MONITORING WELL COMPLETION LOG GRJ01-0726

PROJECT UMTRA GROUND WATER

WELL NUMBER 0726

SITE GRAND JUNCTION

DATES DRILLED 2/14/85 to 3/7/85

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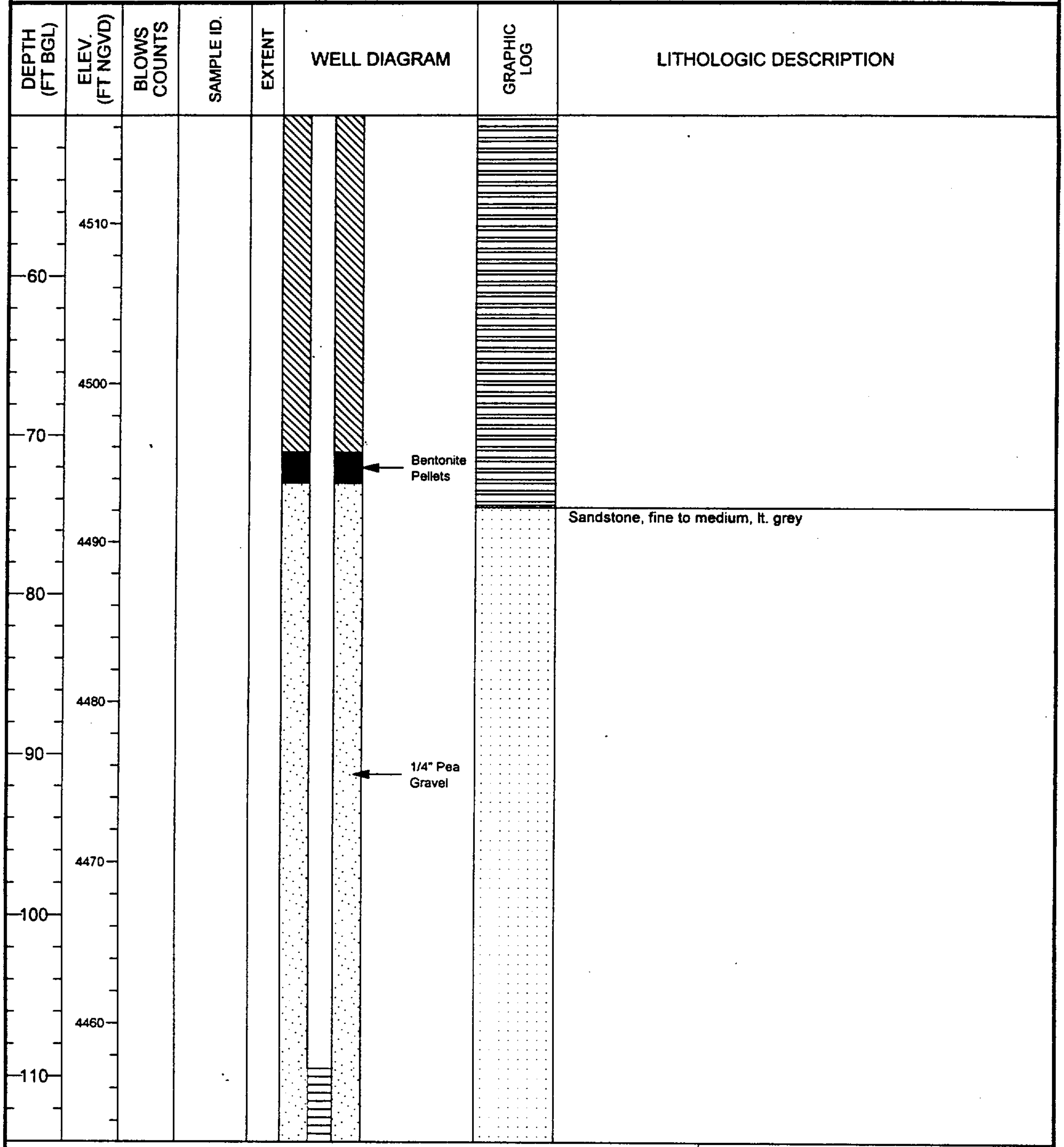


Sandstone, fine to medium, lt. grey

MONITORING WELL COMPLETION LOG GRJ01-0726

PROJECT UMTRA GROUND WATER

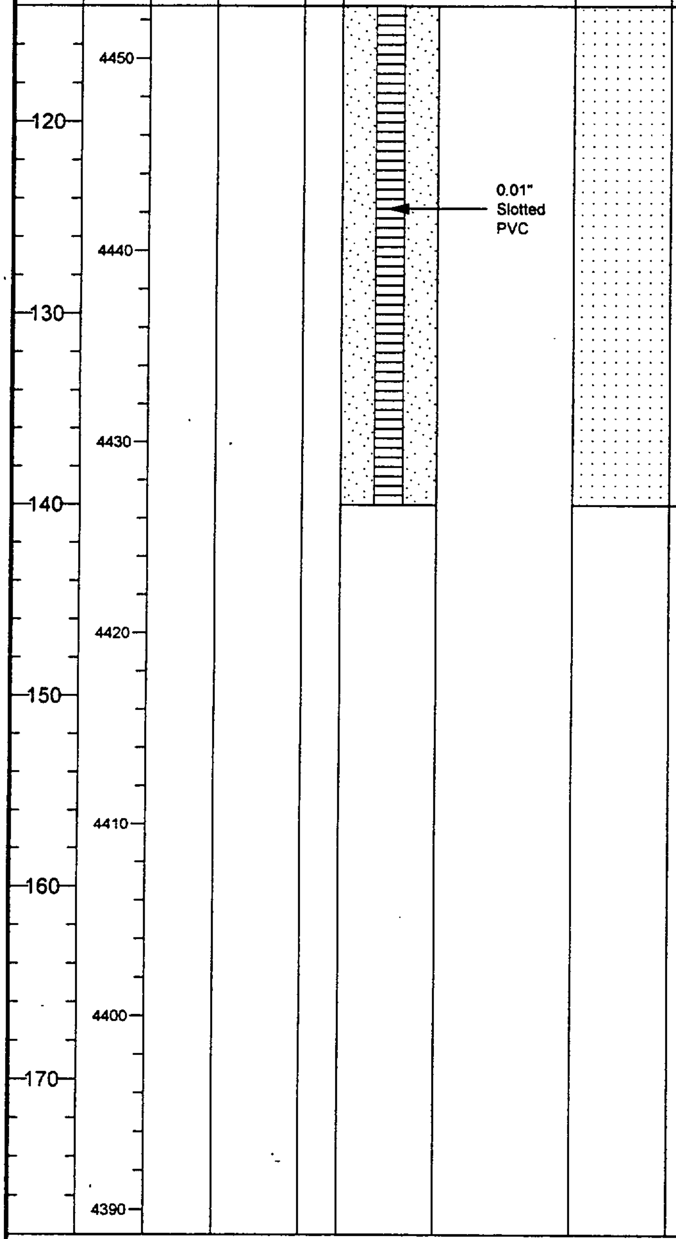
WELL NUMBER 0726

SITE GRAND JUNCTION

DATES DRILLED 2/14/85 to 3/7/85

Continued from Previous Page

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOWS COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION



Bottom of boring at 140 ft

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GRAND JUNCTION OFFICE, COLORADO

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MONITORING WELL COMPLETION LOG GRJ01-0732

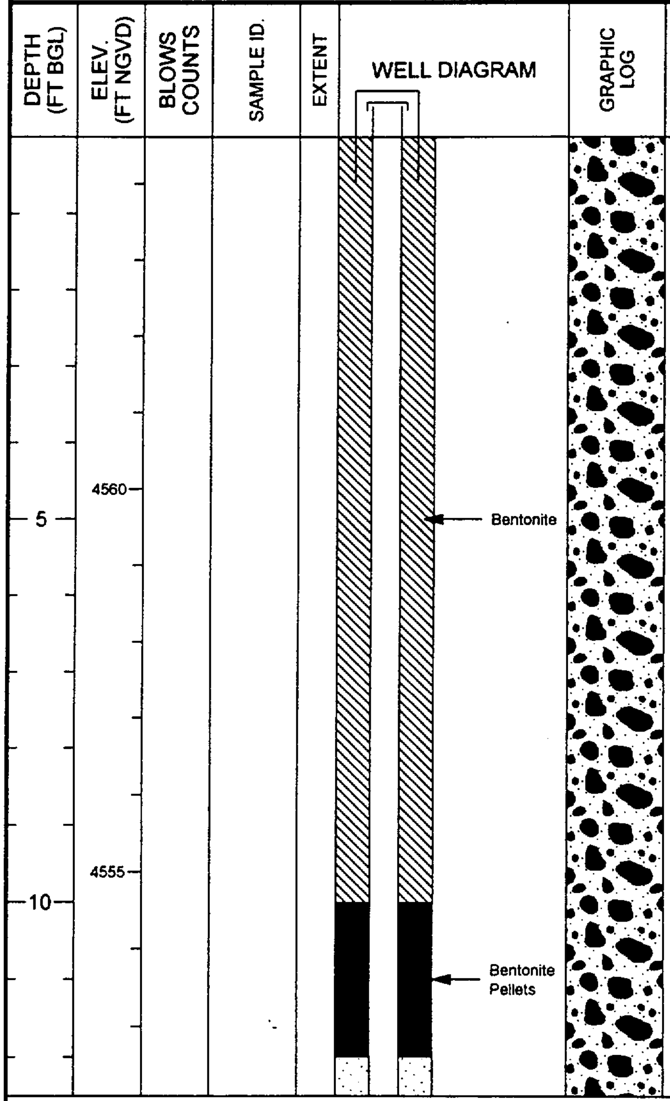
PROJECT UMTRA GROUND WATER
LOCATION GRAND JUNCTION, CO
SITE GRAND JUNCTION
WELL NUMBER 0732

NORTH COORD. (FT) 461157.79
EAST COORD. (FT) 1129019.45
HOLE DEPTH (FT) 21.00
WELL DEPTH (FT) 21.00

DATE DRILLED 2/25/85
SURFACE ELEV. (FT NGVD) 4564.61
TOP OF CASING (FT) 4566.69
MEAS. PT. ELEV. (FT) 4566.69
SLOT SIZE (IN) 0.01
BIT SIZE(S) (IN) 6.0

	WELL INSTALLATION	**INTERVAL (FT)**		
SURFACE CASING:				
BLANK CASING:	2 in. PVC Sch 40	-2.0	to	14.0
WELL SCREEN:	2 in. Machine Slotted PVC	14.0	to	15.0
SUMP/END CAP:	2 in. PVC Sch 40	19.0	to	21.0
SURFACE SEAL:				
GROUT:	Bentonite	0.0	to	10.0
SEAL:	Bentonite Pellets	10.0	to	12.0
UPPER PACK:				
LOWER PACK:	1/4" Pea Gravel	12.0	to	14.0

DRILLING METHOD ROTARY WITH 6" BUTTON BIT
SAMPLING METHOD
DATE DEVELOPED
WATER LEVEL (FT BMP)
LOGGED BY P. Mckenzie
REMARKS



LITHOLOGIC DESCRIPTION

Sandy gravel, well graded, occasional cobble GWS

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GRAND JUNCTION OFFICE, COLORADO

MONITORING WELL COMPLETION LOG GRJ01-0732

PROJECT UMTRA GROUND WATER
WELL NUMBER 0732
SITE GRAND JUNCTION
DATES DRILLED 2/25/85

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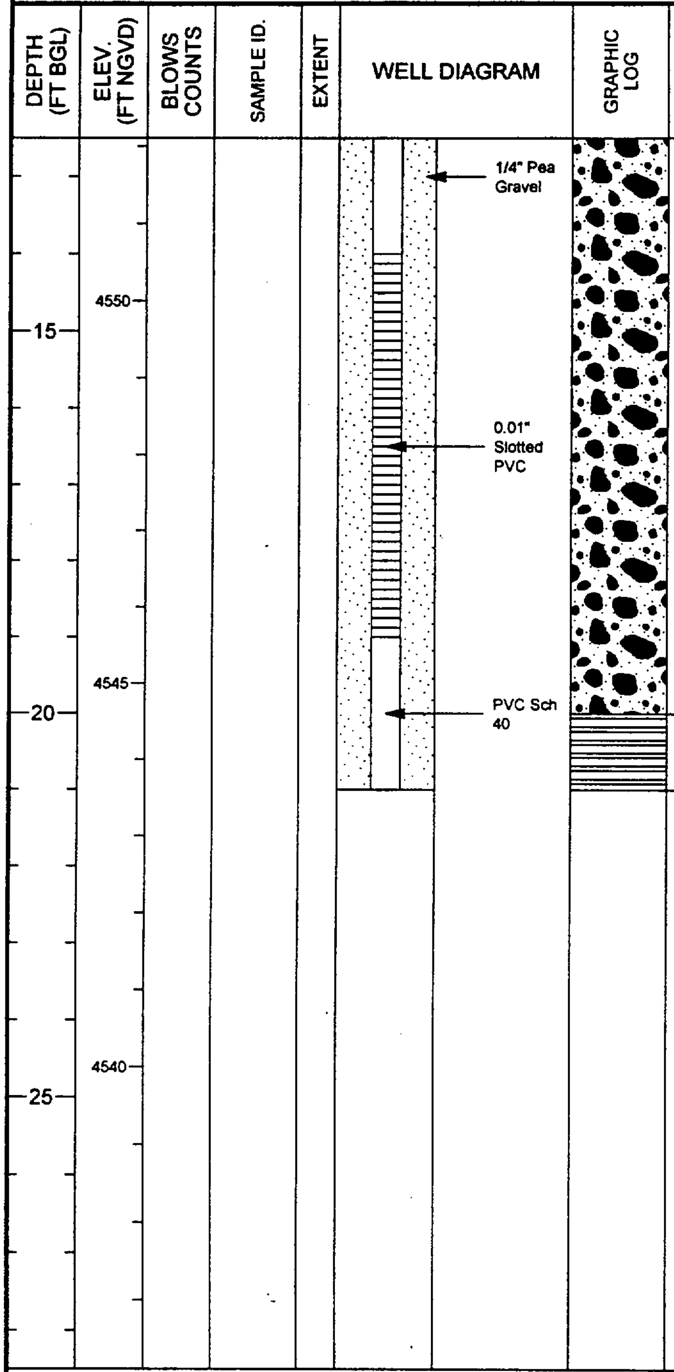


LITHOLOGIC DESCRIPTION

DAKOTA SANDSTONE; Shale, dark grey

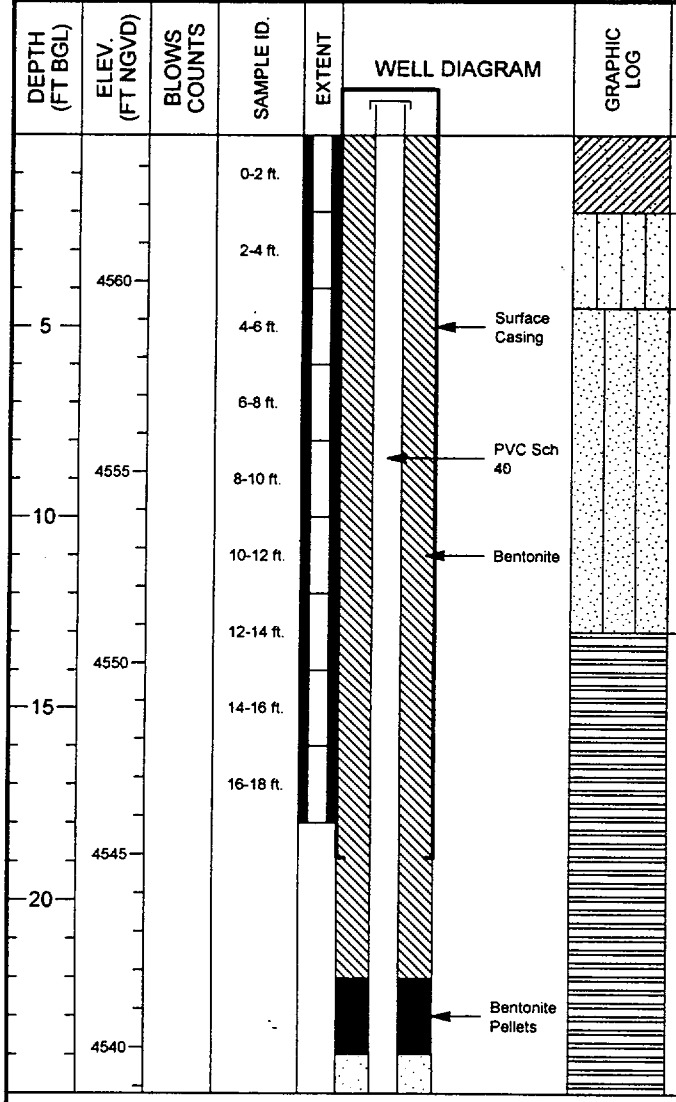
Bottom of boring at 21.0 ft

MONITORING WELL COMPLETION LOG GRJ01-0735

PROJECT	UMTRA GROUND WATER	**NORTH COORD. (FT)**	460079.45	**DATE DRILLED**	2/18/85 to 3/10/85
LOCATION	GRAND JUNCTION, CO	**EAST COORD. (FT)**	1130930.41	**SURFACE ELEV. (FT NGVD)**	4563.82
SITE	GRAND JUNCTION	**HOLE DEPTH (FT)**	50.00	**TOP OF CASING (FT)**	4565.73
WELL NUMBER	0735	**WELL DEPTH (FT)**	38.00	**MEAS. PT. ELEV. (FT)**	4565.73
				SLOT SIZE (IN)	0.01
				BIT SIZE(S) (IN)	6.0 / 6.0

	WELL INSTALLATION	**INTERVAL (FT)**		
SURFACE CASING:	5.5 in. Steel	-2.0	to	18.9
BLANK CASING:	2 in. PVC Sch 40	-2.0	to	26.0
WELL SCREEN:	2 in. Machine Slotted PVC	26.0	to	36.0
SUMP/END CAP:	2 in. PVC Sch 40	36.0	to	38.0
SURFACE SEAL:				
GROUT:	Bentonite	0.0	to	22.0
SEAL:	Bentonite Pellets	22.0	to	24.0
UPPER PACK:				
LOWER PACK:	1/4" Pea Gravel	24.0	to	26.0

DRILLING METHOD	ROTARY CORE (NX)
SAMPLING METHOD	CONTINUOUS CORE
DATE DEVELOPED	3/12/85
WATER LEVEL (FT BMP)	
LOGGED BY	W. Wood
REMARKS	



LITHOLOGIC DESCRIPTION

Sandy clay, medium, plasticity, dark brown CLS

Sandy silt, fine sand, nonplastic, brown MLS

ALLUVIUM; Silty sand, fine, nonplastic, brown SM

DAKOTA SANDSTONE; Shale, highly weathered, soft, dark grey

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MONITORING WELL COMPLETION LOG GRJ01-0735

PROJECT UMTRA GROUND WATER
SITE GRAND JUNCTION
WELL NUMBER 0735
DATES DRILLED 2/18/85 to 3/10/85

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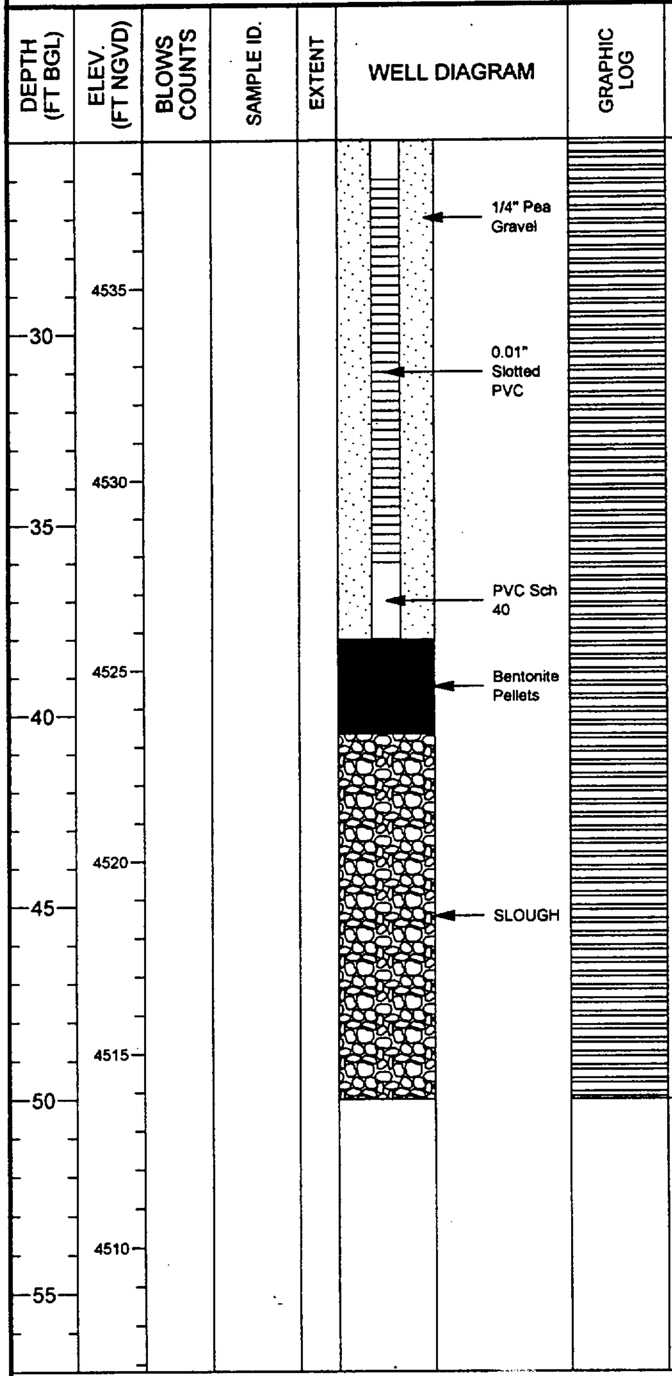


LITHOLOGIC DESCRIPTION

Bottom of boring at 50ft

MONITORING WELL COMPLETION LOG GRJ01-0736

PROJECT	UMTRA GROUND WATER	**NORTH COORD. (FT)**	460065.79	**DATE DRILLED**	2/24/85
LOCATION	GRAND JUNCTION, CO	**EAST COORD. (FT)**	1130939.19	**SURFACE ELEV. (FT NGVD)**	4564.11
SITE	GRAND JUNCTION	**HOLE DEPTH (FT)**	15.50	**TOP OF CASING (FT)**	4565.90
WELL NUMBER	0736	**WELL DEPTH (FT)**	15.00	**MEAS. PT. ELEV. (FT)**	4565.90
				SLOT SIZE (IN)	0.01
				BIT SIZE(S) (IN)	6.0

	WELL INSTALLATION	**INTERVAL (FT)**		
SURFACE CASING:				
BLANK CASING:	2 in. PVC Sch 40	-2.0	to	10.0
WELL SCREEN:	2 in. Machine Slotted PVC	8.0	to	13.0
SUMP/END CAP:	2 in. PVC Sch 40	13.0	to	15.0
SURFACE SEAL:				
GROUT:	Bentonite	0.0	to	4.0
SEAL:	Bentonite Pellets	4.0	to	6.0
UPPER PACK:				
LOWER PACK:	1/4" Pea Gravel	6.0	to	8.0

DRILLING METHOD ROTARY WITH DRAG BIT

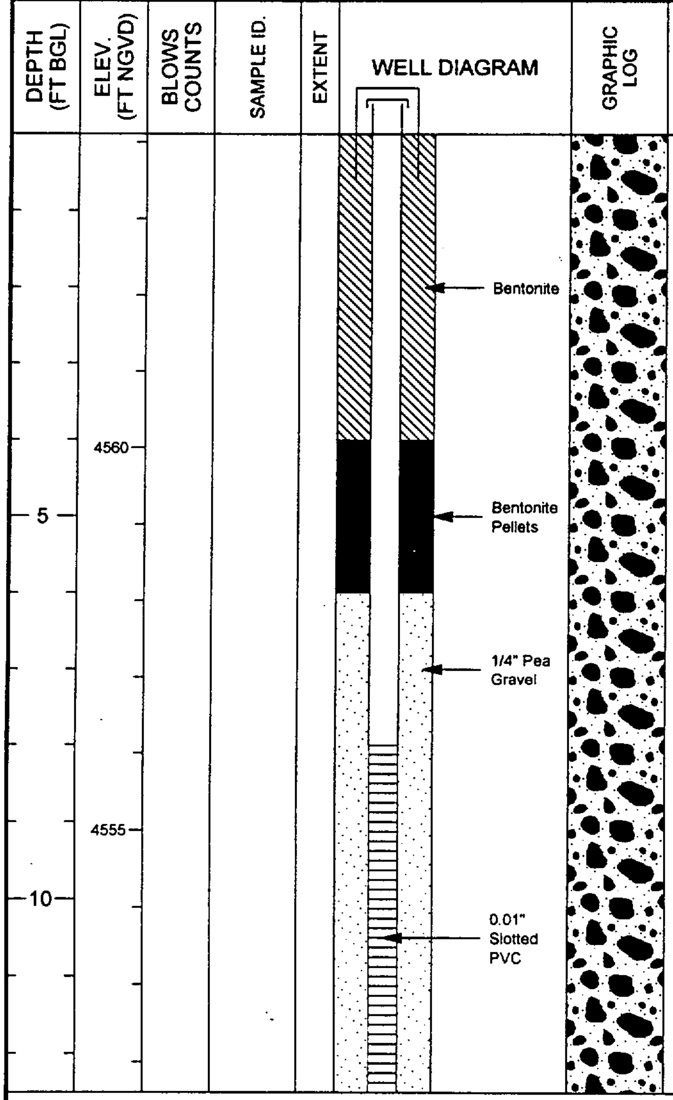
SAMPLING METHOD

DATE DEVELOPED

WATER LEVEL (FT BMP)

LOGGED BY P. Mckenzie

REMARKS



LITHOLOGIC DESCRIPTION

ALLUVIUM: Sandy gravel, well graded, occasional cobbles GWS

MONITORING WELL COMPLETION LOG GRJ01-0736

PROJECT UMTRA GROUND WATER
WELL NUMBER 0736
SITE GRAND JUNCTION
DATES DRILLED 2/24/85

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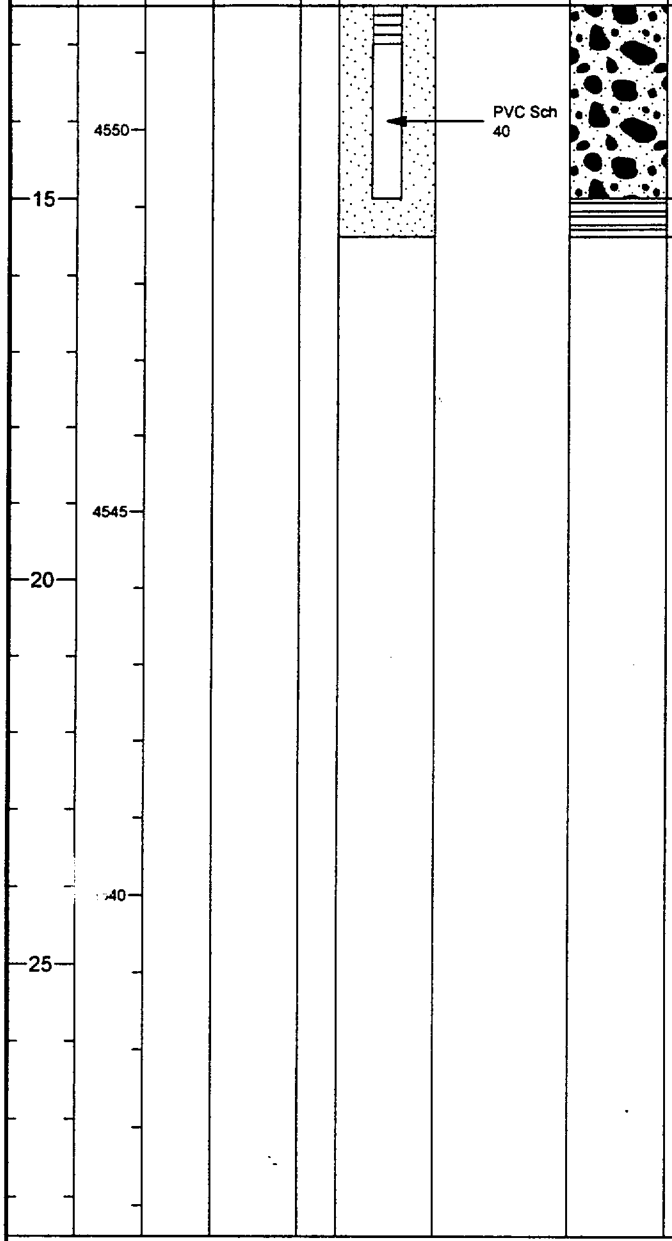
DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOWS COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION



DAKOTA SANDSTONE; Shale, grey

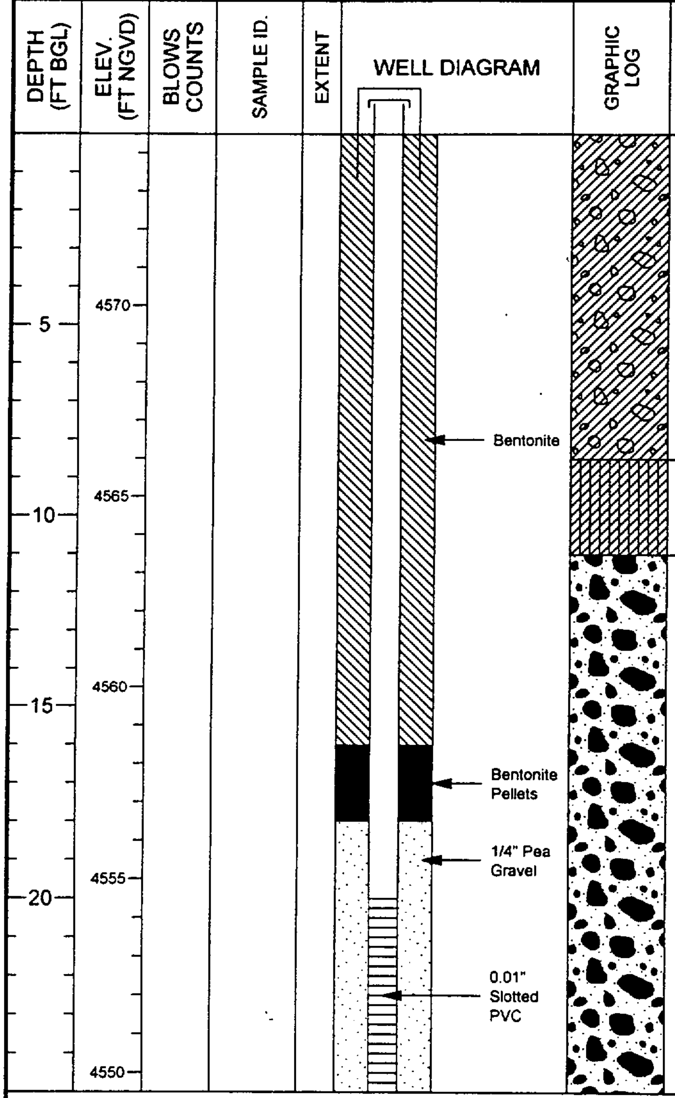
Bottom of boring at 15.5 ft

MONITORING WELL COMPLETION LOG GRJ01-0737

PROJECT	UMTRA GROUND WATER	**NORTH COORD. (FT)**	461766.05	**DATE DRILLED**	2/24/85
LOCATION	GRAND JUNCTION, CO	**EAST COORD. (FT)**	1132634.60	**SURFACE ELEV. (FT NGVD)**	4574.50
SITE	GRAND JUNCTION	**HOLE DEPTH (FT)**	28.00	**TOP OF CASING (FT)**	4576.50
WELL NUMBER	0737	**WELL DEPTH (FT)**	24.00	**MEAS. PT. ELEV. (FT)**	4576.50
				SLOT SIZE (IN)	0.01
				BIT SIZE(S) (IN)	6.0

	WELL INSTALLATION	**INTERVAL (FT)**		
SURFACE CASING:				
BLANK CASING:	2 in. PVC Sch 40	-2.0	to	20.0
WELL SCREEN:	2 in. Machine Slotted PVC	20.0	to	25.0
SUMP/END CAP:	2 in. PVC Sch 40	25.0	to	27.0
SURFACE SEAL:				
GROUT:	Bentonite	0.0	to	16.0
SEAL:	Bentonite Pellets	16.0	to	18.0
UPPER PACK:				
LOWER PACK:	1/4" Pea Gravel	18.0	to	20.0

DRILLING METHOD ROTARY WITH REVERT MUD
SAMPLING METHOD
DATE DEVELOPED
WATER LEVEL (FT BMP)
LOGGED BY P. Mckenzie
REMARKS



LITHOLOGIC DESCRIPTION

FILL: Gravelly clay, lt. brownish grey. NOTE: Extremly loose soils at 6 to 8 ft may indicate utility trench. CLG

ALLUVIUM: Silty clay, with some gravel, lt. brownish grey CL-ML

Sandy gravel, well graded, dark greyish brown GWS

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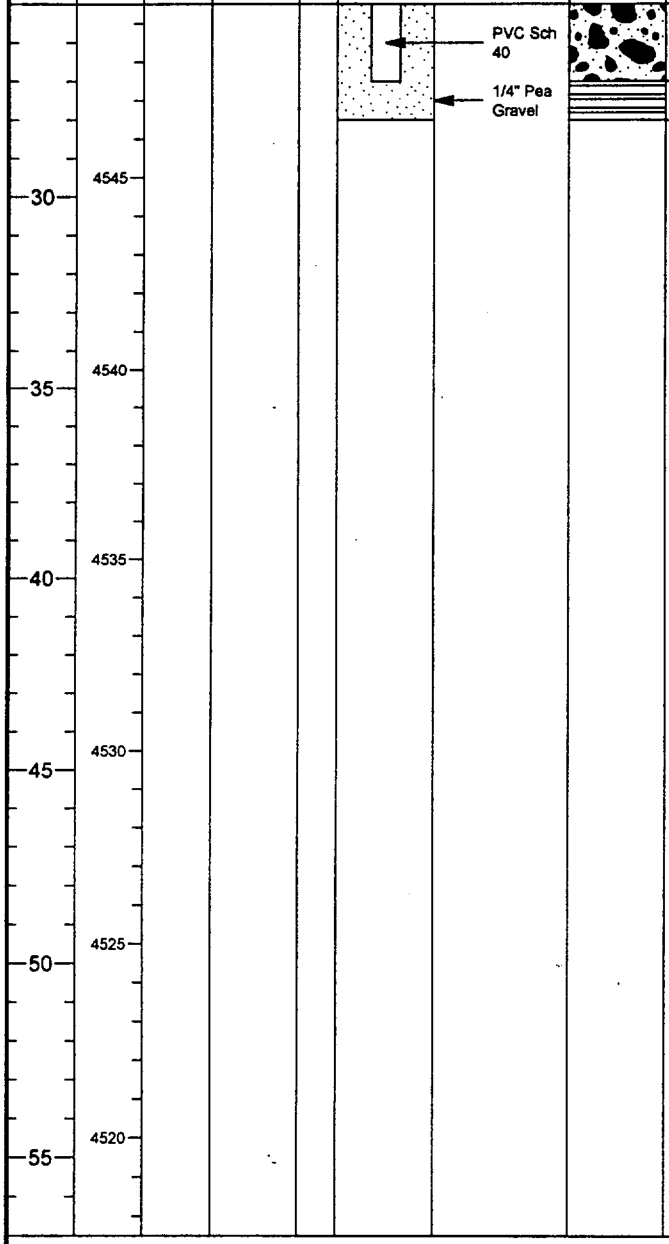
GRAND JUNCTION OFFICE, COLORADO

MONITORING WELL COMPLETION LOG GRJ01-0737

PROJECT UMTRA GROUND WATER
WELL NUMBER 0737
SITE GRAND JUNCTION
DATES DRILLED 2/24/85

Continued from Previous Page

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOWS COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION



DAKOTA SANDSTONE; Shale, fissle, med. to high plasticity, very dark grey (7YR-3/0)

Bottom of boring at 28 ft

U.S. DEPARTMENT OF ENERGY
GRAND JUNCTION OFFICE, COLORADO

MONITORING WELL COMPLETION LOG GRJ01-0740

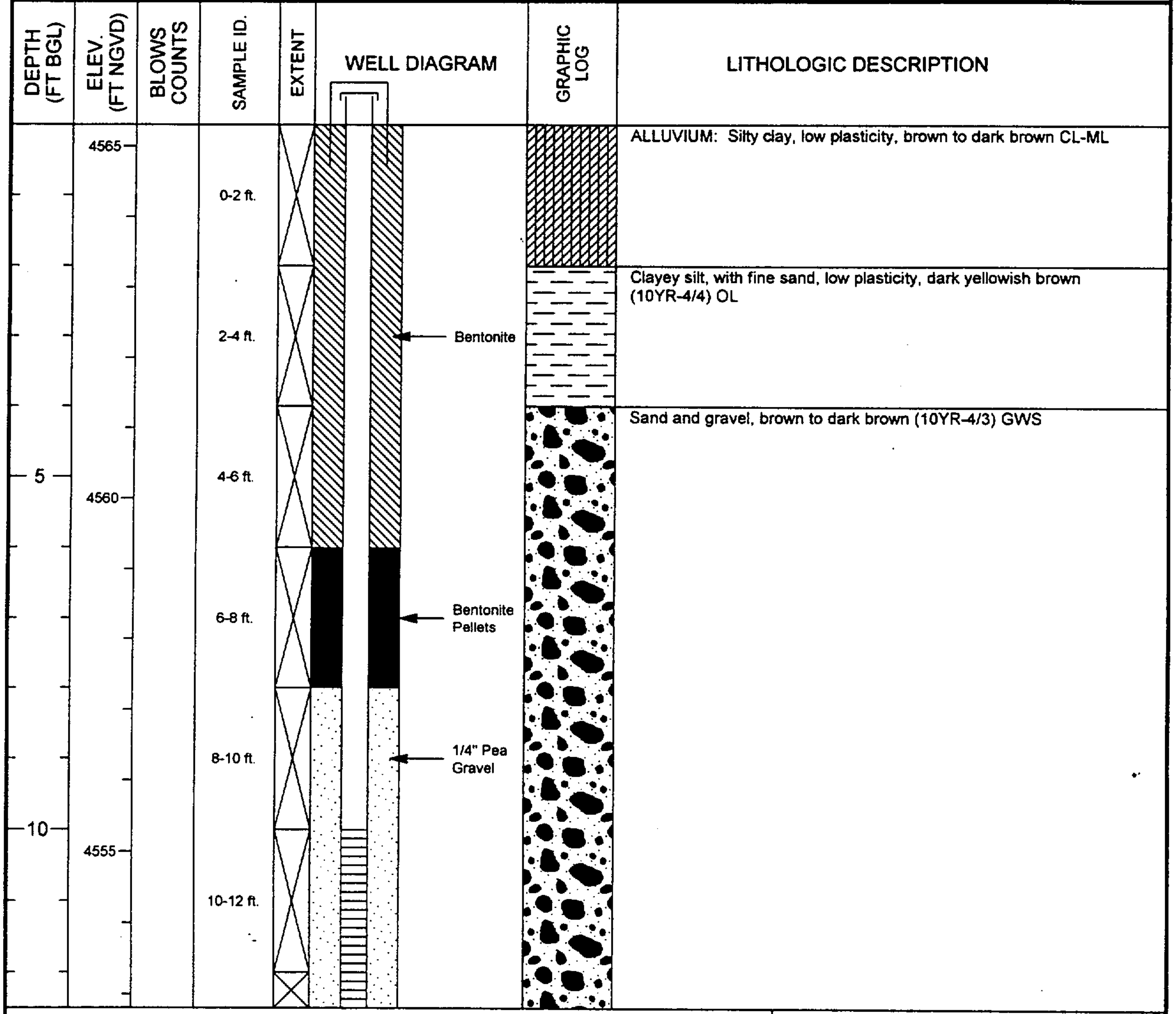
PROJECT UMTRA GROUND WATER
LOCATION GRAND JUNCTION, CO
SITE GRAND JUNCTION
WELL NUMBER 0740

NORTH COORD. (FT) 459776.38
EAST COORD. (FT) 1131669.57
HOLE DEPTH (FT) 18.00
WELL DEPTH (FT) 17.00

DATE DRILLED 2/22/85 to 2/23/85
SURFACE ELEV. (FT NGVD) 4565.31
TOP OF CASING (FT) 4567.86
MEAS. PT. ELEV. (FT) 4567.86
SLOT SIZE (IN) 0.01
BIT SIZE(S) (IN) 6.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	2 in. PVC Sch 40	-2.0	to	10.0
WELL SCREEN:	2 in. Machine Slotted PVC	10.0	to	15.0
SUMP/END CAP:	2 in. PVC Sch 40	15.0	to	17.0
SURFACE SEAL:				
GROUT:	Bentonite	0.0	to	6.0
SEAL:	Bentonite Pellets	6.0	to	8.0
UPPER PACK:				
LOWER PACK:	1/4" Pea Gravel	8.0	to	10.0

DRILLING METHOD ROTARY WITH BUTTON BIT
SAMPLING METHOD SPLIT SPOON
DATE DEVELOPED
WATER LEVEL (FT BMP)
LOGGED BY P. Mckenzie
REMARKS



ALLUVIUM: Silty clay, low plasticity, brown to dark brown CL-ML

Clayey silt, with fine sand, low plasticity, dark yellowish brown (10YR-4/4) OL

Sand and gravel, brown to dark brown (10YR-4/3) GWS

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GRAND JUNCTION OFFICE, COLORADO

MONITORING WELL COMPLETION LOG GRJ01-0740

PROJECT UMTRA GROUND WATER
WELL NUMBER 0740
SITE GRAND JUNCTION
DATES DRILLED 2/22/85 to 2/23/85

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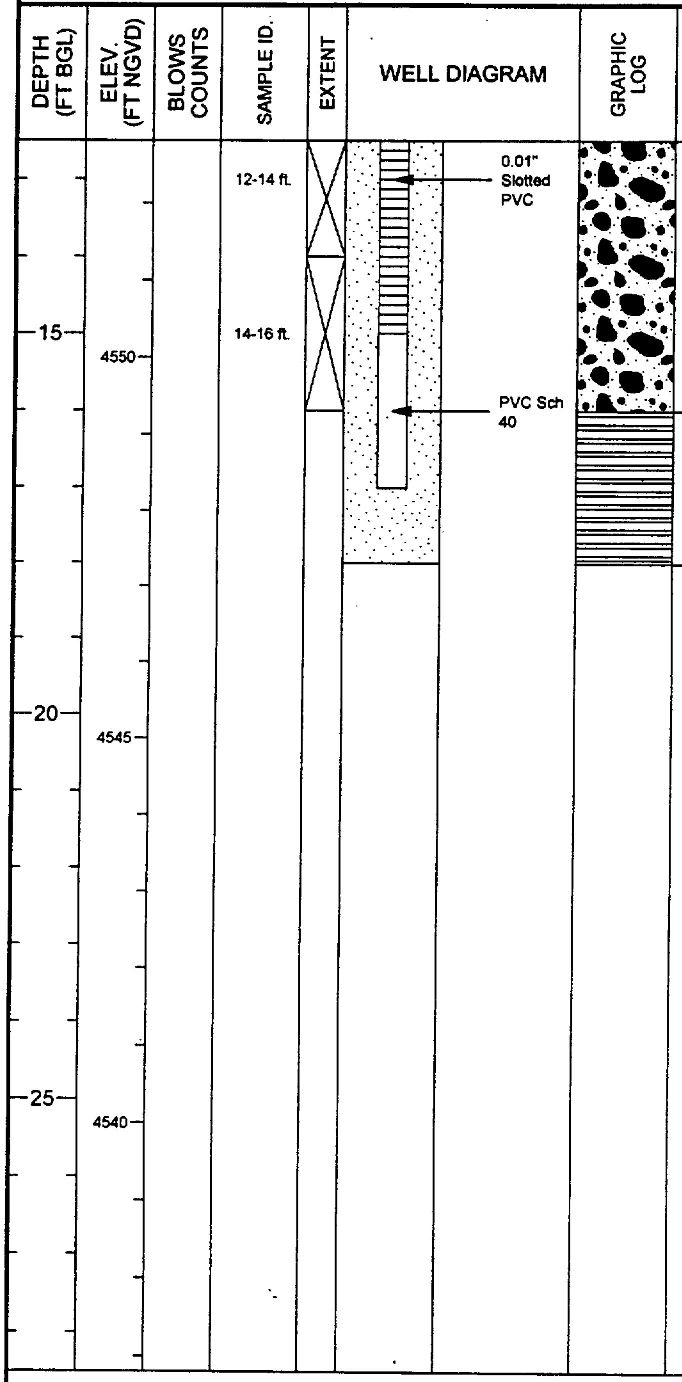

LITHOLOGIC DESCRIPTION

DAKOTA SANDSTONE; Shale, medium to high plasticity, dark grey (7YR-3/0)

Bottom of boring at 18 ft

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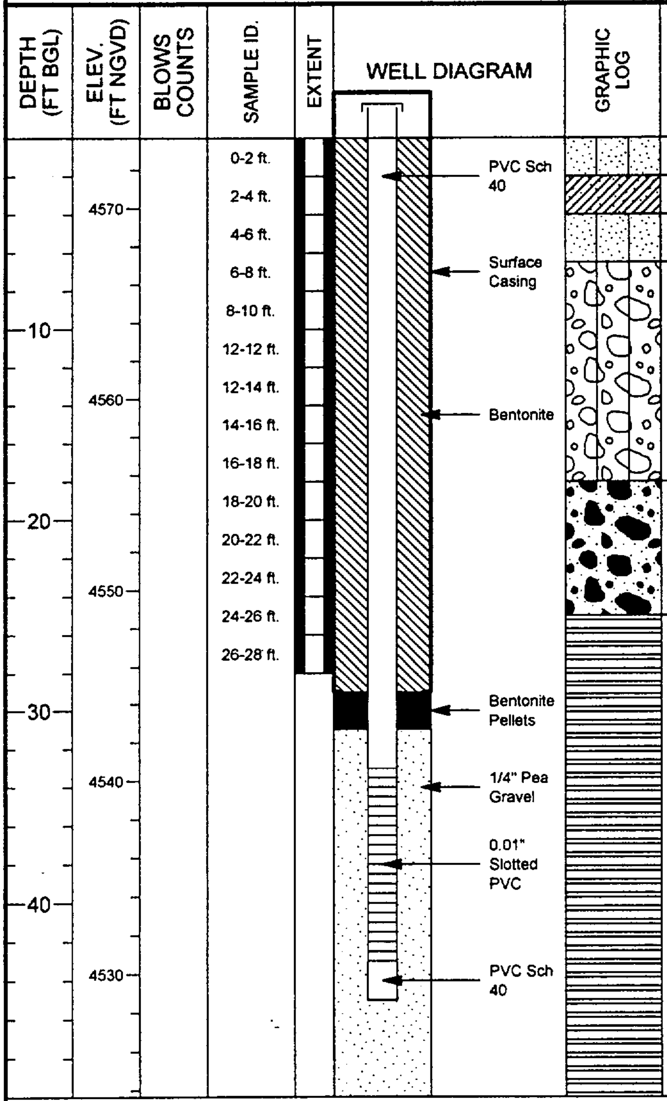
MONITORING WELL COMPLETION LOG GRJ01-0741

PROJECT	UMTRA GROUND WATER	**NORTH COORD. (FT)**	460663.51	**DATE DRILLED**	2/10/85 to 3/10/98
LOCATION	GRAND JUNCTION, CO	**EAST COORD. (FT)**	1132717.00	**SURFACE ELEV. (FT NGVD)**	4573.67
SITE	GRAND JUNCTION	**HOLE DEPTH (FT)**	55.50	**TOP OF CASING (FT)**	4574.02
WELL NUMBER	0741	**WELL DEPTH (FT)**	45.00	**MEAS. PT. ELEV. (FT)**	4574.02
				SLOT SIZE (IN)	0.01
				BIT SIZE(S) (IN)	6.0 / 6.0

	WELL INSTALLATION	**INTERVAL (FT)**		
SURFACE CASING:	5.5 in. Steel	-2.0	to	29.0
BLANK CASING:	2 in. PVC Sch 40	-2.0	to	33.0
WELL SCREEN:	2 in. Machine Slotted PVC	33.0	to	43.0
SUMP/END CAP:	2 in. PVC Sch 40	43.0	to	45.0
SURFACE SEAL:				
GROUT:	Bentonite	0.0	to	29.0
SEAL:	Bentonite Pellets	29.0	to	31.0
UPPER PACK:				
LOWER PACK:	1/4" Pea Gravel	31.0	to	33.0

DRILLING METHOD ROTARY CORE (NX)
SAMPLING METHOD CONTINUOUS CORE
DATE DEVELOPED 3/10/85
WATER LEVEL (FT BMP)
LOGGED BY W. Wood
REMARKS



LITHOLOGIC DESCRIPTION

FILL: Silty sand, fine, little gravel, nonplastic, dark brown SM

Sandy clay, medium plasticity, dark brown CLS

ALLUVIUM: Silty sand, fine, nonplastic, brown SM

Silty gravel, with sand, subrounded, poorly graded, nonplastic, brown GM

Sandy gravel, with cobbles, well graded, little silt, subrounded, lt. brown GWS

DAKOTA SANDSTONE; Shale, highly weathered, soft, dark grey

Note: Shale becomes moderately hard

MONITORING WELL COMPLETION LOG GRJ01-0741

PROJECT	UMTRA GROUND WATER	**WELL NUMBER**	0741
SITE	GRAND JUNCTION	**DATES DRILLED**	2/10/85 to 3/10/98

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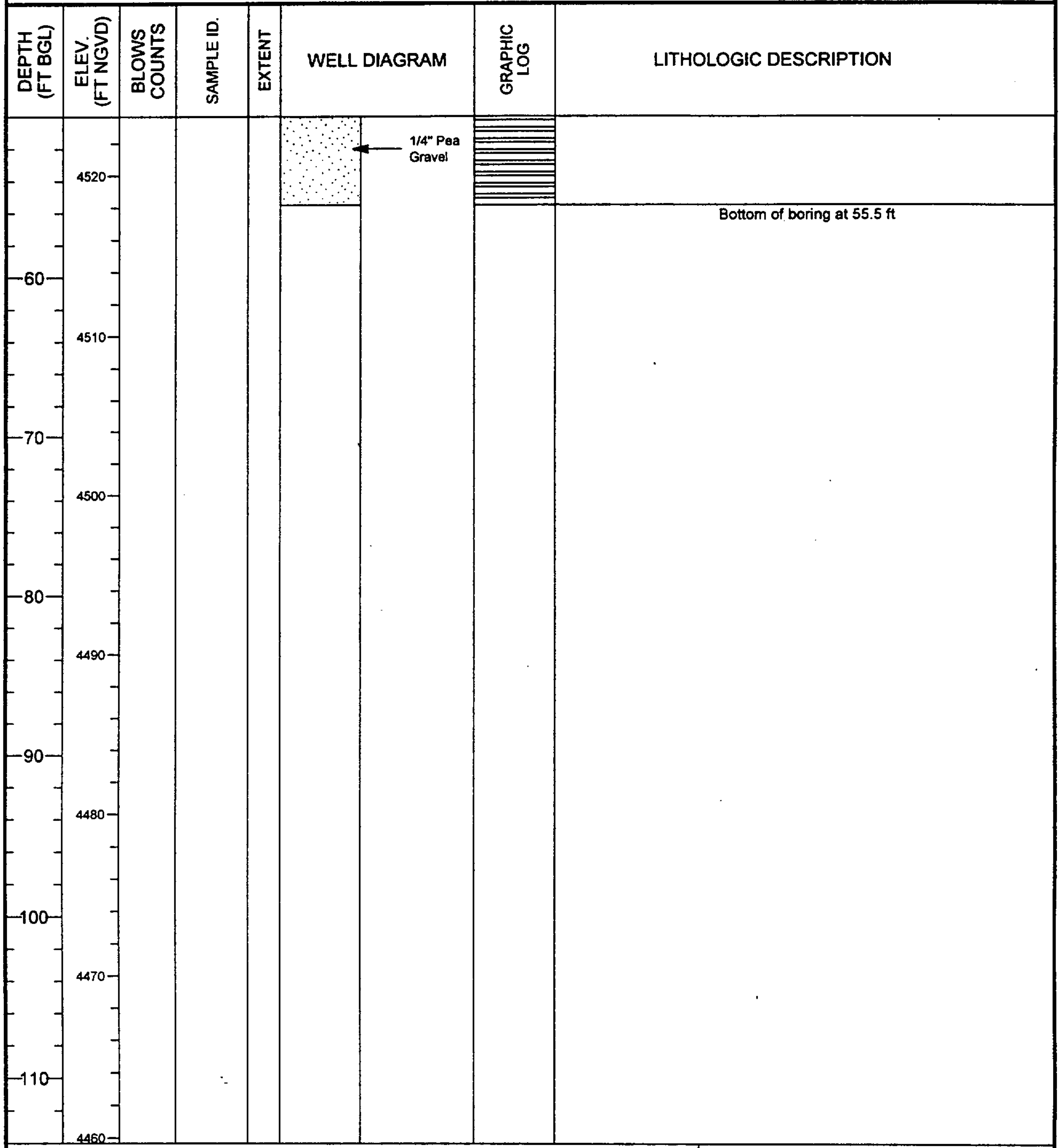


Bottom of boring at 55.5 ft

MONITORING WELL COMPLETION LOG GRJ01-0742

PROJECT UMTRA GROUND WATER
LOCATION GRAND JUNCTION, CO
SITE GRAND JUNCTION
WELL NUMBER 0742

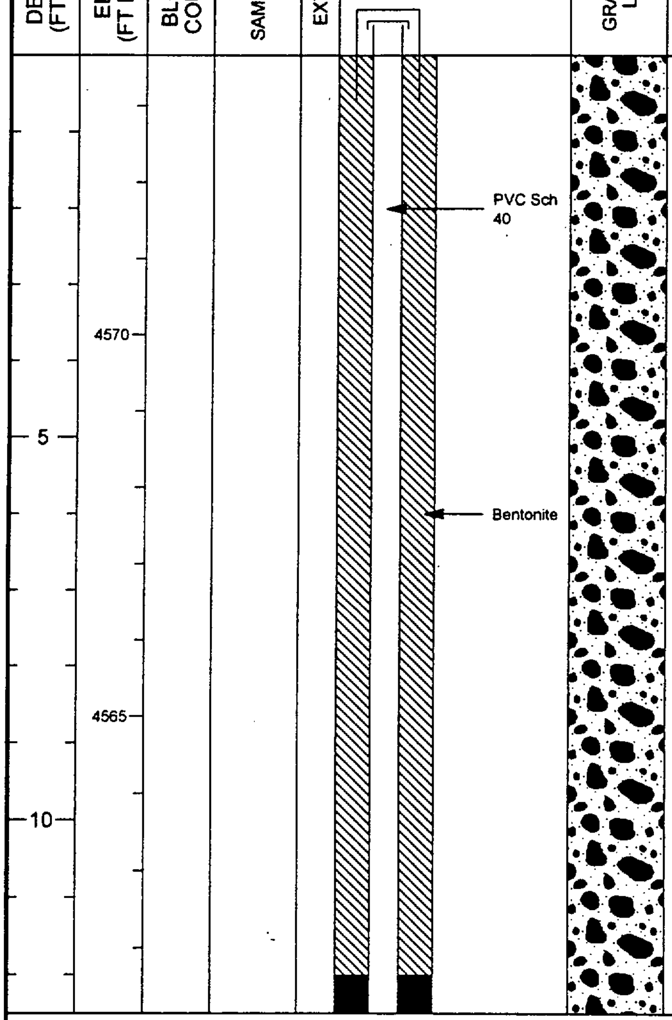
NORTH COORD. (FT) 460642.09
EAST COORD. (FT) 1132715.69
HOLE DEPTH (FT) 23.00
WELL DEPTH (FT) 23.00

DATE DRILLED 2/24/85
SURFACE ELEV. (FT NGVD) 4573.66
TOP OF CASING (FT) 4574.19
MEAS. PT. ELEV. (FT) 4574.19
SLOT SIZE (IN) 0.01
BIT SIZE(S) (IN) 6.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	2 in. PVC Sch 40	-2.0	to	16.0
WELL SCREEN:	2 in. Machine Slotted PVC	16.0	to	21.0
SUMP/END CAP:	2 in. PVC Sch 40	21.0	to	23.0
SURFACE SEAL:				
GROUT:	Bentonite	0.0	to	12.0
SEAL:	Bentonite Pellets	12.0	to	14.0
UPPER PACK:				
LOWER PACK:	1/4" Pea Gravel	14.0	to	16.0

DRILLING METHOD ROTARY WITH 6" BUTTON BIT
SAMPLING METHOD
DATE DEVELOPED
WATER LEVEL (FT BMP)
LOGGED BY P. Mckenzie
REMARKS

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOWS COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							ALLUVIUM; Sandy gravel, well graded GWS



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GRAND JUNCTION OFFICE, COLORADO

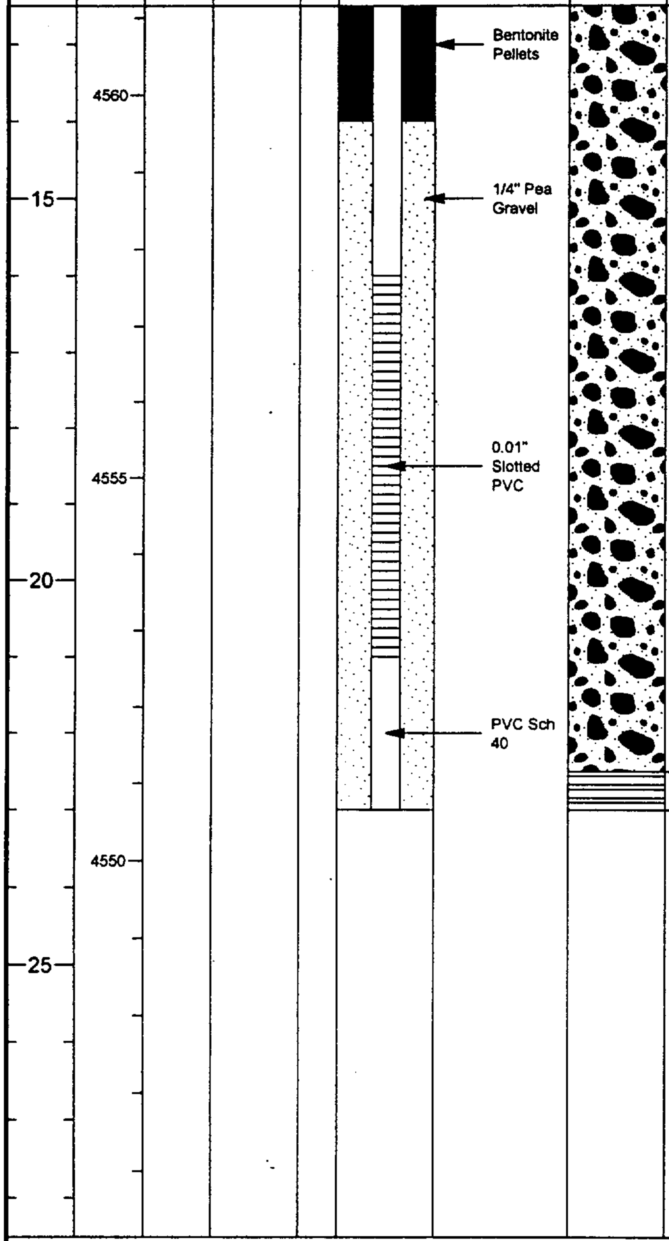
PAGE 1 OF 2 2/1/99

MONITORING WELL COMPLETION LOG GRJ01-0742

PROJECT UMTRA GROUND WATER
WELL NUMBER 0742
SITE GRAND JUNCTION
DATES DRILLED 2/24/85

Continued from Previous Page

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOWS COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION



DAKOTA SANDSTONE; Shale

Bottom of boring at 23 ft

U.S. DEPARTMENT OF ENERGY
GRAND JUNCTION OFFICE, COLORADO

MONITORING WELL COMPLETION LOG GRJ01-0743

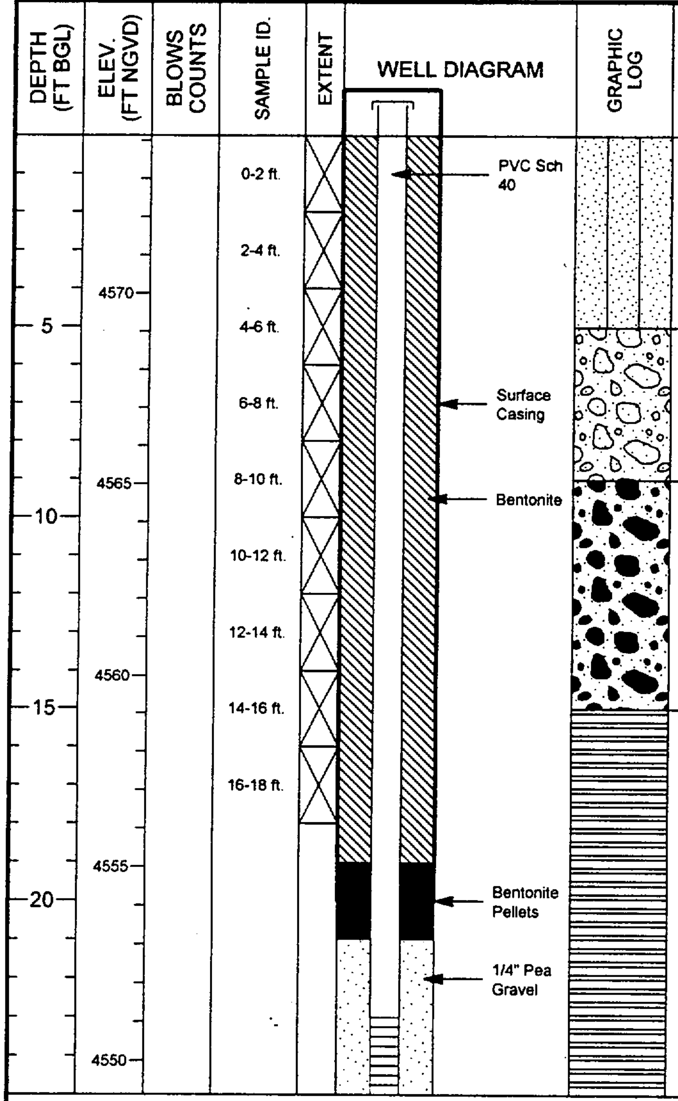
PROJECT UMTRA GROUND WATER
LOCATION GRAND JUNCTION, CO
SITE GRAND JUNCTION
WELL NUMBER 0743

NORTH COORD. (FT) 459359.30
EAST COORD. (FT) 1136736.57
HOLE DEPTH (FT) 50.00
WELL DEPTH (FT) 35.00

DATE DRILLED 2/20/85 to 3/10/85
SURFACE ELEV. (FT NGVD) 4574.13
TOP OF CASING (FT) 4576.10
MEAS. PT. ELEV. (FT) 4576.10
SLOT SIZE (IN) 0.01
BIT SIZE(S) (IN) 6.0 / 6.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:	5.5 in. Steel	-2.0	to	20.0
BLANK CASING:	2 in. PVC Sch 40	-2.0	to	23.0
WELL SCREEN:	2 in. Machine Slotted PVC	23.0	to	33.0
SUMP/END CAP:	2 in. PVC Sch 40	33.0	to	35.0
SURFACE SEAL:				
GROUT:	Bentonite	0.0	to	19.0
SEAL:	Bentonite Pellets	19.0	to	21.0
UPPER PACK:				
LOWER PACK:	1/4" Pea Gravel	21.0	to	23.0

DRILLING METHOD ROTARY WITH DRAG BIT
SAMPLING METHOD SPLIT SPOON
DATE DEVELOPED 3/12/85
WATER LEVEL (FT BMP)
LOGGED BY P. Mckenzie
REMARKS



LITHOLOGIC DESCRIPTION

ALLUVIUM; Silty sand, brown to dark brown,(10YR-4/3) NOTE: Some fine gravel below 3 ft SM

Sandy gravel, poorly graded, little or no fines, low plasticity, lt. brown GPS

Sandy gravel, well graded, lt. brown (10YR-6/3) GWS

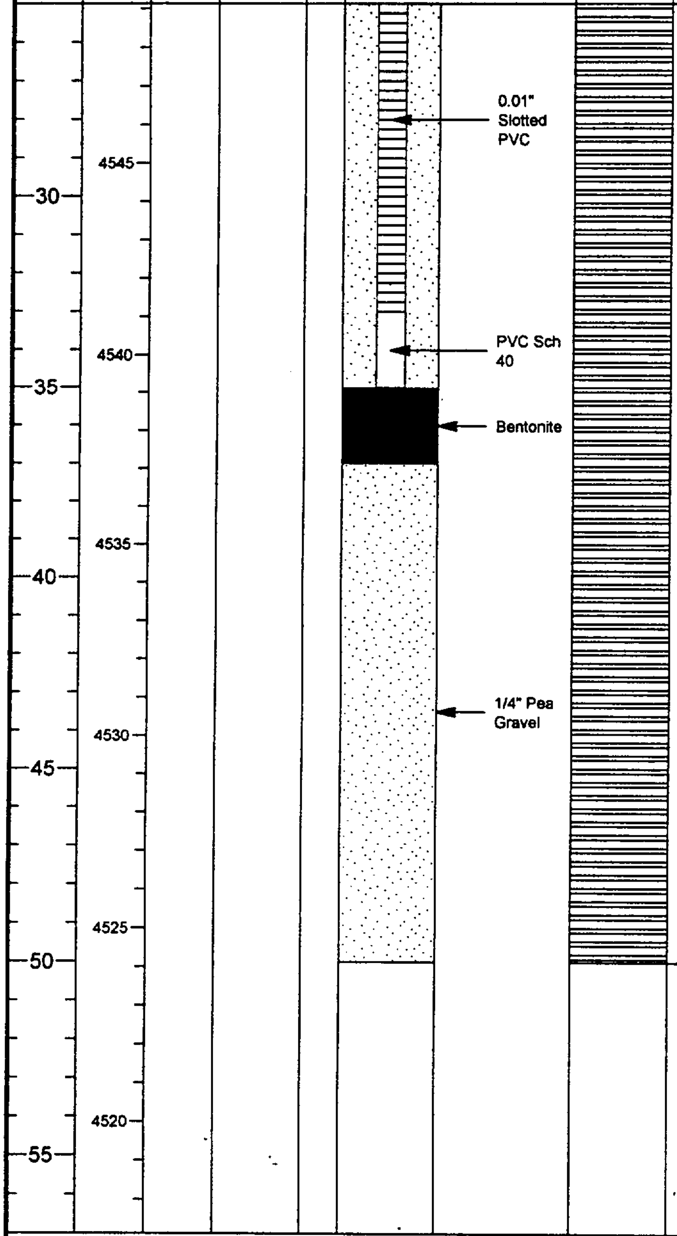
DAKOTA SANDSTONE; Shale, moderately weathered, soft, dark grey

MONITORING WELL COMPLETION LOG GRJ01-0743

PROJECT	UMTRA GROUND WATER	**WELL NUMBER**	0743
SITE	GRAND JUNCTION	**DATES DRILLED**	2/20/85 to 3/10/85

Continued from Previous Page

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOWS COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION



Bottom of boring at 50 ft

U.S. DEPARTMENT OF ENERGY
GRAND JUNCTION OFFICE, COLORADO

MONITORING WELL COMPLETION LOG GRJ01-0744

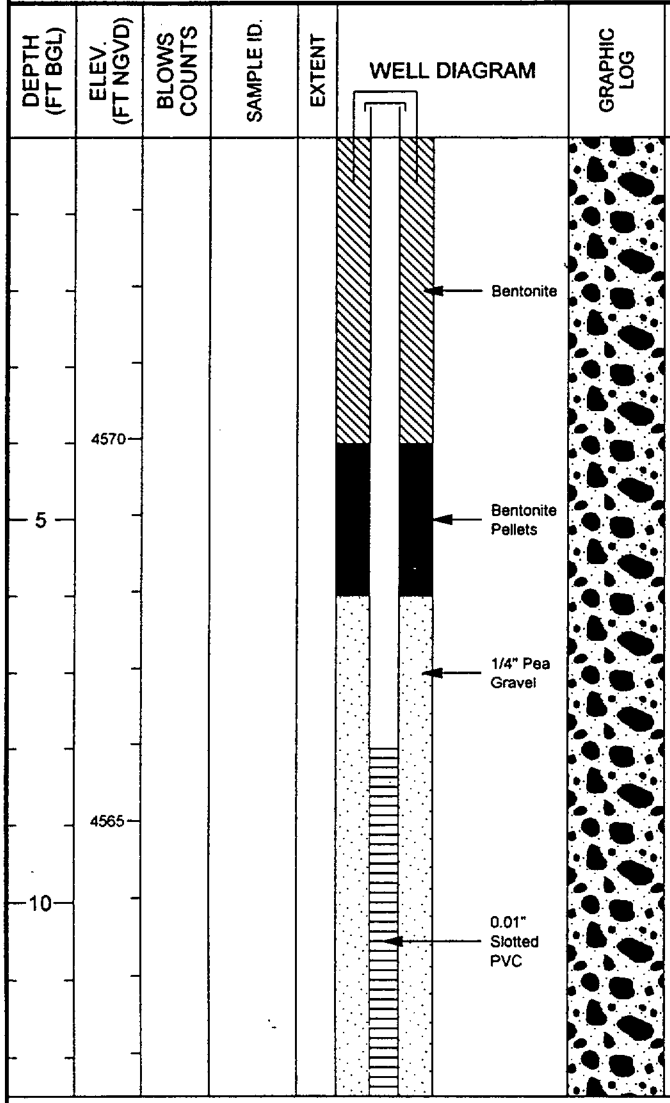
PROJECT UMTRA GROUND WATER
LOCATION GRAND JUNCTION, CO
SITE GRAND JUNCTION
WELL NUMBER 0744

NORTH COORD. (FT) 459359.70
EAST COORD. (FT) 1136718.31
HOLE DEPTH (FT) 15.00
WELL DEPTH (FT) 15.00

DATE DRILLED 2/26/85
SURFACE ELEV. (FT NGVD) 4573.94
TOP OF CASING (FT) 4576.15
MEAS. PT. ELEV. (FT) 4576.15
SLOT SIZE (IN) 0.01
BIT SIZE(S) (IN) 6.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	2 in. PVC Sch 40	-2.0	to	8.0
WELL SCREEN:	2 in. Machine Slotted PVC	8.0	to	13.0
SUMP/END CAP:	2 in. PVC Sch 40	13.0	to	15.0
SURFACE SEAL:				
GROUT:	Bentonite	0.0	to	4.0
SEAL:	Bentonite Pellets	4.0	to	6.0
UPPER PACK:				
LOWER PACK:	1/4" Pea Gravel	6.0	to	8.0

DRILLING METHOD ROTARY WITH 6" BUTTON BIT
SAMPLING METHOD
DATE DEVELOPED
WATER LEVEL (FT BMP)
LOGGED BY P. Mckenzie
REMARKS



LITHOLOGIC DESCRIPTION

ALLUVIUM; Sandy gravel, well graded, subrounded GWS

MONITORING WELL COMPLETION LOG GRJ01-0744

PROJECT UMTRA GROUND WATER
WELL NUMBER 0744
SITE GRAND JUNCTION
DATES DRILLED 2/26/85

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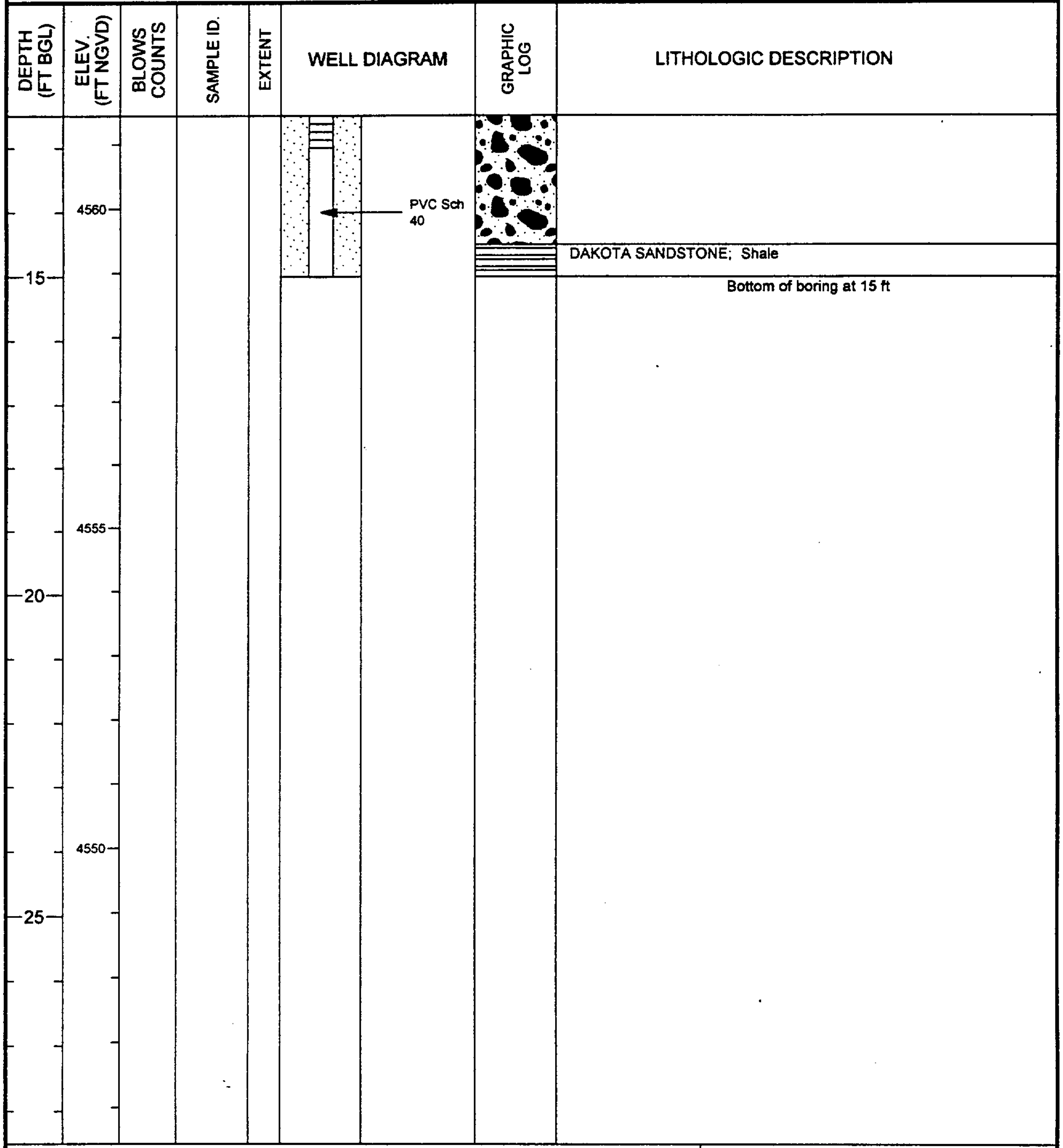


DAKOTA SANDSTONE; Shale

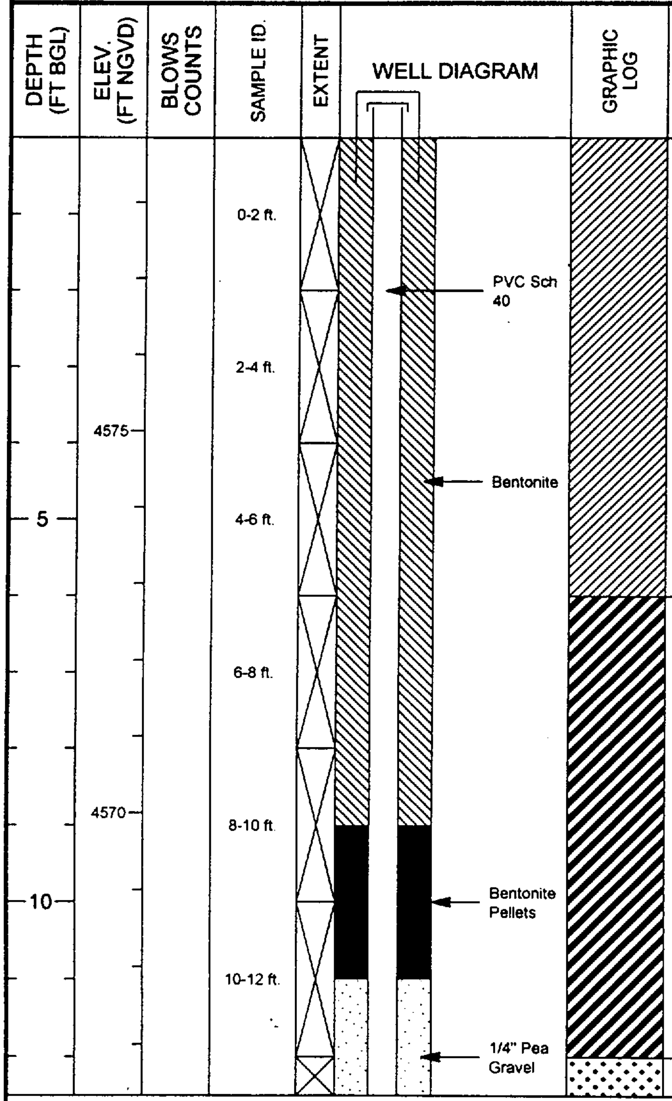
Bottom of boring at 15 ft

MONITORING WELL COMPLETION LOG GRJ01-0745

PROJECT	UMTRA GROUND WATER	**NORTH COORD. (FT)**	460907.05	**DATE DRILLED**	2/20/85 to 2/21/85
LOCATION	GRAND JUNCTION, CO	**EAST COORD. (FT)**	1136625.46	**SURFACE ELEV. (FT NGVD)**	4578.84
SITE	GRAND JUNCTION	**HOLE DEPTH (FT)**	22.00	**TOP OF CASING (FT)**	4580.76
WELL NUMBER	0745	**WELL DEPTH (FT)**	20.00	**MEAS. PT. ELEV. (FT)**	4580.76
				SLOT SIZE (IN)	0.01
				BIT SIZE(S) (IN)	6.0

	WELL INSTALLATION	**INTERVAL (FT)**		
SURFACE CASING:				
BLANK CASING:	2 in. PVC Sch 40	-2.0	to	13.0
WELL SCREEN:	2 in. Machine Slotted PVC	13.0	to	18.0
SUMP/END CAP:	2 in. PVC Sch 40	18.0	to	20.0
SURFACE SEAL:				
GROUT:	Bentonite	0.0	to	9.0
SEAL:	Bentonite Pellets	9.0	to	11.0
UPPER PACK:				
LOWER PACK:	1/4" Pea Gravel	11.0	to	13.0

DRILLING METHOD ROTARY WITH DRAG BIT
SAMPLING METHOD SPLIT SPOON
DATE DEVELOPED
WATER LEVEL (FT BMP)
LOGGED BY P. Mckenzie
REMARKS



LITHOLOGIC DESCRIPTION

ALLUVIUM: Silty clay, medium plasticity, lt.greyish brown (10YR-6/2)
NOTE: rootless in upper 2ft CL

Silty clay, medium to high plasticity, light brownish grey (10YR-6/2) CH

Sand, well graded, little silt, brown (10YR-5/3) SW

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MONITORING WELL COMPLETION LOG GRJ01-0745

PROJECT	UMTRA GROUND WATER	**WELL NUMBER**	0745
SITE	GRAND JUNCTION	**DATES DRILLED**	2/20/85 to 2/21/85

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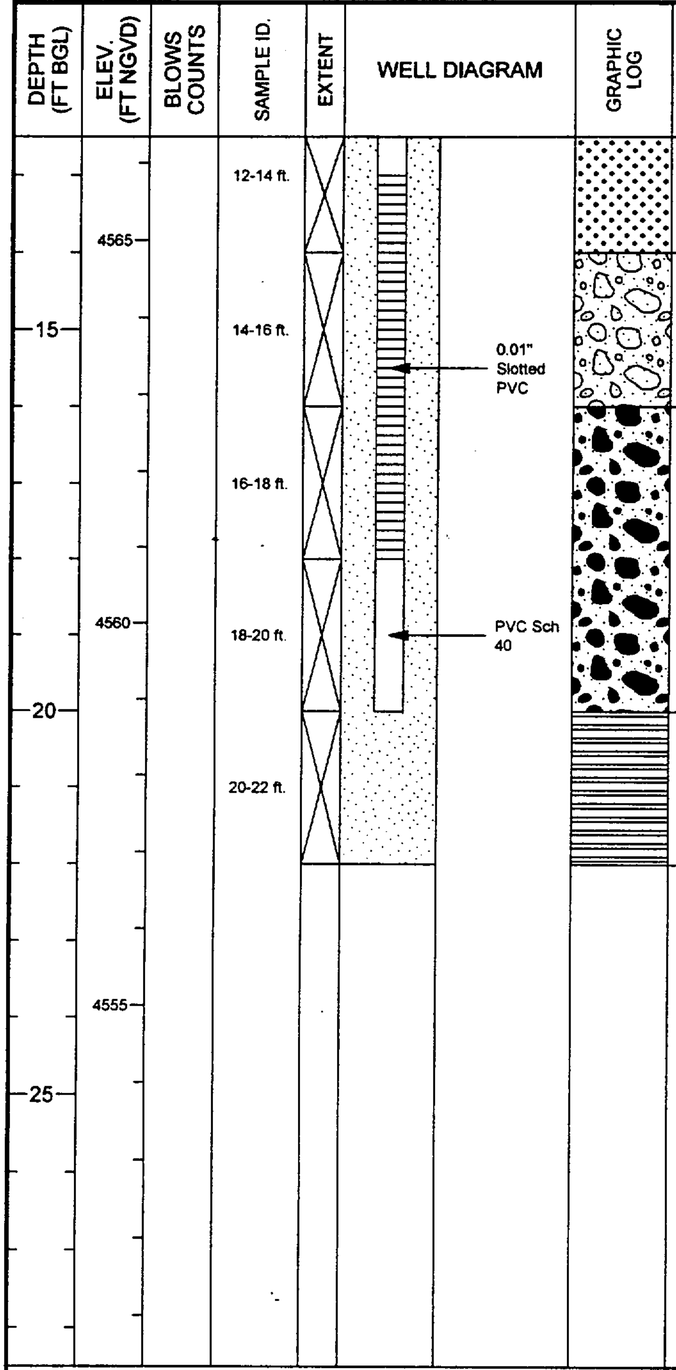

LITHOLOGIC DESCRIPTION

Sandy gravel, poorly graded GPS

Sandy gravel, well graded, little silt, brown (10YR-5/3) GWS

MANCOS SHALE: Shale, very fissle, dark grey (10YR-4/1)

Bottom of boring at 22 ft

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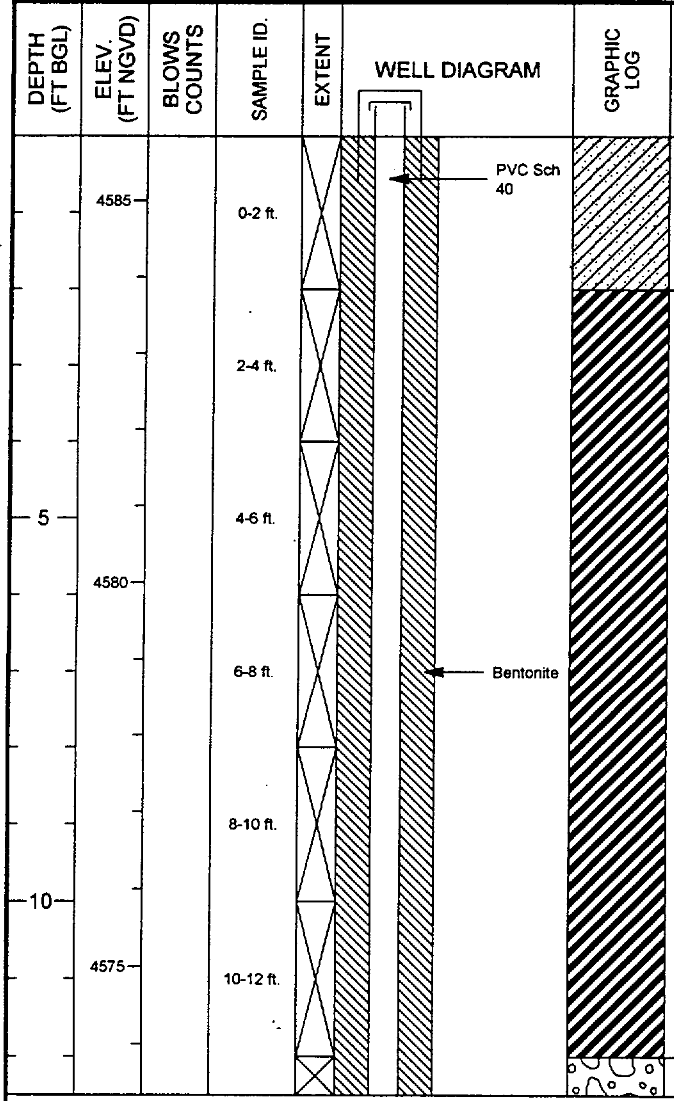
MONITORING WELL COMPLETION LOG GRJ01-0746

PROJECT	UMTRA GROUND WATER	**NORTH COORD. (FT)**	462231.93	**DATE DRILLED**	3/15/85
LOCATION	GRAND JUNCTION, CO	**EAST COORD. (FT)**	1135473.93	**SURFACE ELEV. (FT NGVD)**	4585.84
SITE	GRAND JUNCTION	**HOLE DEPTH (FT)**	25.00	**TOP OF CASING (FT)**	4587.85
WELL NUMBER	0746	**WELL DEPTH (FT)**	25.00	**MEAS. PT. ELEV. (FT)**	4587.85
				SLOT SIZE (IN)	0.01
				BIT SIZE(S) (IN)	6.0

	WELL INSTALLATION	**INTERVAL (FT)**		
SURFACE CASING:				
BLANK CASING:	2 in. PVC Sch 40	-1.9	to	18.0
WELL SCREEN:	2 in. Machine Slotted PVC	18.0	to	23.0
SUMP/END CAP:	2 in. PVC Sch 40	23.0	to	25.0
SURFACE SEAL:				
GROUT:	Bentonite	0.0	to	14.0
SEAL:	Bentonite Pellets	14.0	to	16.0
UPPER PACK:				
LOWER PACK:	1/4" Pea Gravel	16.0	to	18.0

DRILLING METHOD ROTARY WITH REVERT MUD
SAMPLING METHOD SPLIT SPOON
DATE DEVELOPED
WATER LEVEL (FT BMP)
LOGGED BY R. Crockett
REMARKS



LITHOLOGIC DESCRIPTION

ALLUVIUM: Clayey sand, some gravel and cobble, fine,lt. brown SC

Clay, high plasticity, brown CH

Gravel, sandy, fine to medium grain, sub-angular to rounded, grey to

MONITORING WELL COMPLETION LOG GRJ01-0746

PROJECT	UMTRA GROUND WATER	**WELL NUMBER**	0746
SITE	GRAND JUNCTION	**DATES DRILLED**	3/15/85

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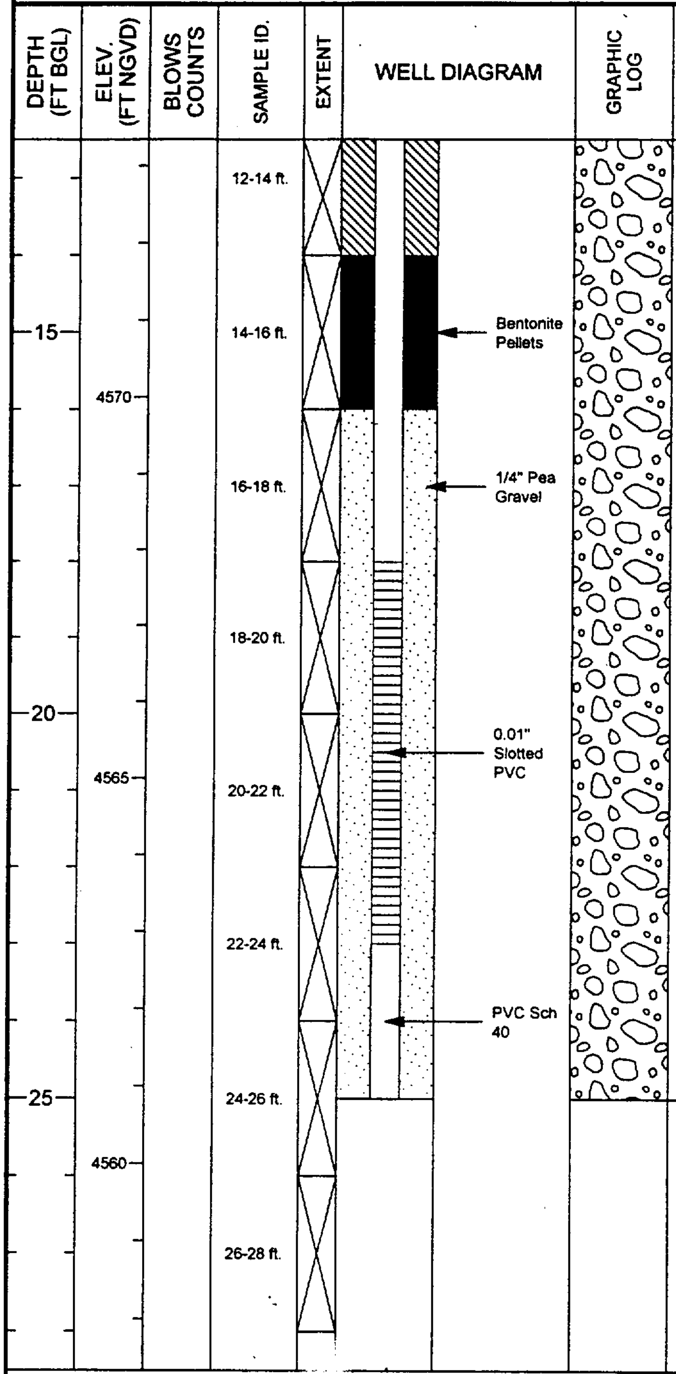

LITHOLOGIC DESCRIPTION

black GP

Bottom of boring at 25 ft

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MONITORING WELL COMPLETION LOG GRJ01-1000

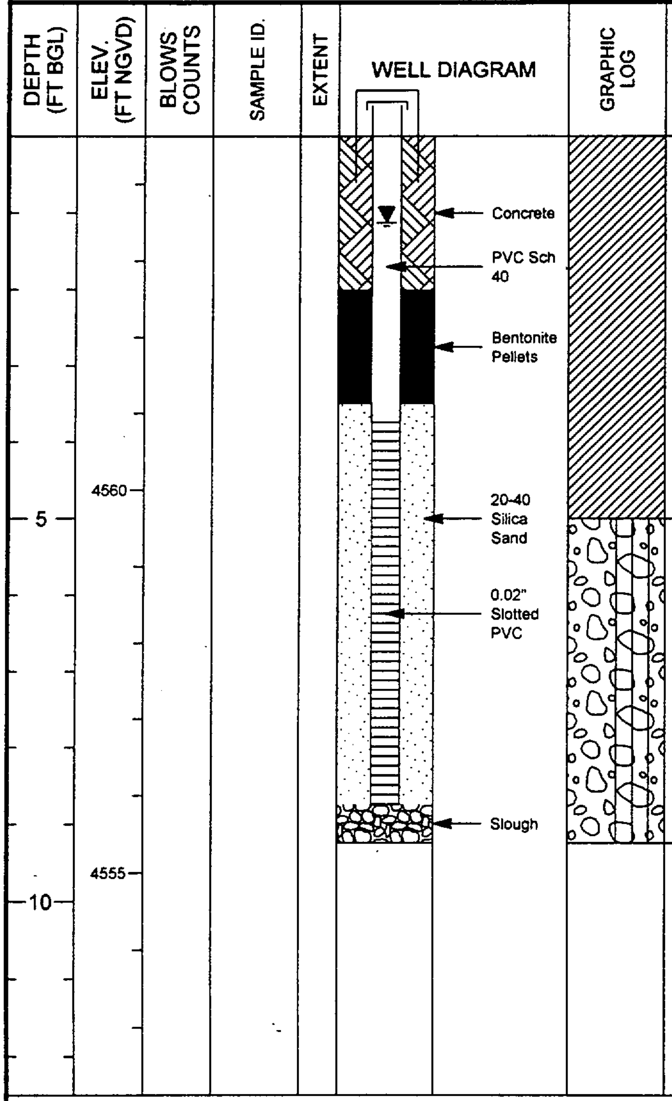
PROJECT UMTRA GROUND WATER
LOCATION GRAND JUNCTION, CO
SITE GRAND JUNCTION
WELL NUMBER 1000

NORTH COORD. (FT) 459213.46
EAST COORD. (FT) 1132559.95
HOLE DEPTH (FT) 9.24
WELL DEPTH (FT) 8.74

DATE DRILLED 9/27/94 to 9/28/94
SURFACE ELEV. (FT NGVD) 4564.63
TOP OF CASING (FT) 4566.80
MEAS. PT. ELEV. (FT) 4566.80
SLOT SIZE (IN) 0.02
BIT SIZE(S) (IN) 8.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-1.96	to	3.74
WELL SCREEN:	4 in. Machine Slotted PVC	3.74	to	8.74
SUMP/END CAP:				
SURFACE SEAL:	Concrete	0.0	to	2.0
GROUT:				
SEAL:	Bentonite Pellets	2.0	to	3.5
UPPER PACK:				
LOWER PACK:	20-40 Silica Sand	3.5	to	8.74

DRILLING METHOD HOLLOW STEM AUGER
SAMPLING METHOD
DATE DEVELOPED
WATER LEVEL (FT BMP) 3.3
LOGGED BY T. Monks
REMARKS Slow drilling due to high percentage of small cobbles from 5' to 9.3'.



LITHOLOGIC DESCRIPTION

ALLUVIUM; Clay with some gravel, 50% fines, 40% fine sands, 10% gravel, pale yellow brown, (10YR-6/2) CL

Poorly graded gravel with silt and cobbles, 50% subrounded to angular gravel, 30% cobbles 3/4 inch, 20% fines-clays, pale yellow brown, (10YR-6/2) GP-GM

Bottom of boring 9.24 ft

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MONITORING WELL COMPLETION LOG GRJ01-1001

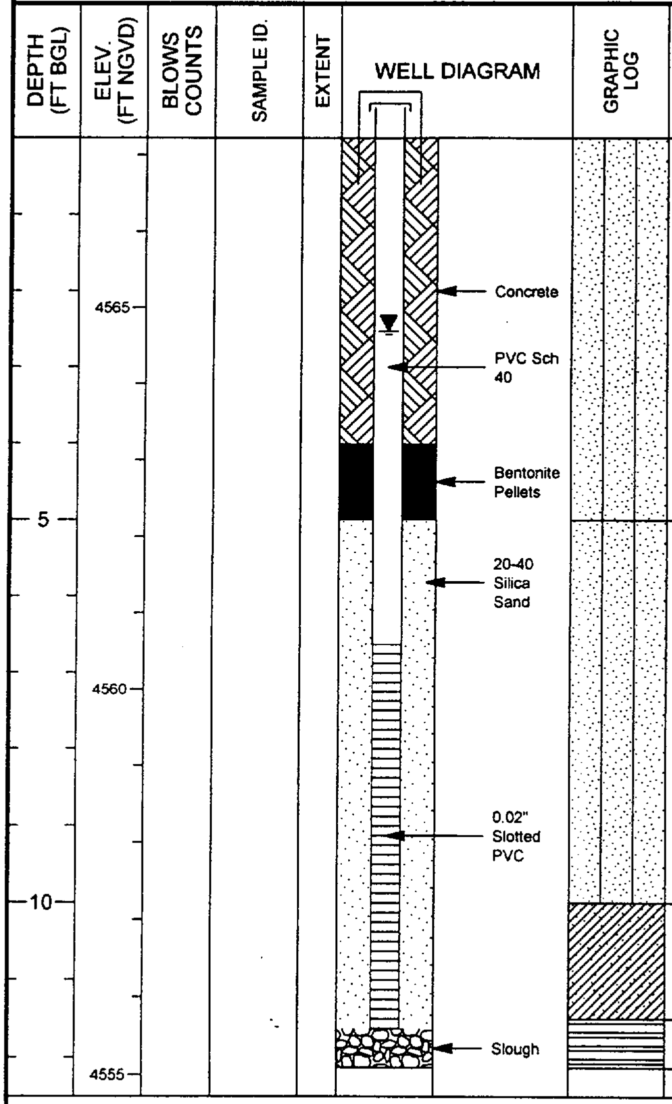
PROJECT UMTRA GROUND WATER
LOCATION GRAND JUNCTION, CO
SITE GRAND JUNCTION
WELL NUMBER 1001

NORTH COORD. (FT) 459287.53
EAST COORD. (FT) 1132654.44
HOLE DEPTH (FT) 12.13
WELL DEPTH (FT) 11.63

DATE DRILLED 9/28/94 to 9/29/94
SURFACE ELEV. (FT NGVD) 4567.22
TOP OF CASING (FT) 4569.69
MEAS. PT. ELEV. (FT) 4569.69
SLOT SIZE (IN) 0.02
BIT SIZE(S) (IN) 8.0

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-1.25	to	6.63
WELL SCREEN:	4 in. Machine Slotted PVC	6.63	to	11.63
SUMP/END CAP:				
SURFACE SEAL:	Concrete	0.0	to	4.0
GROUT:				
SEAL:	Bentonite Pellets	4.0	to	5.0
UPPER PACK:				
LOWER PACK:	20-40 Silica Sand	5.0	to	11.63

DRILLING METHOD HOLLOW STEM AUGER
SAMPLING METHOD
DATE DEVELOPED
WATER LEVEL (FT BMP) 5.0
LOGGED BY T. Monks
REMARKS Fast drilling with less gravel and silty material



LITHOLOGIC DESCRIPTION

ALLUVIUM; Silty sand with gravel, 50% fines, 30% fine sands, 20% subrounded to angular gravel, no plasticity, reaction to HCL, pale brown (10YR-6/2) SM

Silty sand with gravel; 70% dominantly fine sand; about 20% fines, 10% subrounded to angular gravel; no plasticity; reaction to HCL; pale brown (10YR 6/2). SM

Sandy clay, 60% fines, 40% fine sand, reaction to HCL, low plasticity, pale brown (10YR-6/2) CLS

DAKOTA SANDSTONE; Shale

Bottom of boring 12.13 ft

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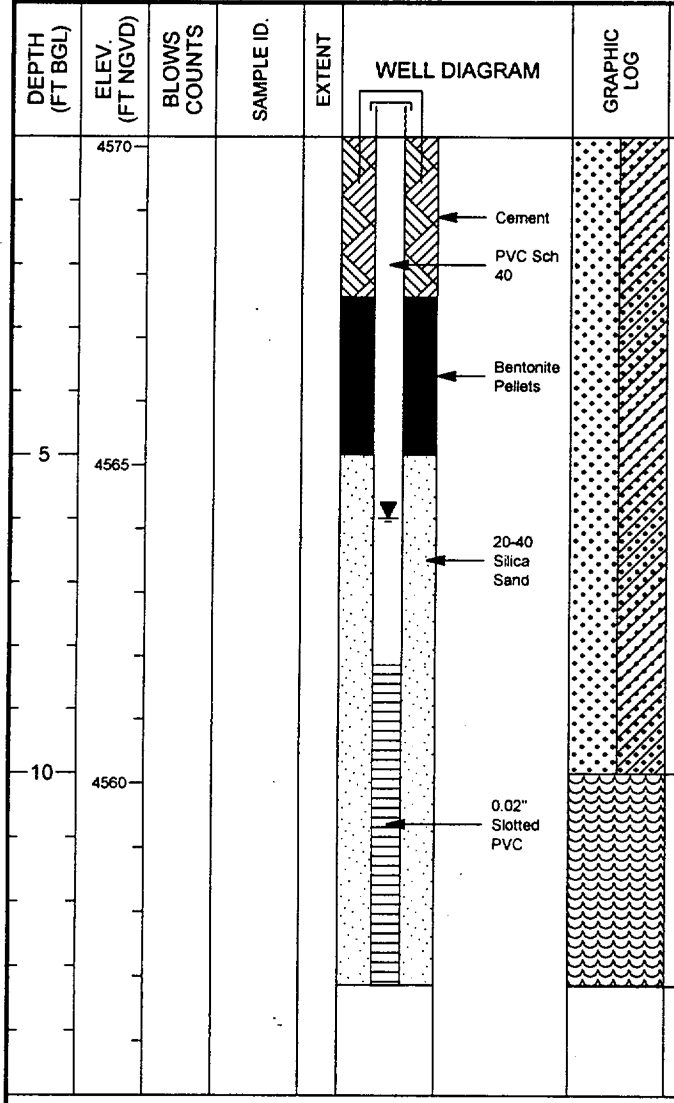
MONITORING WELL COMPLETION LOG GRJ01-1002

PROJECT	UMTRA GROUND WATER	**NORTH COORD. (FT)**	459477.23	**DATE DRILLED**	9/28/94 to 9/29/94
LOCATION	GRAND JUNCTION, CO	**EAST COORD. (FT)**	1132899.81	**SURFACE ELEV. (FT NGVD)**	4570.16
SITE	GRAND JUNCTION	**HOLE DEPTH (FT)**	13.29	**TOP OF CASING (FT)**	4572.62
WELL NUMBER	1002	**WELL DEPTH (FT)**	13.29	**MEAS. PT. ELEV. (FT)**	4572.62
				SLOT SIZE (IN)	0.02
				BIT SIZE(S) (IN)	8.0

	WELL INSTALLATION	**INTERVAL (FT)**		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-1.78	to	8.29
WELL SCREEN:	4 in. Machine Slotted PVC	8.29	to	13.29
SUMP/END CAP:				
SURFACE SEAL:	Concrete	0.0	to	2.5
GROUT:				
SEAL:	Bentonite Pellets	2.5	to	5.0
UPPER PACK:				
LOWER PACK:	20-40 Silica Sand	5.0	to	13.29

DRILLING METHOD HOLLOW STEM AUGER
SAMPLING METHOD
DATE DEVELOPED
WATER LEVEL (FT BMP) 8.45
LOGGED BY T. Monks
REMARKS Fast drilling, very little gravel



LITHOLOGIC DESCRIPTION

ALLUVIUM; Well graded sand with silt nodules, 70% fine sand, 20% silt nodules, no plasticity, reation to HCL, yellowish brown, (10YR-2/20) SW-SC

Organic silt with sand, 90% fines, 10% finesand, low plasticity, reation with HCL, (10TY-2/2), yellow brown OH

DAKOTA SANDSTONE; Shale
Bottom of borehole 13.29 ft

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MONITORING WELL COMPLETION LOG GRJ01-1010

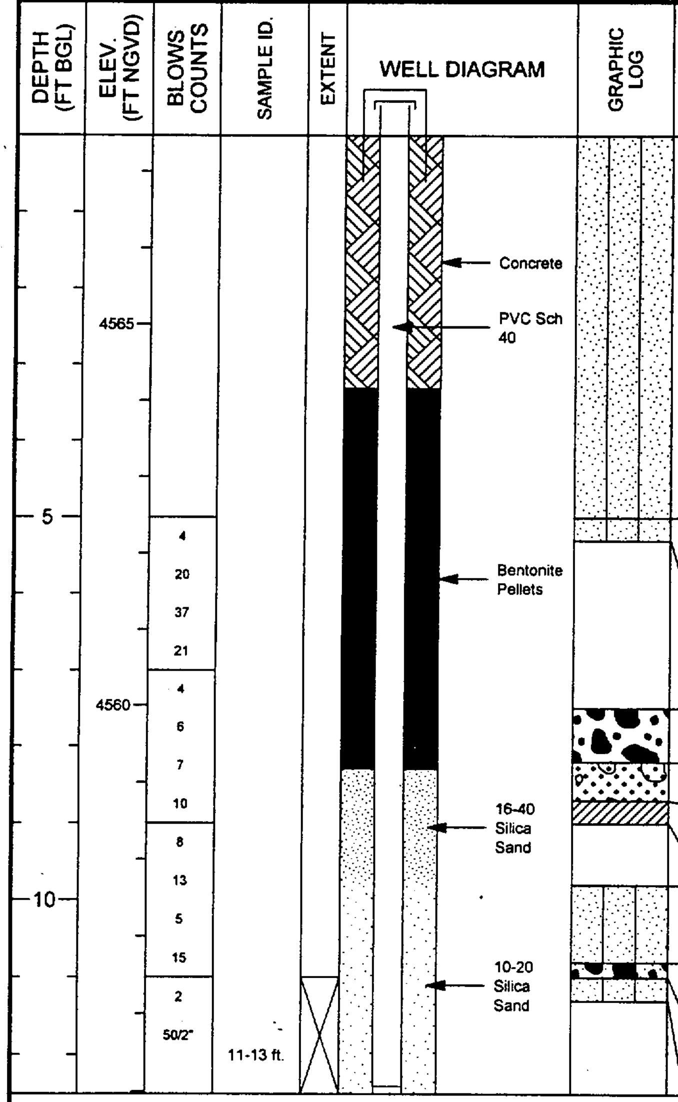
PROJECT UMTRA GROUND WATER
LOCATION GRAND JUNCTION, CO
SITE GRAND JUNCTION
WELL NUMBER 1010

NORTH COORD. (FT) 459680.06
EAST COORD. (FT) 1130095.63
HOLE DEPTH (FT) 23.85
WELL DEPTH (FT) 22.77

DATE DRILLED 11/4/97
SURFACE ELEV. (FT NGVD) 4567.47
TOP OF CASING (FT) 4570.05
MEAS. PT. ELEV. (FT) 4570.05
SLOT SIZE (IN) 0.02
BIT SIZE(S) (IN) 12.25

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-2.6	to	12.4
WELL SCREEN:	4 in. Machine Slotted PVC	12.4	to	22.4
SUMP/END CAP:	4 in. PVC Sch 40	22.4	to	22.77
SURFACE SEAL:	Concrete	0.0	to	3.3
GROUT:				
SEAL:	Bentonite Pellets	3.3	to	8.3
UPPER PACK:	16-40 Silica Sand	8.3	to	9.8
LOWER PACK:	10-20 Silica Sand	9.8	to	22.77

DRILLING METHOD HOLLOW STEM AUGER
SAMPLING METHOD SPLIT SPOON
DATE DEVELOPED 12/8/97
WATER LEVEL (FT BMP) 15.56
LOGGED BY L. Spencer
REMARKS



LITHOLOGIC DESCRIPTION

FILL; Silty sand; yellowish brown (10 YR 5/4); 60% sand, 25% silt, 10% gravel, 5%clay; well graded subrounded cobbles to 1/4" gravel; slight plasticity when wet; dry. SM

Silty sand fine to medium grained; yellowish brown (10YR 5/4); 60% sand, 30% silt, 10% gravel; subrounded, well sorted; slight plasticity when wet; dry SM

No recovery - cobble in shoe. Poor sample.

Gravel; 80% gravel, 20% sand; subrounded to subangular, well graded; moist. GW

Gravelly sand; yellowish brown (10YR 5/6); 60% sand, 30% gravel (subrounded), 10% silt; well graded; wet. SWG

Clayey silt; dark brown (10YR 4/3); 70% silt, 25% sand (fine to medium grained), 5% clay; poorly graded; low plasticity; moist. CL

No recovery

Road base; black (10YR 2/1); 60% sand, 30% silt, 10% gravel; subrounded to subangular; well graded; moist. SM

Gravely sand; light yellowish brown (10YR 6/4); 60% gravel, 30% sand, 10% silt; subrounded to subangular; well graded; moist. GWS

Silty sand; yellowish brown (10YR 5/4); 60% sand, 35% gravel, 5% silt; subrounded to subangular; well graded; moist. Some dark road base sands. SM

No recovery - rock in shoe

MONITORING WELL COMPLETION LOG GRJ01-1010

PROJECT UMTRA GROUND WATER
WELL NUMBER 1010
SITE GRAND JUNCTION
DATES DRILLED 11/4/97

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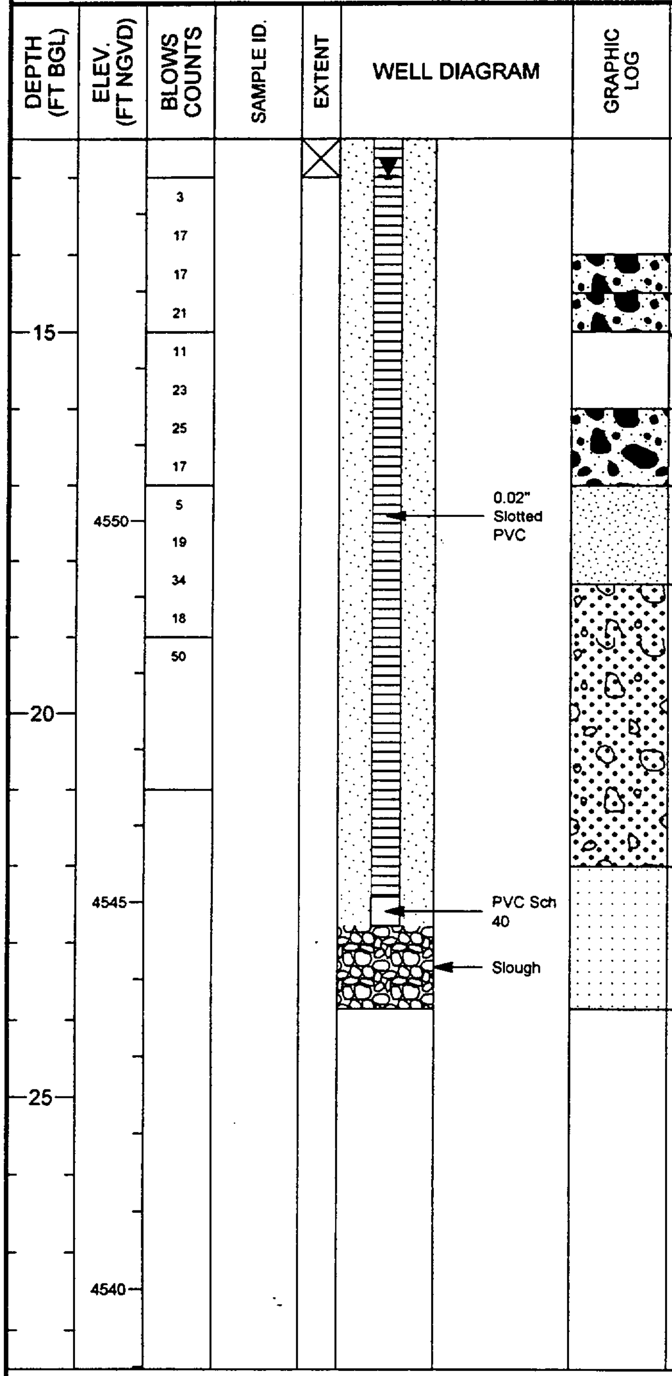


LITHOLOGIC DESCRIPTION

Sandy gravel; 60% gravel, 50% sand, 10% silt; subrounded to subangular; well graded; wet. Oily odor and asphalt chips. GWS

ALLUVIUM; Sandy gravel; very dark gray (10YR 3/1); 70% gravel (subrounded from 1/4" to cobbles), 25% sand (fine grained to medium grained), 5% silt; well graded; saturated. GWS

Slough - No recovery

Sandy gravel; very dark gray (10YR 3/1); 70% gravel (subrounded from 1/4" to cobbles), 25% sand (fine grained to medium grained), 5% silt; well graded; saturated. GWS

Sand: very dark gray (10YR 3/1); 100% sand; fairly clean, fine to coarse grained; poorly graded; subrounded; saturated. Red, yellow, green and black mineral grains, some carbon? Yellowish white tiny chert chips. SP

Gravelly sand; very dark gray (10Y 3/1); fairly clean fine to coarse grained with gravel from 1/4" to 2"; well graded; saturated. SWG

Note: drilling became hard at 22.0 feet. Suspect weathered bedrock at this point. Over-drilled due to running sands/gravels coming into the auger. SWG

DAKOTA SANDSTONE; Sandstone; gray (10YR 6/1); fine grained, a small amount of carbon, a few read and yellow mineral grains; mostly clean quartzose sandstone, weathered.

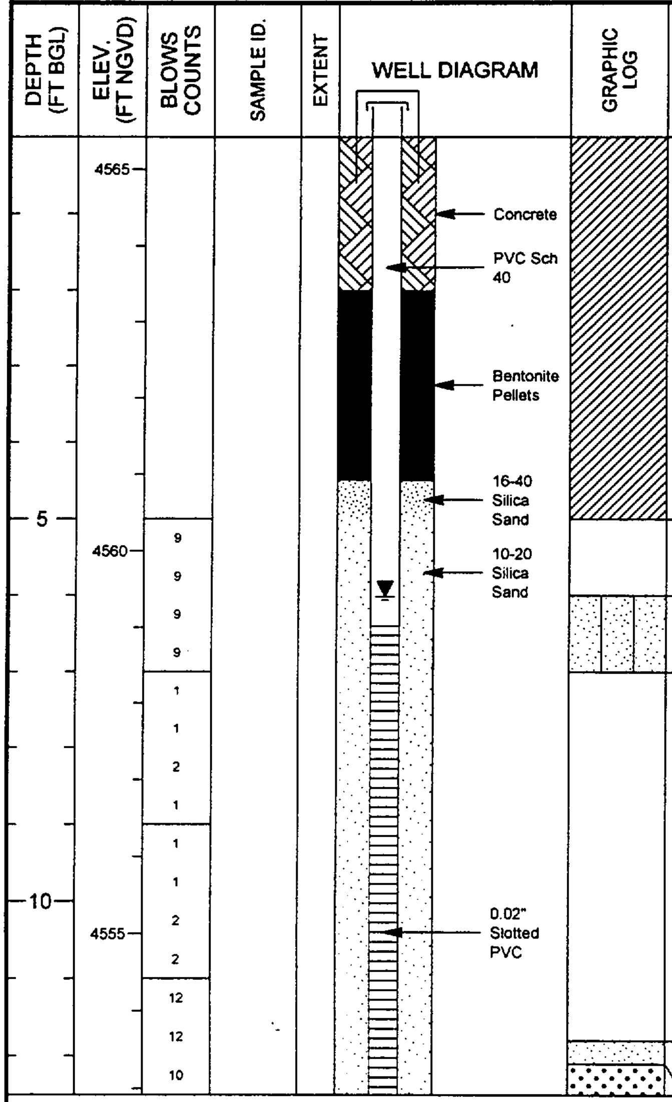
Bottom of boring at 23.85 feet.

MONITORING WELL COMPLETION LOG GRJ01-1011

PROJECT	UMTRA GROUND WATER	**NORTH COORD. (FT)**	459320.39	**DATE DRILLED**	11/3/97
LOCATION	GRAND JUNCTION, CO	**EAST COORD. (FT)**	1131706.55	**SURFACE ELEV. (FT NGVD)**	4565.42
SITE	GRAND JUNCTION	**HOLE DEPTH (FT)**	15.00	**TOP OF CASING (FT)**	4567.67
WELL NUMBER	1011	**WELL DEPTH (FT)**	14.65	**MEAS. PT. ELEV. (FT)**	4567.67
				SLOT SIZE (IN)	0.02
				BIT SIZE(S) (IN)	12.25

	WELL INSTALLATION	**INTERVAL (FT)**		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-2.2	to	6.4
WELL SCREEN:	4 in. Machine Slotted PVC	6.4	to	14.4
SUMP/END CAP:	4 in. PVC Sch 40	14.4	to	14.65
SURFACE SEAL:	Concrete	0.0	to	2.0
GROUT:				
SEAL:	Bentonite Pellets	2.0	to	4.5
UPPER PACK:	16-40 Silica Sand	4.5	to	5.0
LOWER PACK:	10-20 Silica Sand	5.0	to	14.65

DRILLING METHOD	HOLLOW STEM AUGER
SAMPLING METHOD	
DATE DEVELOPED	11/25/97
WATER LEVEL (FT BMP)	8.27
LOGGED BY	L. Spencer
REMARKS	



LITHOLOGIC DESCRIPTION

FILL; Silty sand, yellowish brown (10 YR 5/4) 60% sand, 30% silt, 5% gravel, 5% clay, subrounded poorly graded low plasticity, moist, a few roots/root hairs. CL

No recovery.

Silty sand, yellowish brown (10 YR 5/6) 60% sand, 20% silt, 15% gravel, subrounded, 1/4" to cobble and 5% clay, well graded, moist. SM

No recovery-cobble in shoe.

ALLUVIUM; Sand, dark grayish brown (10 YR 4/2) fine grained to medium, 100% sand, poorly graded, saturated. SP

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MONITORING WELL COMPLETION LOG GRJ01-1011

PROJECT UMTRA GROUND WATER
WELL NUMBER 1011
SITE GRAND JUNCTION
DATES DRILLED 11/3/97

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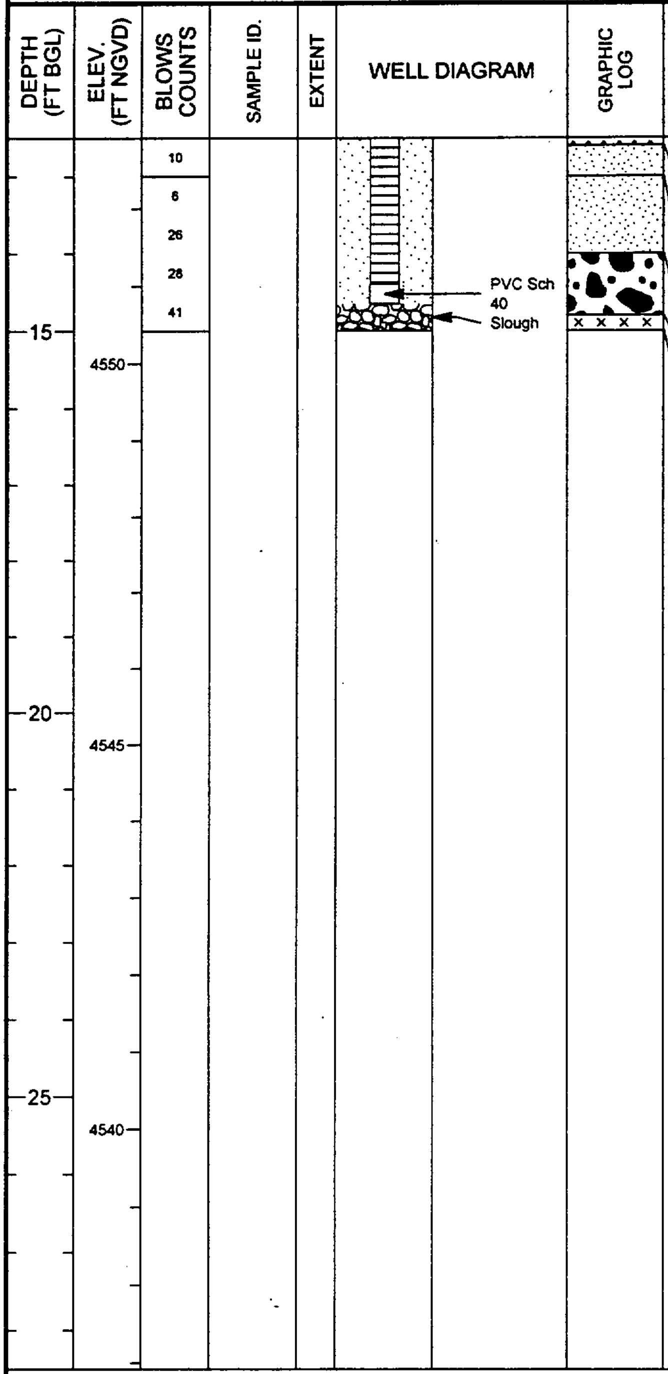


LITHOLOGIC DESCRIPTION

Gravel 80%, sand 15%, silt 5%, subrounded, well graded, saturated. SW

Sand, fine to medium grained, dark yellowish brown (10 YR 4/6) quartzose, red, yellow, and black mineral grains, some bits of black carbon, poorly graded, subrounded, 100% sand, saturated. SP

Sand, 100% fine grained dark gray (10 YR 4/1) quartzose, red, yellow, and black mineral grains, some carbon poorly graded, subrounded, saturated. SP

Gravel 60%, sand 35%, silt 5%,subrounded well sorted from cobbles to 1/4", saturated. GW

DAKOTA SANDSTONE; Bedrock, weathered siltstone, very dark gray (10 YR 3/1) slightly carbonaceous, moist. Noncalcareous.

Bottom of boring 15.0 ft

MONITORING WELL COMPLETION LOG GRJ01-1012

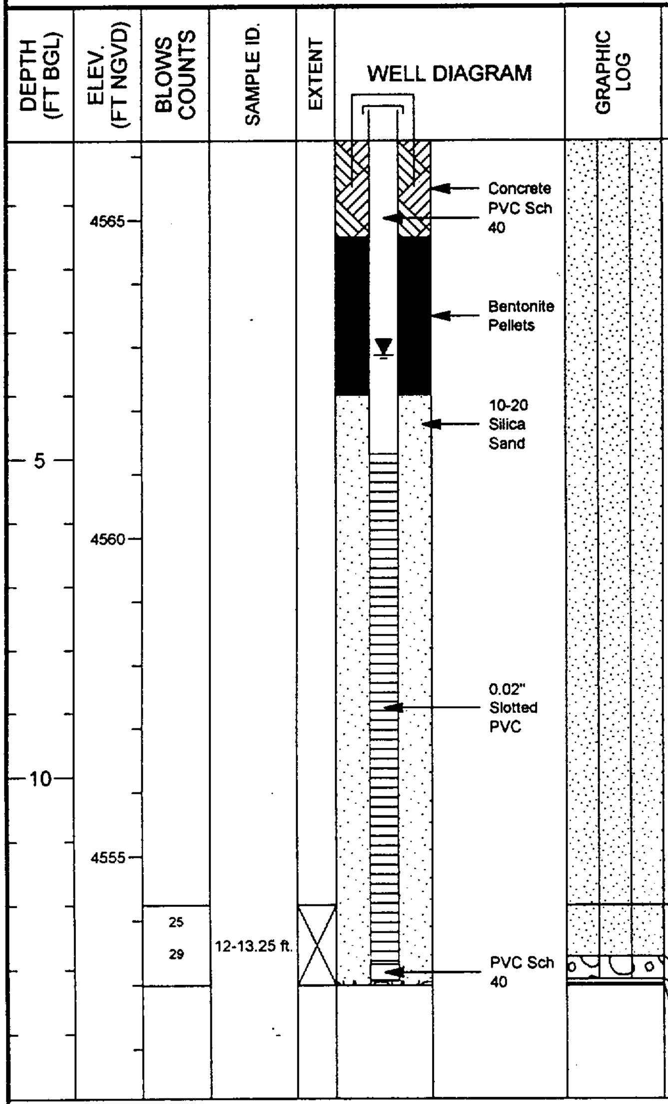
PROJECT UMTRA GROUND WATER
LOCATION GRAND JUNCTION, CO
SITE GRAND JUNCTION
WELL NUMBER 1012

NORTH COORD. (FT) 459540.22
EAST COORD. (FT) 1132241.70
HOLE DEPTH (FT) 13.25
WELL DEPTH (FT) 13.17

DATE DRILLED 10/31/97
SURFACE ELEV. (FT NGVD) 4566.24
TOP OF CASING (FT) 4568.61
MEAS. PT. ELEV. (FT) 4568.61
SLOT SIZE (IN) 0.02
BIT SIZE(S) (IN) 12.25

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-2.5	to	4.92
WELL SCREEN:	4 in. Machine Slotted PVC	4.92	to	12.92
SUMP/END CAP:	4 in. PVC Sch 40	12.92	to	13.17
SURFACE SEAL:	Concrete	0.0	to	1.5
GROUT:				
SEAL:	Bentonite Pellets	1.5	to	4.0
UPPER PACK:				
LOWER PACK:	10-20 Silica Sand	4.0	to	13.17

DRILLING METHOD HOLLOW STEM AUGER
SAMPLING METHOD SPLIT SPOON
DATE DEVELOPED 11/25/97
WATER LEVEL (FT BMP) 5.74
LOGGED BY L. Spencer
REMARKS



LITHOLOGIC DESCRIPTION

FILL; Silty sand, pale brown (10 YR 6/3) 60% sand, 30% silt, 10% gravel up to 2" long, poorly graded, subrounded, dry (when wet slightly plastic) a few root hairs (of the gravel, 1% cobbles over 3"). SM

ALLUVIUM; Silty sand, fine grained, light yellowish brown (10 YR 6/4), 60% sand, 30% gravel up to 2-1/2" long, 10% silt, well graded, subrounded, saturated. SM

Gravel 70%, sand 25%, silt 5%, subrounded. GM

DAKOTA SANDSTONE; Shale, very dark gray (10 YR 3/1) tiny shiny flecks, moist, calcareous, carbonaceous?, very weathered, siltstone?

Bottom of boring 13.25 ft

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MONITORING WELL COMPLETION LOG GRJ01-1013

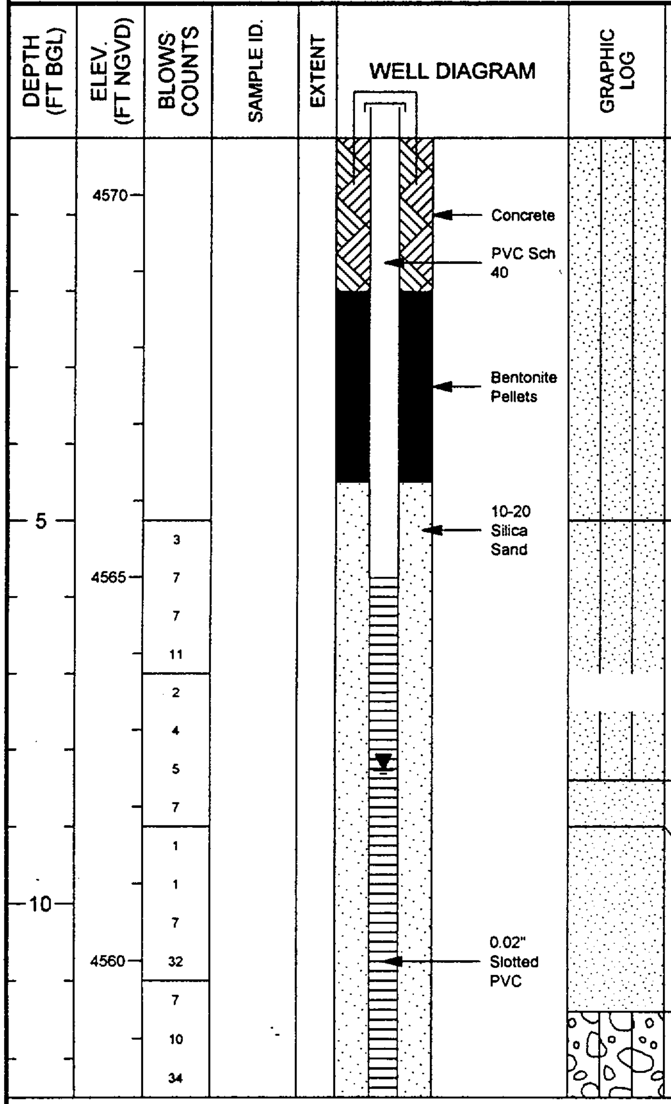
PROJECT UMTRA GROUND WATER
LOCATION GRAND JUNCTION, CO
SITE GRAND JUNCTION
WELL NUMBER 1013

NORTH COORD. (FT) 459475.69
EAST COORD. (FT) 1132879.56
HOLE DEPTH (FT) 16.25
WELL DEPTH (FT) 16.00

DATE DRILLED 10/30/97
SURFACE ELEV. (FT NGVD) 4570.74
TOP OF CASING (FT) 4573.60
MEAS. PT. ELEV. (FT) 4573.60
SLOT SIZE (IN) 0.02
BIT SIZE(S) (IN) 12.25

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-2.5	to	5.75
WELL SCREEN:	4 in. Machine Slotted PVC	5.75	to	15.75
SUMP/END CAP:	4 in. PVC Sch 40	15.75	to	16.0
SURFACE SEAL:	Concrete	0.0	to	2.0
GROUT:				
SEAL:	Bentonite Pellets	2.0	to	4.5
UPPER PACK:				
LOWER PACK:	10-20 Silica Sand	4.5	to	16.0

DRILLING METHOD HOLLOW STEM AUGER
SAMPLING METHOD
DATE DEVELOPED 11/25/98
WATER LEVEL (FT BMP) 11.13
LOGGED BY L. Spencer
REMARKS



LITHOLOGIC DESCRIPTION

FILL; Fine grained, silty sand, light yellowish brown (10 YR 6/4). SM

Fine grained, silty sand, light yellowish brown (10 YR 6/4), 15% gravel up to 2-1/2", dry, color to light brown (7.5 YR 6/4) SM

Lost.

ALLUVIUM; Silty sand, fine grained dark gray (10 YR 4/1) 85% sand, 15% silt. Red, yellow, and black mineral grains, poorly graded, subrounded, wet. SP

Silty sand, fine grained dark gray (10 YR 4/1) 85% sand, 15% silt. Red, yellow, and black mineral grains, poorly graded, subrounded, wet,with some organic matter saturated. SP

Gravel 60%, sand fine grained 35%, silt 5% cobbles, gravel up to 3", dark gray (10 YR 4/1), subrounded, well graded, saturated. GM

MONITORING WELL COMPLETION LOG GRJ01-1013

PROJECT UMTRA GROUND WATER
SITE GRAND JUNCTION
WELL NUMBER 1013
DATES DRILLED 10/30/97

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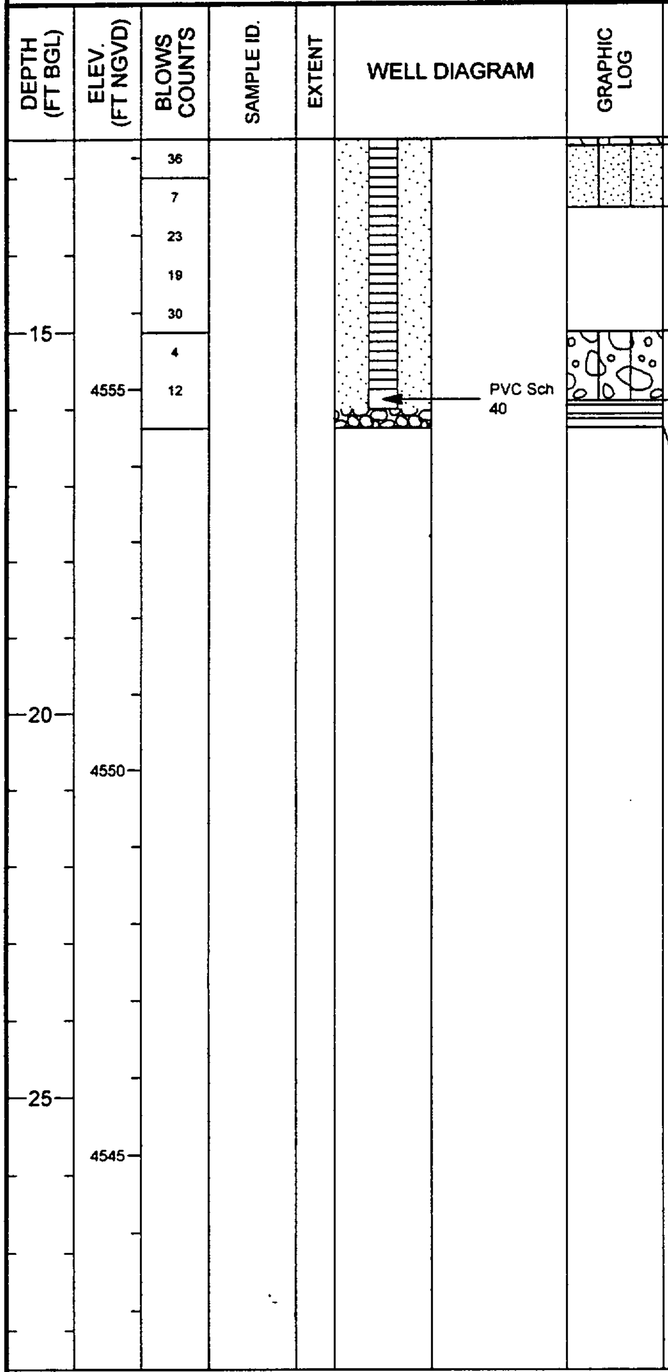

LITHOLOGIC DESCRIPTION

Sand, fine grained dark gray (10 YR 4/1) 40% gravel, 50% sand, 10% silt, well graded, subrounded, saturated. SM

Lost.

Gravel 60%, sand fine grained 35%, silt 5% cobbles, gravel up to 2-1/2", dark gray (10 YR 4/1), subrounded, well graded, saturated. GM

DAKOTA SANDSTONE; Shale, very dark gray, (10 YR 3/1) tiny shiny flecks, moist, (weathered) carbonaceous. Tiny fossil shell imprint in one of the flakes.

Bottom of boring 16.25 ft

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MONITORING WELL COMPLETION LOG GRJ01-1014

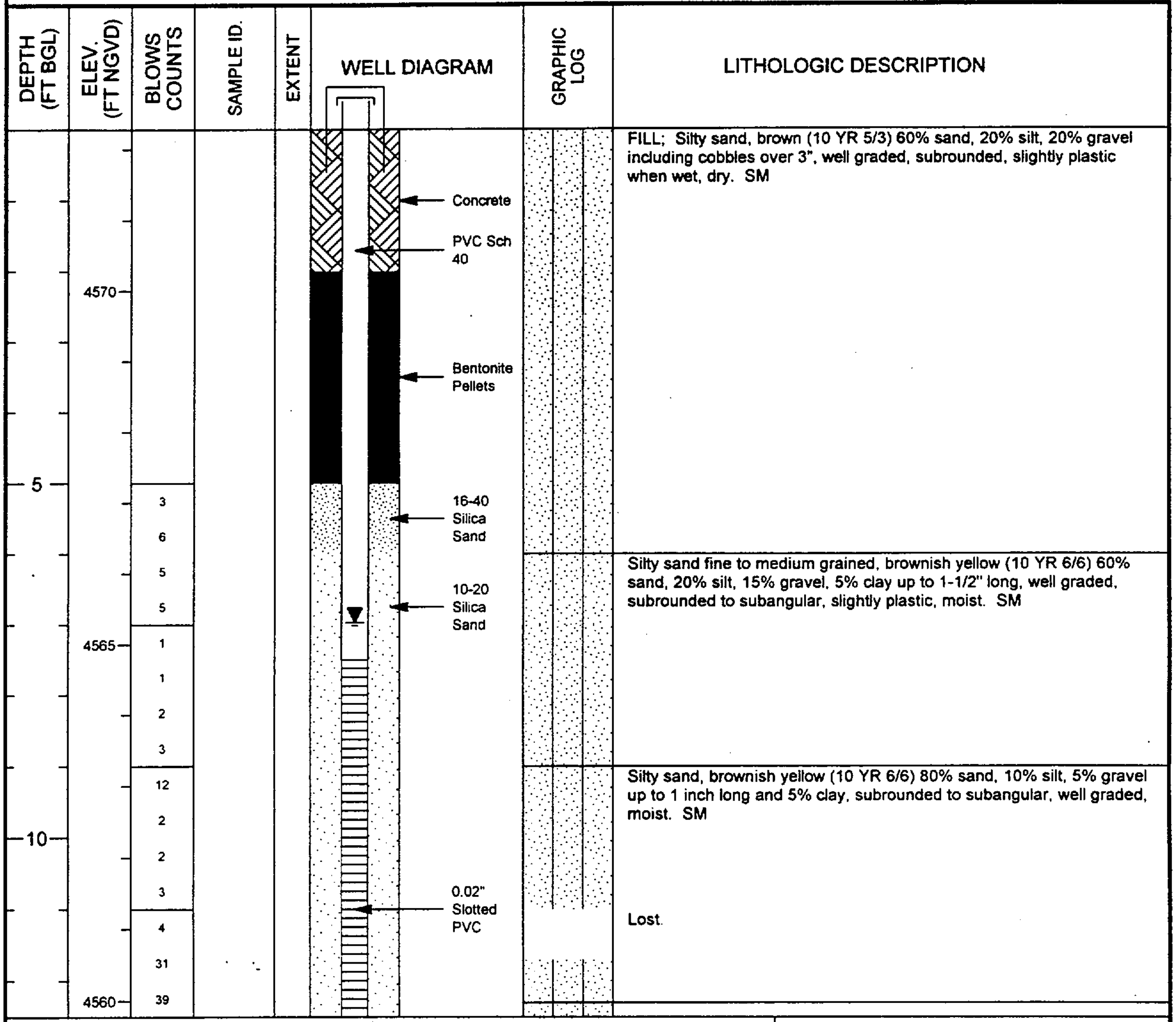
PROJECT UMTRA GROUND WATER
LOCATION GRAND JUNCTION, CO
SITE GRAND JUNCTION
WELL NUMBER 1014

NORTH COORD. (FT) 459838.65
EAST COORD. (FT) 1133222.93
HOLE DEPTH (FT) 18.50
WELL DEPTH (FT) 18.00

DATE DRILLED 10/31/97
SURFACE ELEV. (FT NGVD) 4572.28
TOP OF CASING (FT) 4574.27
MEAS. PT. ELEV. (FT) 4574.27
SLOT SIZE (IN) 0.02
BIT SIZE(S) (IN) 12.25

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-2.0	to	7.75
WELL SCREEN:	4 in. Machine Slotted PVC	7.75	to	17.75
SUMP/END CAP:	4 in. PVC Sch 40	17.75	to	18.0
SURFACE SEAL:	Concrete	0.0	to	2.0
GROUT:				
SEAL:	Bentonite Pellets	2.0	to	5.0
UPPER PACK:	16-40 Silica Sand	5.0	to	6.0
LOWER PACK:	10-20 Silica Sand	6.0	to	18.0

DRILLING METHOD HOLLOW STEM AUGER
SAMPLING METHOD
DATE DEVELOPED 11/24/97
WATER LEVEL (FT BMP) 8.96
LOGGED BY L. Spencer
REMARKS



FILL; Silty sand, brown (10 YR 5/3) 60% sand, 20% silt, 20% gravel including cobbles over 3", well graded, subrounded, slightly plastic when wet, dry. SM

Silty sand fine to medium grained, brownish yellow (10 YR 6/6) 60% sand, 20% silt, 15% gravel, 5% clay up to 1-1/2" long, well graded, subrounded to subangular, slightly plastic, moist. SM

Silty sand, brownish yellow (10 YR 6/6) 80% sand, 10% silt, 5% gravel up to 1 inch long and 5% clay, subrounded to subangular, well graded, moist. SM

Lost.

MONITORING WELL COMPLETION LOG GRJ01-1014

PROJECT	UMTRA GROUND WATER	**WELL NUMBER**	1014
SITE	GRAND JUNCTION	**DATES DRILLED**	10/31/97

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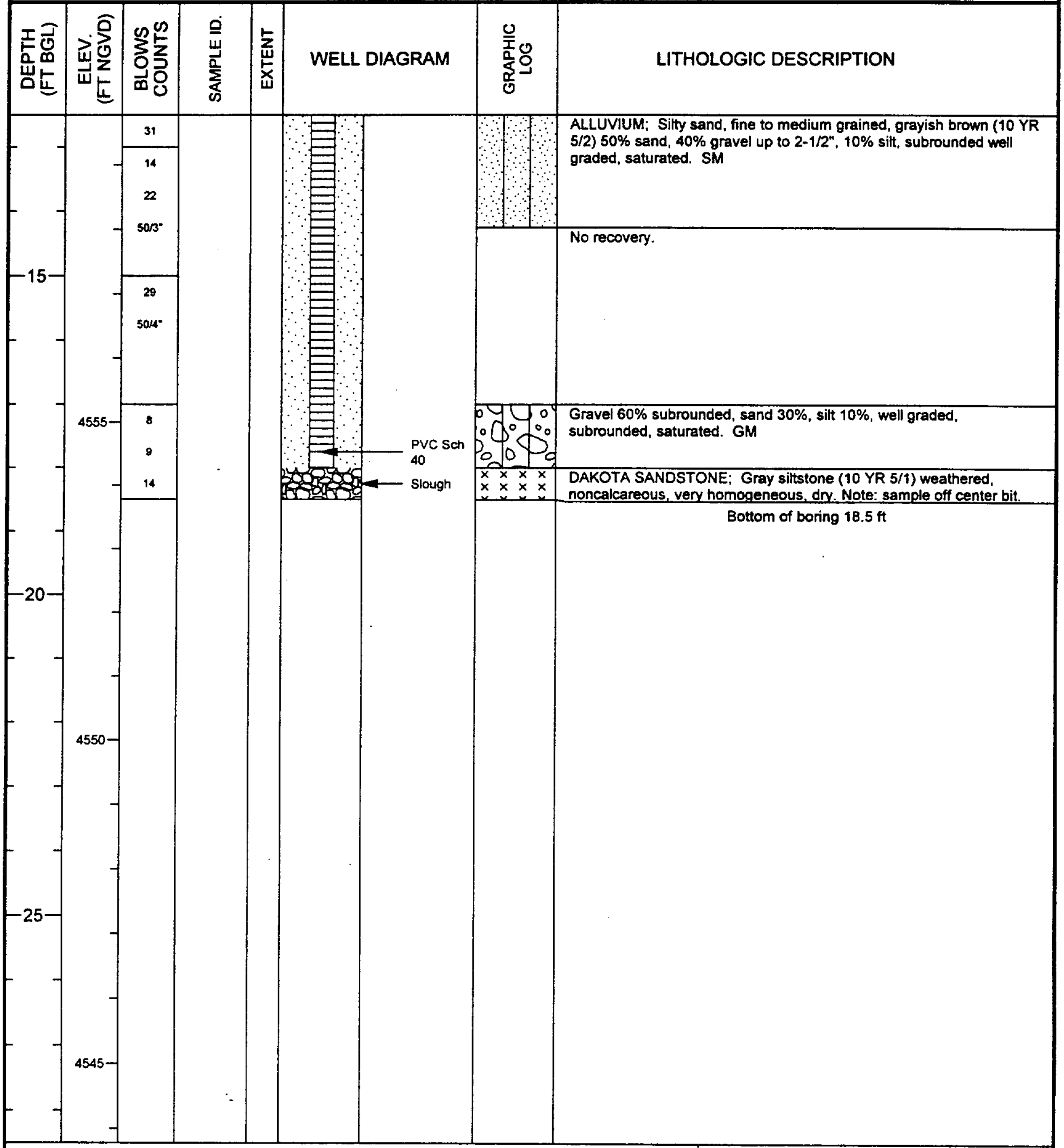

ALLUVIUM; Silty sand, fine to medium grained, grayish brown (10 YR 5/2) 50% sand, 40% gravel up to 2-1/2", 10% silt, subrounded well graded, saturated. SM

No recovery.

Gravel 60% subrounded, sand 30%, silt 10%, well graded, subrounded, saturated. GM

DAKOTA SANDSTONE; Gray siltstone (10 YR 5/1) weathered, noncalcareous, very homogeneous, dry. Note: sample off center bit.

Bottom of boring 18.5 ft

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GRAND JUNCTION OFFICE, COLORADO

MONITORING WELL COMPLETION LOG GRJ01-1015

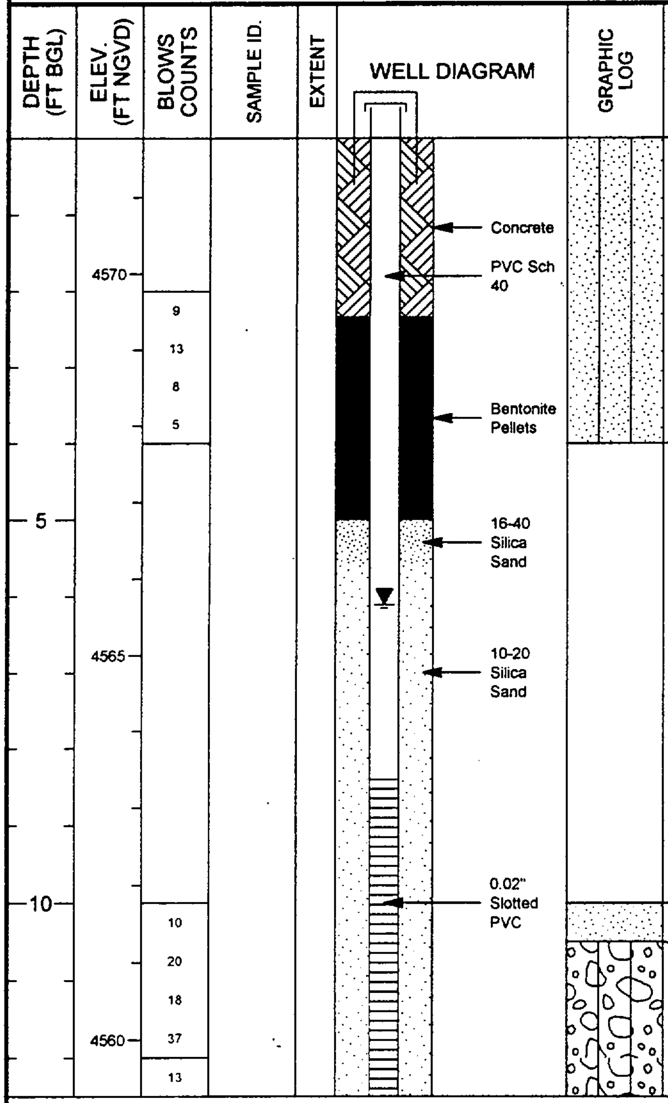
PROJECT UMTRA GROUND WATER
LOCATION GRAND JUNCTION, CO
SITE GRAND JUNCTION
WELL NUMBER 1015

NORTH COORD. (FT) 459873.00
EAST COORD. (FT) 1134015.07
HOLE DEPTH (FT) 17.30
WELL DEPTH (FT) 16.65

DATE DRILLED 11/1/97
SURFACE ELEV. (FT NGVD) 4571.77
TOP OF CASING (FT) 4573.54
MEAS. PT. ELEV. (FT) 4573.54
SLOT SIZE (IN) 0.02
BIT SIZE(S) (IN) 12.25

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-1.6	to	8.4
WELL SCREEN:	4 in. Machine Slotted PVC	8.4	to	16.4
SUMP/END CAP:	4 in. PVC Sch 40	16.4	to	16.65
SURFACE SEAL:	Concrete	0.0	to	2.33
GROUT:				
SEAL:	Bentonite Pellets	2.33	to	5.0
UPPER PACK:	16-40 Silica Sand	5.0	to	5.8
LOWER PACK:	10-20 Silica Sand	5.8	to	16.65

DRILLING METHOD HOLLOW STEM AUGER
SAMPLING METHOD
DATE DEVELOPED 11/22/97
WATER LEVEL (FT BMP) 7.88
LOGGED BY L. Spencer
REMARKS



LITHOLOGIC DESCRIPTION

FILL; Silty sand fine to medium grained, yellowish brown (10 YR 5/4) 60% sand, 25% silt, 10% gravel up to cobbles, 5% clay well graded, low plasticity, moist. SM

No samples collected

ALLUVIUM; Sand fine to medium grained, brown (10 YR 5/3) 95% sand, 5% silt, poorly graded, subrounded, saturated. SP

Gravel 60%, fine grained sand 35%, 5% silt, brown (10 YR 5/3) well graded, subrounded 1/4" to cobbles, saturated GM

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GRAND JUNCTION OFFICE, COLORADO

MONITORING WELL COMPLETION LOG GRJ01-1015

PROJECT UMTRA GROUND WATER **WELL NUMBER** 1015
SITE GRAND JUNCTION **DATES DRILLED** 11/1/97

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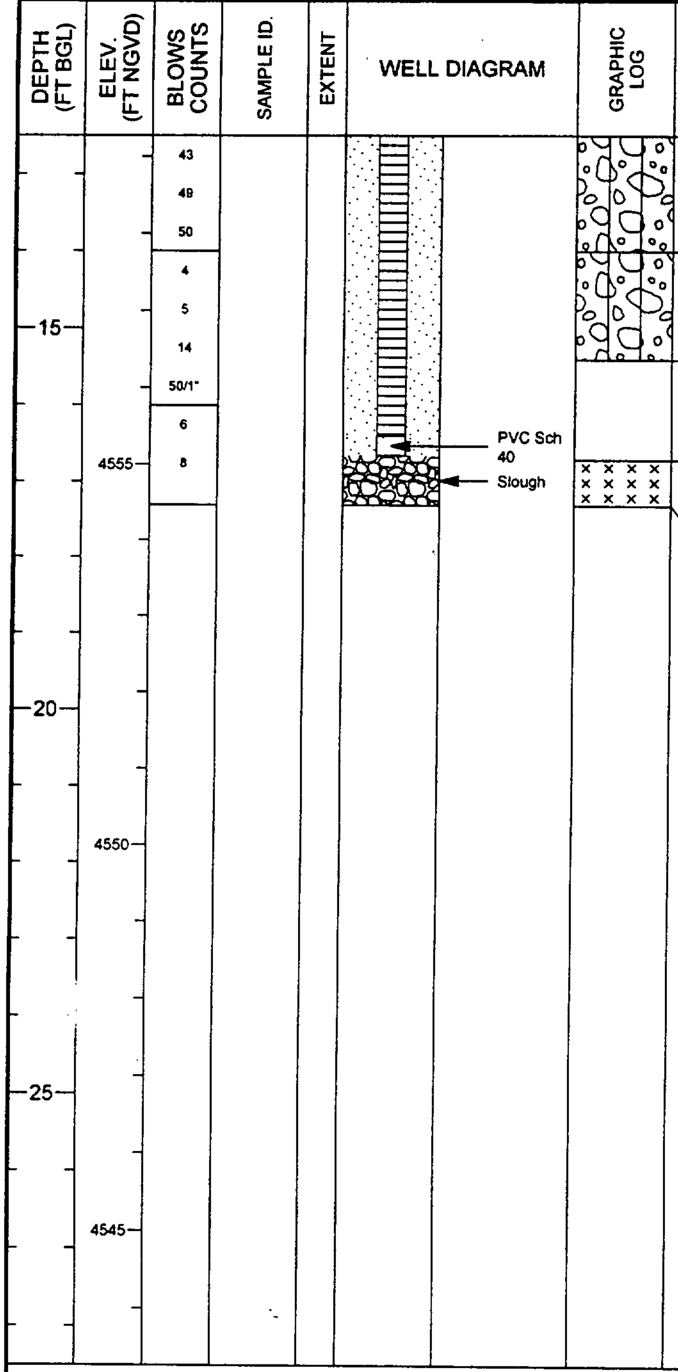


LITHOLOGIC DESCRIPTION

Gravel 60%, fine grained sand 35%, 5% silt, dark grayish brown (10 YR 4/2) well graded, subrounded 1/4" to cobbles, saturated, dark grayish brown, (10 YR 4/2). GM

Cobble in shoe, no sample.

DAKOTA SANDSTONE; Weathered bedrock, siltstone, very dark gray (10 YR 3/1) noncalcareous, a small amount, 10% of very fine grained sand, homogeneous, moist, fairly soft.

Bottom of boring 17.3 ft

MONITORING WELL COMPLETION LOG GRJ01-1016

PROJECT UMTRA GROUND WATER
LOCATION GRAND JUNCTION, CO
SITE GRAND JUNCTION
WELL NUMBER 1016

NORTH COORD. (FT) 459525.33
EAST COORD. (FT) 1133925.54
HOLE DEPTH (FT) 15.00
WELL DEPTH (FT) 14.35

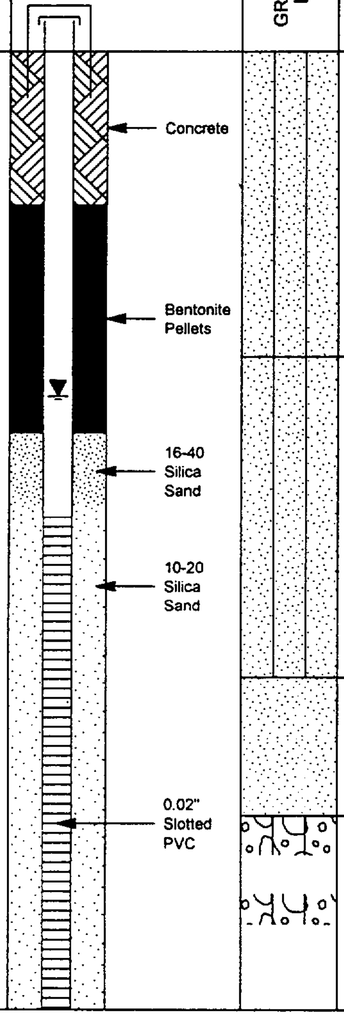
DATE DRILLED 11/1/97
SURFACE ELEV. (FT NGVD) 4569.37
TOP OF CASING (FT) 4571.87
MEAS. PT. ELEV. (FT) 4571.87
SLOT SIZE (IN) 0.02
BIT SIZE(S) (IN) 12.25

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-2.5	to	6.1
WELL SCREEN:	4 in. Machine Slotted PVC	6.1	to	14.1
SUMP/END CAP:	4 in. PVC Sch 40	14.1	to	14.35
SURFACE SEAL:	Concrete	0.0	to	2.0
GROUT:				
SEAL:	Bentonite Pellets	2.0	to	5.0
UPPER PACK:	16-40 Silica Sand	5.0	to	6.0
LOWER PACK:	10-20 Silica Sand	6.0	to	14.35

DRILLING METHOD HOLLOW STEM AUGER
SAMPLING METHOD
DATE DEVELOPED 11/25/97
WATER LEVEL (FT BMP) 7.02
LOGGED BY L. Spencer
REMARKS

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOWS COUNTS	SAMPLE ID.	EXTENT
		3		
		3		
	4565	5		
		3		
5				
		2		
		2		
		3		
		3		
		1		
		3		
		3		
		3		
	4560	13		
		23		
10		50/5'		
		12		
		24		
		50/5"		

WELL DIAGRAM / GRAPHIC LOG



LITHOLOGIC DESCRIPTION

FILL; Silty sand, brown (10 YR 5/3) sand 60%, silt 20%, 15% gravel, 5% clay, well graded, subrounded cobbles, moist, low plasticity when wet. SM

Silty sand, light yellowish brown (10 YR 6/4) sand 60%, silt 15%, gravel 10%, clay 15%, subrounded gravel up to 1-1/2", medium plasticity, wet, poorly graded. SM

Cobble in shoe.

ALLUVIUM; Sand, fine grained, very dark gray (10 YR 3/1) 90% sand, 5% silt, 5% clay, red, yellow, and black carbonaceous, sand, swampy odor, a few shine bits of mica. Poorly graded, saturated. SP

Gravel 60%, fine to medium grained sand 35%, 5% silt, subrounded cobbles to 1/2 centimeter gravel well graded, saturated. GM
Lost.

Lost (cobble in shoe).

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GRAND JUNCTION OFFICE, COLORADO

MONITORING WELL COMPLETION LOG GRJ01-1016

PROJECT	UMTRA GROUND WATER	**WELL NUMBER**	1016
SITE	GRAND JUNCTION	**DATES DRILLED**	11/1/97

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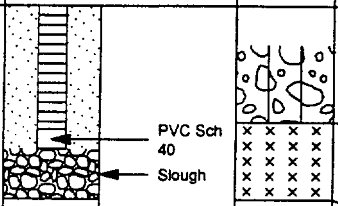

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOWS COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
	4555	6 30 50/4"					DAKOTA SANDSTONE; Weathered siltstone, very dark gray, 15% sand very fined grained, low plasticity (sample is fairly soft) tiny bits of carbon, moist, (10 YR 3/1). Siltstone, gray (10 YR 5/1) moist, noncalcareous.
15							Bottom of boring 15.0 ft
	4550						
20							
	4545						
25							

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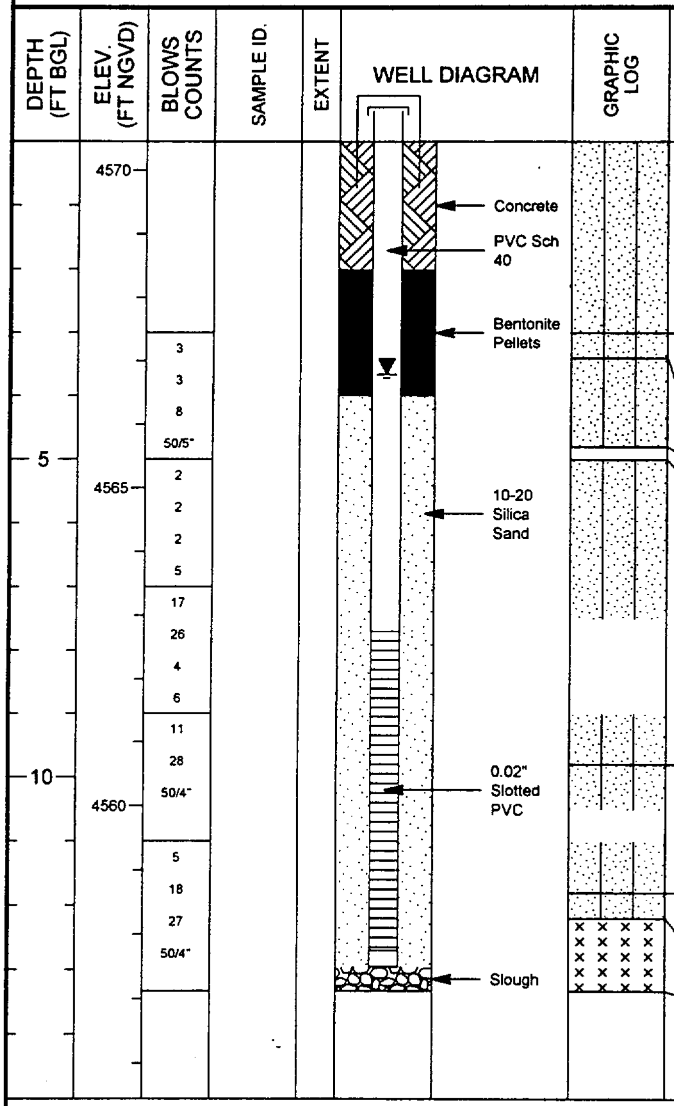
GRAND JUNCTION OFFICE, COLORADO

MONITORING WELL COMPLETION LOG GRJ01-1017

PROJECT	UMTRA GROUND WATER	**NORTH COORD. (FT)**	459662.89	**DATE DRILLED**	11/1/97
LOCATION	GRAND JUNCTION, CO	**EAST COORD. (FT)**	1135119.26	**SURFACE ELEV. (FT NGVD)**	4570.45
SITE	GRAND JUNCTION	**HOLE DEPTH (FT)**	13.33	**TOP OF CASING (FT)**	4572.72
WELL NUMBER	1017	**WELL DEPTH (FT)**	12.95	**MEAS. PT. ELEV. (FT)**	4572.72
				SLOT SIZE (IN)	0.02
				BIT SIZE(S) (IN)	12.25

	WELL INSTALLATION	**INTERVAL (FT)**		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-2.3	to	7.7
WELL SCREEN:	4 in. Machine Slotted PVC	7.7	to	12.7
SUMP/END CAP:	4 in. PVC Sch 40	12.7	to	12.95
SURFACE SEAL:	Concrete	0.0	to	2.0
GROUT:				
SEAL:	Bentonite Pellets	2.0	to	4.0
UPPER PACK:				
LOWER PACK:	10-20 Silica Sand	4.0	to	12.95

DRILLING METHOD HOLLOW STEM AUGER
SAMPLING METHOD
DATE DEVELOPED 11/24/97
WATER LEVEL (FT BMP) 5.93
LOGGED BY L. Spencer
REMARKS



LITHOLOGIC DESCRIPTION

FILL; Silty sandy, yellowish brown (10 YR 5/4) 60% sand, 20% silt, 10% gravel, 10% clay, subrounded from cobbles to 1/4", low plasticity when wet, well graded, moist, a few root hairs. SM

Silty sandy, brown (7.5 YR 5/4) 60% sand, 20% silt, 10% gravel, 10% clay, subrounded from cobbles to 1/4", low plasticity when wet, well graded, moist, a few root hairs; brown, (7.5 YR 5/4). SM

Silty sand, yellowish brown (10 YR 5/4) 60% sand, 30% silt, 5% gravel, 5% clay, subrounded to angular, well graded, medium plasticity, moist. SM

No recovery rock in shoe

Silty sand, yellowish brown (10 YR 5/4) 60% sand, 30% silt, 5% gravel, 5% clay, subrounded to angular, well graded, medium plasticity, moist, with some brown (7.5 YR 5/4) colored material in sample. SM

Cobble in shoe, no recovery.

ALLUVIUM; Gravel, 60%, sand fine to medium grain, 30% silt, 10% well graded,, saturated. Red yellow and white chert grains in quartzose sand. SM
No recovery-cobble in shoe.

Graveley sand, fine to coarse grain 60% sand, 35% gravel up to 3 in., 5% silt, well graded, subrounded, saturated SM

DAKOTA SANDSTONE; Weathered bedrock, siltstone, very dark gray (10 YR 3/1) tiny shiny flecks of mica, homogeneous moist, fairly soft. Noncalcareous.

Bottom of boring 13.33 ft

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GRAND JUNCTION OFFICE, COLORADO

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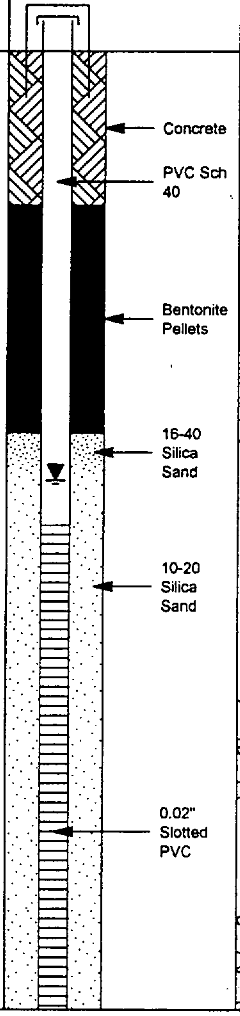
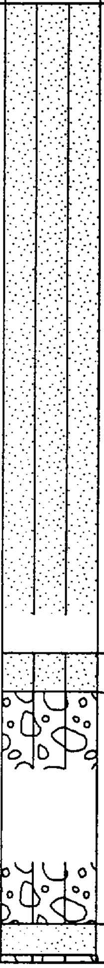
MONITORING WELL COMPLETION LOG GRJ01-1018

PROJECT	UMTRA GROUND WATER	**NORTH COORD. (FT)**	460091.24	**DATE DRILLED**	11/2/97
LOCATION	GRAND JUNCTION, CO	**EAST COORD. (FT)**	1134920.84	**SURFACE ELEV. (FT NGVD)**	4573.90
SITE	GRAND JUNCTION	**HOLE DEPTH (FT)**	15.10	**TOP OF CASING (FT)**	4575.91
WELL NUMBER	1018	**WELL DEPTH (FT)**	14.45	**MEAS. PT. ELEV. (FT)**	4575.91
				SLOT SIZE (IN)	0.02
				BIT SIZE(S) (IN)	12.25

	WELL INSTALLATION	**INTERVAL (FT)**		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-1.9	to	6.2
WELL SCREEN:	4 in. Machine Slotted PVC	6.2	to	14.2
SUMP/END CAP:	4 in. PVC Sch 40	14.2	to	14.45
SURFACE SEAL:	Concrete	0.0	to	2.0
GROUT:				
SEAL:	Bentonite Pellets	2.0	to	5.0
UPPER PACK:	16-40 Silica Sand	5.0	to	5.5
LOWER PACK:	10-20 Silica Sand	5.5	to	14.45

DRILLING METHOD HOLLOW STEM AUGER
SAMPLING METHOD
DATE DEVELOPED 11/24/97
WATER LEVEL (FT BMP) 7.63
LOGGED BY L. Spencer
REMARKS





DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOWS COUNTS	SAMPLE ID.	EXTENT	LITHOLOGIC DESCRIPTION
					FILL; Silty sand, yellowish brown, (10 YR 5/4) 60% sand, 25% silt, 10% gravel, 5% clay, well graded, subrounded, moist. Slight plasticity when wet, a few root hairs from 0-2 feet only. Water Level about 7.0 feet. SM
	4570				
5					
		12			No recovery.
	4565	18			Silty sand, brown (10 YR 5/3), 60% sand, 20% silt, 10% gravel subrounded, 10% clay, slight plasticity saturated, roots. SM
		29			ALLUVIUM; Gravel, 60% subrounded, 30% sand, 10% silt, sell graded, no plasticity, saturated. GM
		36			
10		12			No recovery.
		26			
		29			
		25			
		8			Sand, fine to medium grain, fairly clean, red, yellow and black mineral

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GRAND JUNCTION OFFICE, COLORADO

MONITORING WELL COMPLETION LOG GRJ01-1018

PROJECT UMTRA GROUND WATER
WELL NUMBER 1018
SITE GRAND JUNCTION
DATES DRILLED 11/2/97

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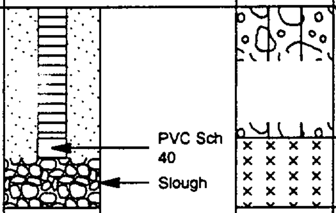


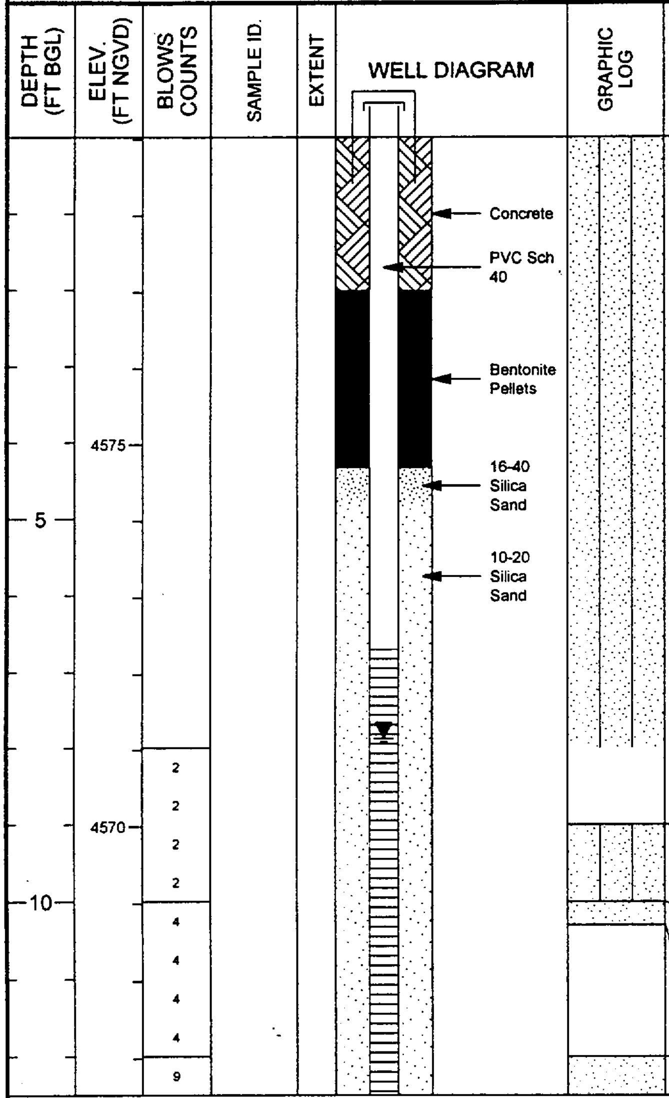
DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOWS COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
		41					grains, white to yellow tiny cherts, tiny amount of carbon bits. 100% sand, poorly graded, subrounded, saturated. SP
	4560	50/3"					Gravel, 60%, sand 35%, 5% silt, subrounded 1/4" gravel to cobbles, subrounded well graded saturated. GM No recovery-rock in shoe.
15		4 34					DAKOTA SANDSTONE; Weathered bedrock, siltstone, very dark gray (10 YR 3/1) carbonaceous, tine flecks of shiny mica, moist. Noncalcareous.
							Bottom of boring 15.1 ft
	4555						
20							
	4550						
25							

MONITORING WELL COMPLETION LOG GRJ01-1019

PROJECT	UMTRA GROUND WATER	**NORTH COORD. (FT)**	460949.30	**DATE DRILLED**	11/2/97
LOCATION	GRAND JUNCTION, CO	**EAST COORD. (FT)**	1134933.23	**SURFACE ELEV. (FT NGVD)**	4579.03
SITE	GRAND JUNCTION	**HOLE DEPTH (FT)**	27.00	**TOP OF CASING (FT)**	4580.99
WELL NUMBER	1019	**WELL DEPTH (FT)**	26.95	**MEAS. PT. ELEV. (FT)**	4580.99
				SLOT SIZE (IN)	0.02
				BIT SIZE(S) (IN)	12.25

	WELL INSTALLATION	**INTERVAL (FT)**		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-1.6	to	6.7
WELL SCREEN:	4 in. Machine Slotted PVC	6.7	to	26.7
SUMP/END CAP:	4 in. PVC Sch 40	26.7	to	26.95
SURFACE SEAL:	Concrete	0.0	to	2.0
GROUT:				
SEAL:	Bentonite Pellets	2.0	to	4.33
UPPER PACK:	16-40 Silica Sand	4.33	to	4.8
LOWER PACK:	10-20 Silica Sand	4.8	to	26.95

DRILLING METHOD	HOLLOW STEM AUGER
SAMPLING METHOD	SPLIT SPOON
DATE DEVELOPED	11/22/97
WATER LEVEL (FT BMP)	9.84
LOGGED BY	L. Spencer
REMARKS	



LITHOLOGIC DESCRIPTION

FILL; Silty sand, yellowish brown (10 YR 5/4) 60% sand, 30% gravel subrounded from 1/4" to cobbles 3.0 inches or larger, 10% silt, well graded, slightly plasticity moist. A few root hairs/roots. SM

No recovery.

Silty sand, yellowish brown (10 YR 5/4) 60% sand, 30% gravel subrounded from 1/4" to cobbles 3.0 inches or larger, 10% silt, well graded, slightly plasticity moist. A few root hairs/roots. Angular gravel, a bit more plasticity. Note: 9.9 to 10.0 saturated. SM

ALLUVIUM; Sand, fine to medium grain, yellowish brown (10 YR 5/4) 100%, red, yellow, and black mineral grains, subrounded tiny yellowish white chert chips, poorly graded, saturated. SP

No recovery-cobble in shoe.

Sand, quartzose, fairly clean, fine to medium grain, yellowish brown

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GRAND JUNCTION OFFICE, COLORADO

MONITORING WELL COMPLETION LOG GRJ01-1019

PROJECT	UMTRA GROUND WATER	**WELL NUMBER**	1019
SITE	GRAND JUNCTION	**DATES DRILLED**	11/2/97

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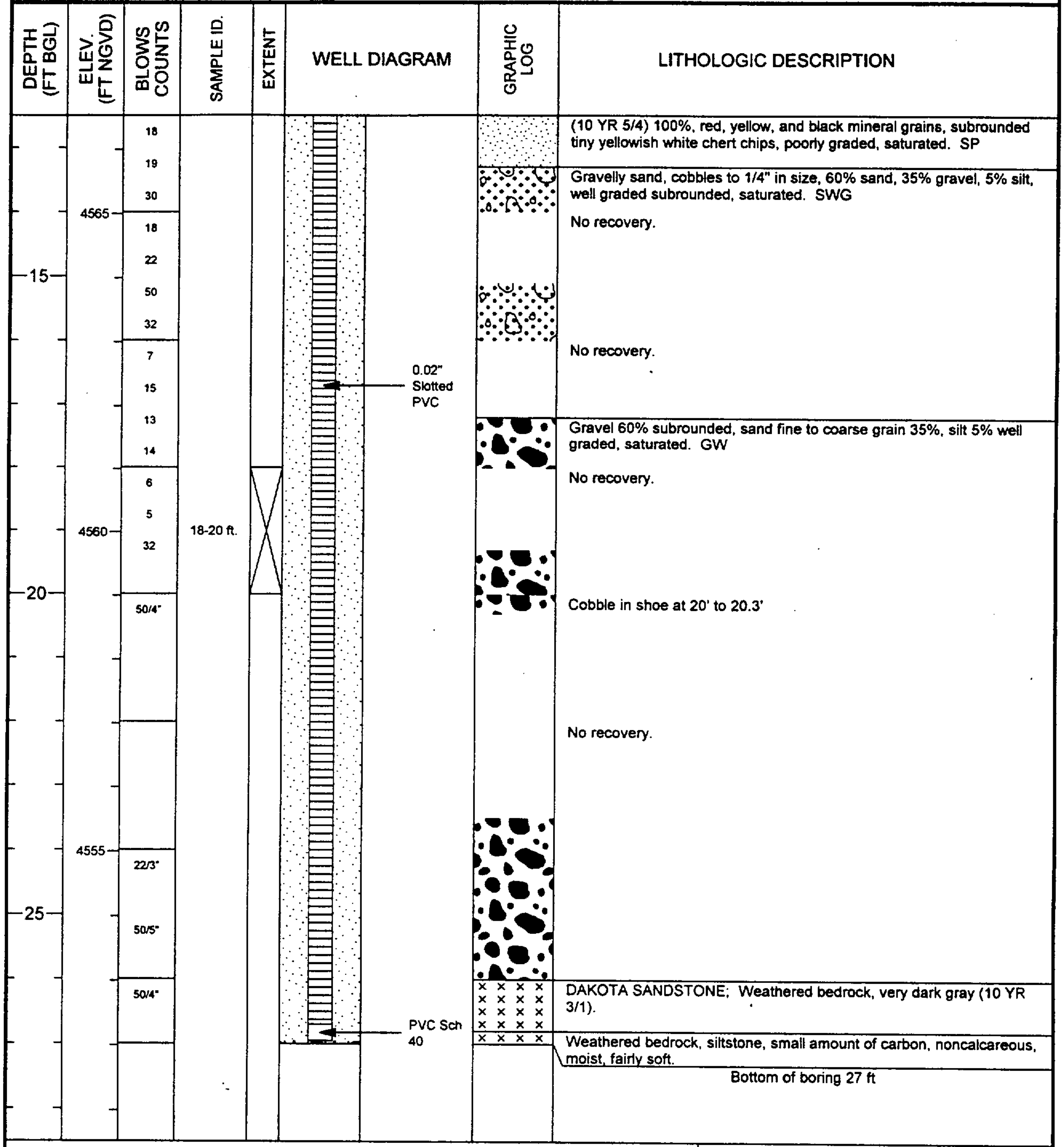


(10 YR 5/4) 100%, red, yellow, and black mineral grains, subrounded tiny yellowish white chert chips, poorly graded, saturated. SP

Gravelly sand, cobbles to 1/4" in size, 60% sand, 35% gravel, 5% silt, well graded subrounded, saturated. SWG

No recovery.

No recovery.

Gravel 60% subrounded, sand fine to coarse grain 35%, silt 5% well graded, saturated. GW

No recovery.

Cobble in shoe at 20' to 20.3'

No recovery.

DAKOTA SANDSTONE; Weathered bedrock, very dark gray (10 YR 3/1).

Weathered bedrock, siltstone, small amount of carbon, noncalcareous, moist, fairly soft.

Bottom of boring 27 ft

MONITORING WELL COMPLETION LOG GRJ01-1020

PROJECT UMTRA GROUND WATER
LOCATION GRAND JUNCTION, CO
SITE GRAND JUNCTION
WELL NUMBER 1020

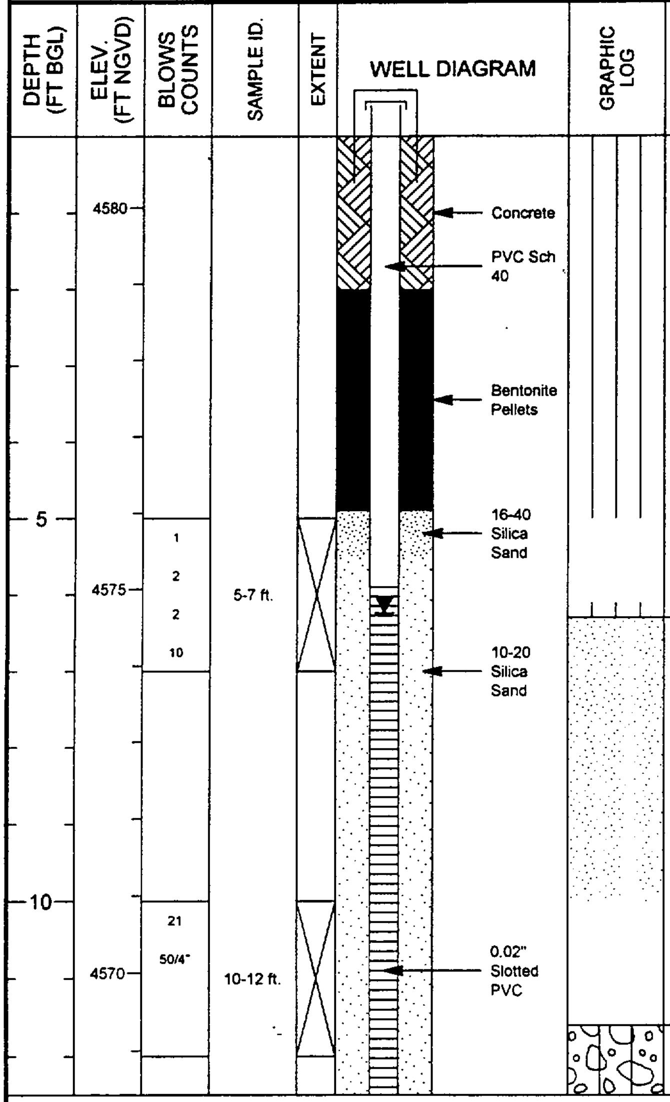
NORTH COORD. (FT) 459637.77
EAST COORD. (FT) 1139020.66
HOLE DEPTH (FT) 17.00
WELL DEPTH (FT) 16.20

DATE DRILLED 11/16/97
SURFACE ELEV. (FT NGVD) 4580.93
TOP OF CASING (FT) 4582.90
MEAS. PT. ELEV. (FT) 4582.90
SLOT SIZE (IN) 0.02
BIT SIZE(S) (IN) 12.25

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-1.9	to	5.9
WELL SCREEN:	4 in. Machine Slotted PVC	5.9	to	15.9
SUMP/END CAP:	4 in. PVC Sch 40	15.9	to	16.2
SURFACE SEAL:	Concrete	0.0	to	2.0
GROUT:				
SEAL:	Bentonite Pellets	2.0	to	4.9
UPPER PACK:	16-40 Silica Sand	4.9	to	5.5
LOWER PACK:	10-20 Silica Sand	5.5	to	16.2

DRILLING METHOD HOLLOW STEM AUGER
SAMPLING METHOD SPLIT SPOON
DATE DEVELOPED 12/8/97
WATER LEVEL (FT BMP) 8.21
LOGGED BY L. Spencer
REMARKS

DEPTH (FT BGL) | ELEV. (FT NGVD) | BLOWS COUNTS | SAMPLE ID. | EXTENT | WELL DIAGRAM | GRAPHIC LOG | LITHOLOGIC DESCRIPTION



FILL; Sandy silt, dark grayish brown (10 YR 4/2) 80% silt, 10% clay, 10% fine grained sand, poorly graded, homogenous, subrounded sands, low plasticity, moist. A few roots and root hairs. ML

No recovery.

ALLUVIUM; Sand, quartzose, fine to medium grain, dark brown (10 YR 4/3) 90% sand, 10% silt, subrounded, poorly graded, no plasticity, saturated. Red, yellow and black mineral grains with whitish yellow chert chips and tiny gray chips. SP

No recovery.

Sandy gravel, 80% gravel, 15% sand, 5% silt, subrounded, well graded, saturated. 1/4" to cobble size gravel. GM

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MONITORING WELL COMPLETION LOG GRJ01-1020

PROJECT UMTRA GROUND WATER
SITE GRAND JUNCTION
WELL NUMBER 1020
DATES DRILLED 11/16/97

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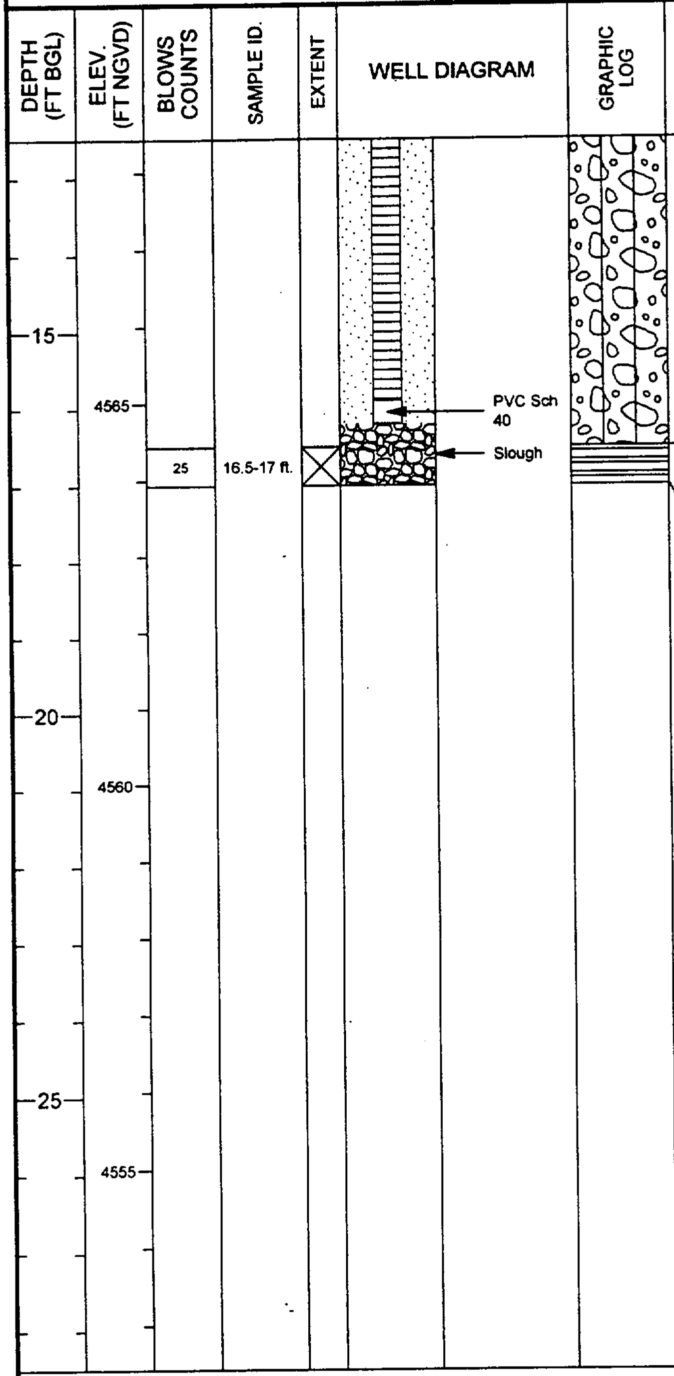


LITHOLOGIC DESCRIPTION

Note: From 15' to 16.5 ft' slow drilling cobbles-no sample collected.

MANCOS SHALE; Shale, very dark gray (10 YR 3/1) , very tiny shiny flakes, fossil shell imprints, a small amount of pyrite, a few patches of very fine grained sand, clear to white, calcareous.

Bottom of boring 17 ft

MONITORING WELL COMPLETION LOG GRJ01-1021

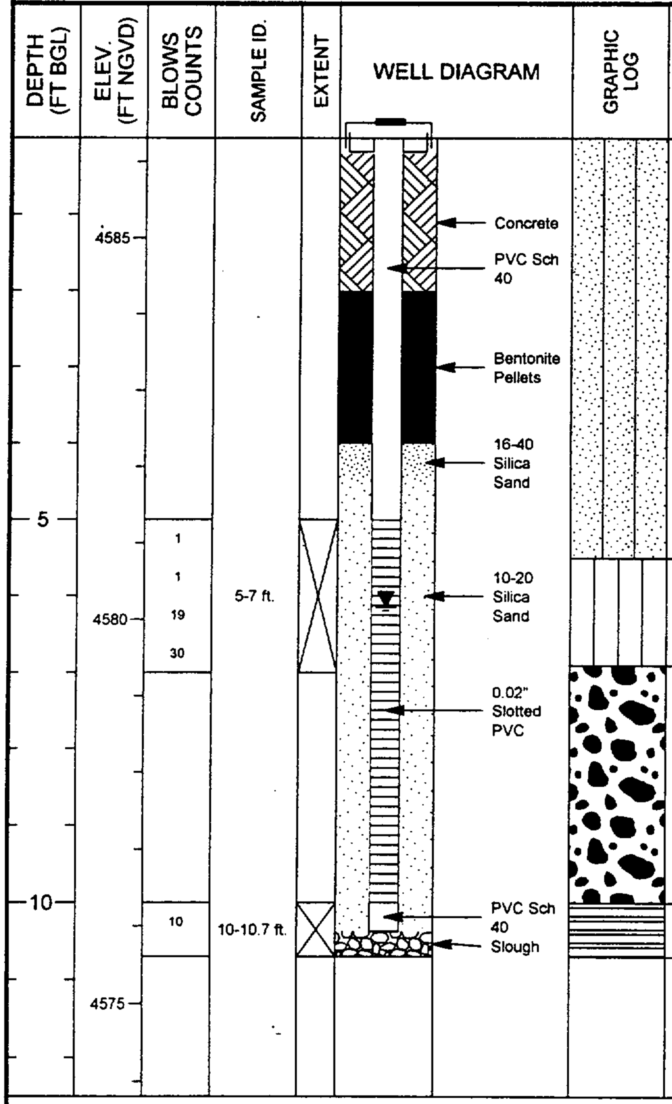
PROJECT UMTRA GROUND WATER
LOCATION GRAND JUNCTION, CO
SITE GRAND JUNCTION
WELL NUMBER 1021

NORTH COORD. (FT) 458330.91
EAST COORD. (FT) 1143967.96
HOLE DEPTH (FT) 10.70
WELL DEPTH (FT) 10.37

DATE DRILLED 11/16/97
SURFACE ELEV. (FT NGVD) 4586.31
TOP OF CASING (FT) 4586.42
MEAS. PT. ELEV. (FT) 4586.42
SLOT SIZE (IN) 0.02
BIT SIZE(S) (IN) 12.25

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	0.0	to	5.0
WELL SCREEN:	4 in. Machine Slotted PVC	5.0	to	10.0
SUMP/END CAP:	4 in. PVC Sch 40	10.0	to	10.37
SURFACE SEAL:	Concrete	0.0	to	2.0
GROUT:				
SEAL:	Bentonite Pellets	2.0	to	4.0
UPPER PACK:	16-40 Silica Sand	4.0	to	4.5
LOWER PACK:	10-20 Silica Sand	4.5	to	10.37

DRILLING METHOD HOLLOW STEM AUGER
SAMPLING METHOD SPLIT SPOON
DATE DEVELOPED 12/7/98
WATER LEVEL (FT BMP) 6.26
LOGGED BY L. Spencer
REMARKS Flush mount well



LITHOLOGIC DESCRIPTION

FILL; Silty sand, dark yellowish brown (10 YR 3/4) 60% fine grained sand, 40% silt, well graded, subrounded slight plasticity, moist, roots and root hairs. SM

ALLUVIUM; Silty sand, dark brown, (10 YR 4/3) 60% sand, 30% silt, 10% clay, well graded, subrounded, saturated, low plasticity, red, yellow and black mineral grains. MS

Gravel, 80%, 15% sand, 5% silt, well graded, subrounded saturated. GW

MANCOS SHALE; Bedrock, shale, very dark gray (10 YR 3/1) tiny shiny flakes, calcareous, dry.

Bottom of boring 10.7 ft

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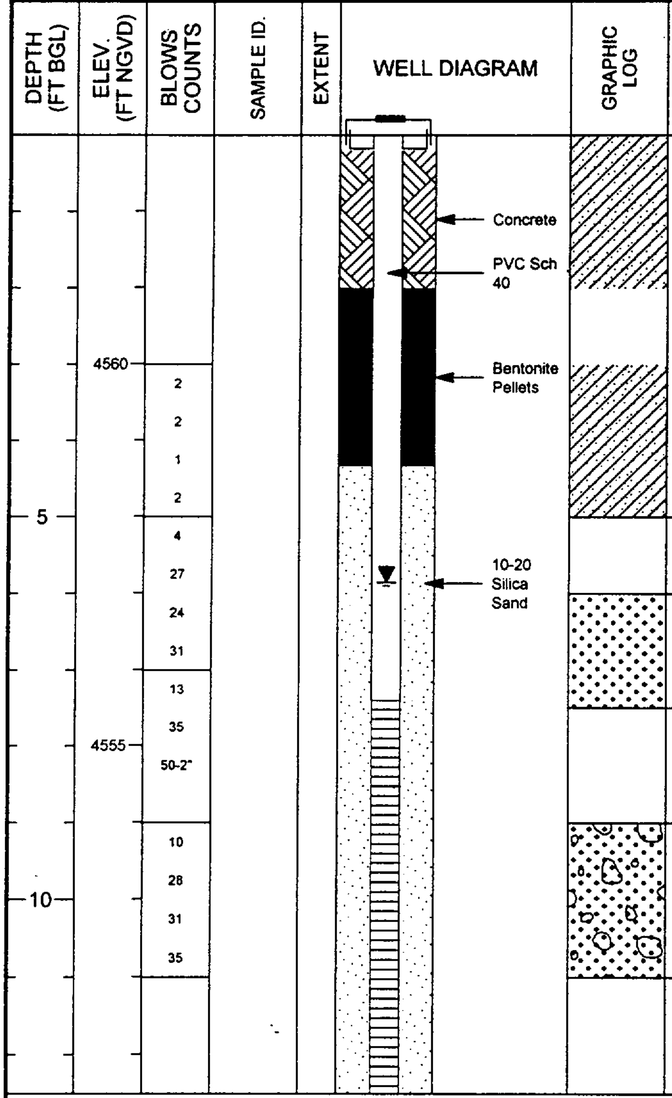
MONITORING WELL COMPLETION LOG GRJ01-1022

PROJECT	UMTRA GROUND WATER	**NORTH COORD. (FT)**	459743.37	**DATE DRILLED**	11/3/97
LOCATION	GRAND JUNCTION, CO	**EAST COORD. (FT)**	1130947.60	**SURFACE ELEV. (FT NGVD)**	4562.99
SITE	GRAND JUNCTION	**HOLE DEPTH (FT)**	19.00	**TOP OF CASING (FT)**	4562.76
WELL NUMBER	1022	**WELL DEPTH (FT)**	17.77	**MEAS. PT. ELEV. (FT)**	4562.76
				SLOT SIZE (IN)	0.02
				BIT SIZE(S) (IN)	12.25

	WELL INSTALLATION	**INTERVAL (FT)**		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	0.0	to	7.4
WELL SCREEN:	4 in. Machine Slotted PVC	7.4	to	17.4
SUMP/END CAP:	4 in. PVC Sch 40	17.4	to	17.77
SURFACE SEAL:	Concrete	0.0	to	2.0
GROUT:				
SEAL:	Bentonite Pellets	2.0	to	4.33
UPPER PACK:				
LOWER PACK:	10-20 Silica Sand	4.33	to	17.77

DRILLING METHOD	HOLLOW STEM AUGER
SAMPLING METHOD	
DATE DEVELOPED	12/10/97
WATER LEVEL (FT BMP)	5.63
LOGGED BY	L. Spencer
REMARKS	Flush mount well



LITHOLOGIC DESCRIPTION

FILL; Silty sand, yellowish brown (10 YR 5/4) 60% fine grained sand, 30% silt, 10% clay, poorly graded subrounded, slightly to low plasticity, moist. SC

No recovery.

No recovery.

Silty sand, fine to medium grained, yellowish brown (10 YR 5/4) 60% sand, 30% gravel, 10% silt, well graded, 1/4" to cobbles, subrounded to subangular, wet. SW

No recovery - Cobble in shoe

ALLUVIUM; Gravelly sand, 60% gravel from 1/4" cobbles, subrounded, 35% sand, 5% silt, well sorted, saturated. Red, yellow, and black mineral grains and yellowish white tiny chert chips. SWG

Flowing sands/gravel in augers-no samples from 11.0 to 17.5 feet.

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MONITORING WELL COMPLETION LOG GRJ01-1022

PROJECT	UMTRA GROUND WATER	**WELL NUMBER**	1022
SITE	GRAND JUNCTION	**DATES DRILLED**	11/3/97

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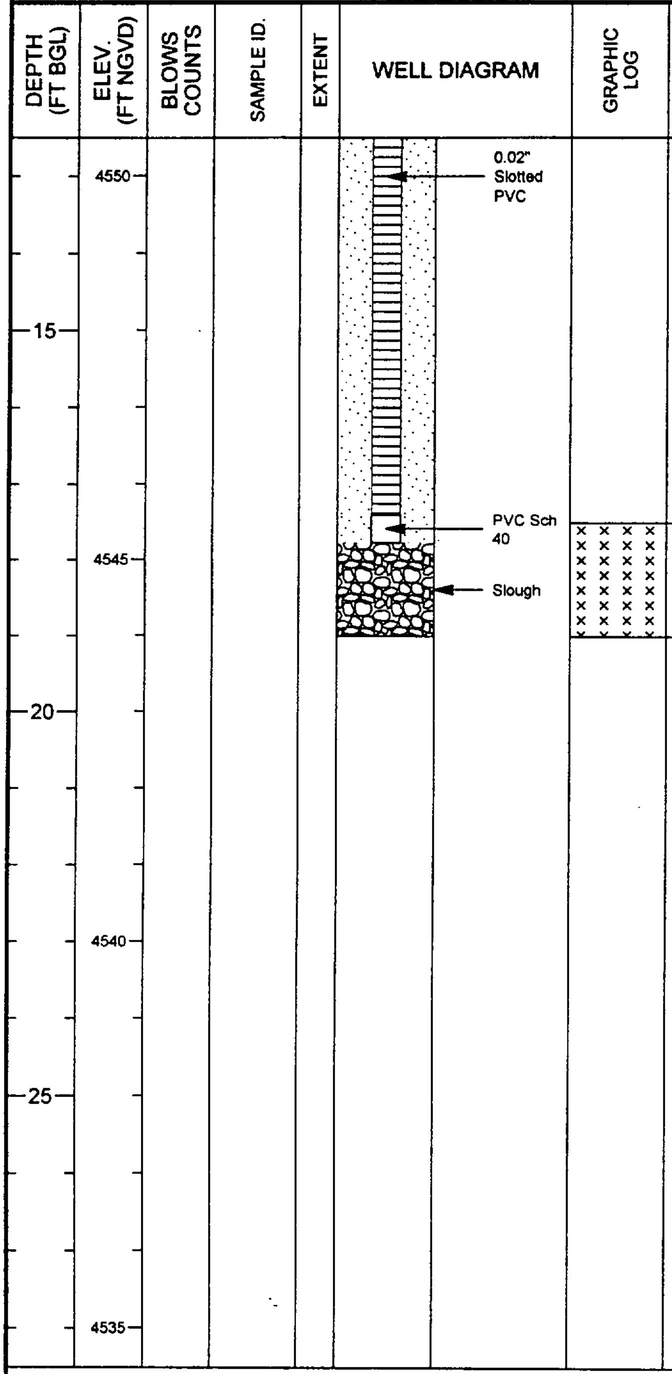


LITHOLOGIC DESCRIPTION

MANCOS SHALE; Weathered bedrock, very dark gray (10 YR 3/1) siltstone some carbon, noncalcareous, moist. NOTE: Sample collected off center bit and auger flight.

Bottom of boring 18 ft

MONITORING WELL COMPLETION LOG GRJ01-1023

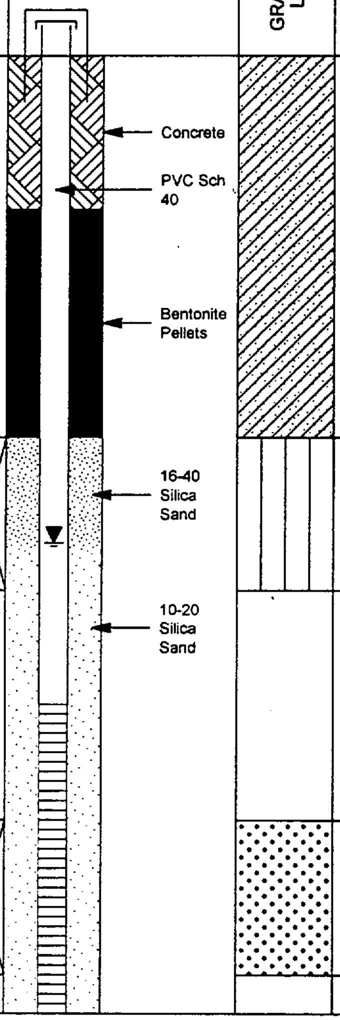
PROJECT UMTRA GROUND WATER
LOCATION GRAND JUNCTION, CO
SITE GRAND JUNCTION
WELL NUMBER 1023

NORTH COORD. (FT) 461339.62
EAST COORD. (FT) 1161786.21
HOLE DEPTH (FT) 22.00
WELL DEPTH (FT) 21.75

DATE DRILLED 11/16/97
SURFACE ELEV. (FT NGVD) 4628.54
TOP OF CASING (FT) 4630.22
MEAS. PT. ELEV. (FT) 4630.22
SLOT SIZE (IN) 0.02
BIT SIZE(S) (IN) 12.25

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-1.5	to	8.5
WELL SCREEN:	4 in. Machine Slotted PVC	8.5	to	21.5
SUMP/END CAP:	4 in. PVC Sch 40	21.5	to	21.75
SURFACE SEAL:	Concrete	0.0	to	2.0
GROUT:				
SEAL:	Bentonite Pellets	2.0	to	5.0
UPPER PACK:	16-40 Silica Sand	5.0	to	6.5
LOWER PACK:	10-20 Silica Sand	6.5	to	21.75

DRILLING METHOD HOLLOW STEM AUGER
SAMPLING METHOD SPLIT SPOON
DATE DEVELOPED 12/6/97
WATER LEVEL (FT BMP) 8.06
LOGGED BY L. Spencer
REMARKS



DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOWS COUNTS	SAMPLE ID.	LITHOLOGIC DESCRIPTION
	4625			FILL; Silty sand, brown (10 YR 5.3), 60% sand fine grained, 30% silt, 10% clay, well graded subrounded, low plasticity, moist. A few roots and root hairs. SC
5		2 2 2 2	5-7 ft.	ALLUVIUM; Clayey silt, brown (10 YR 5/3) 60% silt, 30% sand, fine grained, 10% clay, homogeneous, subrounded sand, medium plasticity, wet, a few root hairs. ML
	4620			No recovery.
10		4 2 5 10	10-12 ft.	Silty sand, dark brown, (10 YR 4/3) 80% sand, 20% silt, fine to medium grain, subrounded, well graded saturated, red, black, and yellow mineral grains, green and yellowish white tiny chert chips. A few white chert chips. NOTE: Driller hit gravel at 14 feet SW
				No recovery.

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MONITORING WELL COMPLETION LOG GRJ01-1023

PROJECT UMTRA GROUND WATER
WELL NUMBER 1023
SITE GRAND JUNCTION
DATES DRILLED 11/16/97

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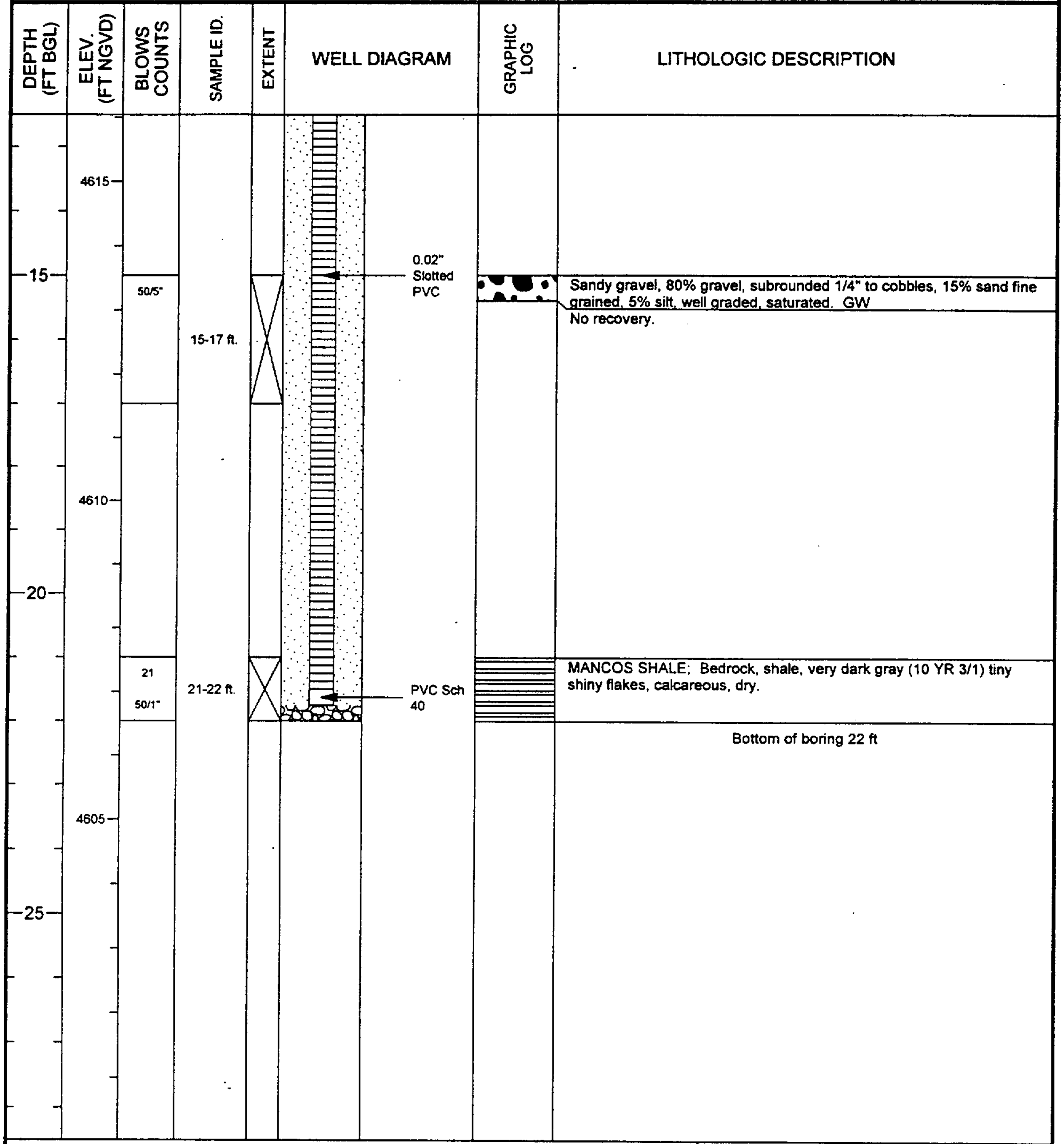


Sandy gravel, 80% gravel, subrounded 1/4" to cobbles, 15% sand fine grained, 5% silt, well graded, saturated. GW

No recovery.

MANCOS SHALE; Bedrock, shale, very dark gray (10 YR 3/1) tiny shiny flakes, calcareous, dry.

Bottom of boring 22 ft

MONITORING WELL COMPLETION LOG GRJ01-1024

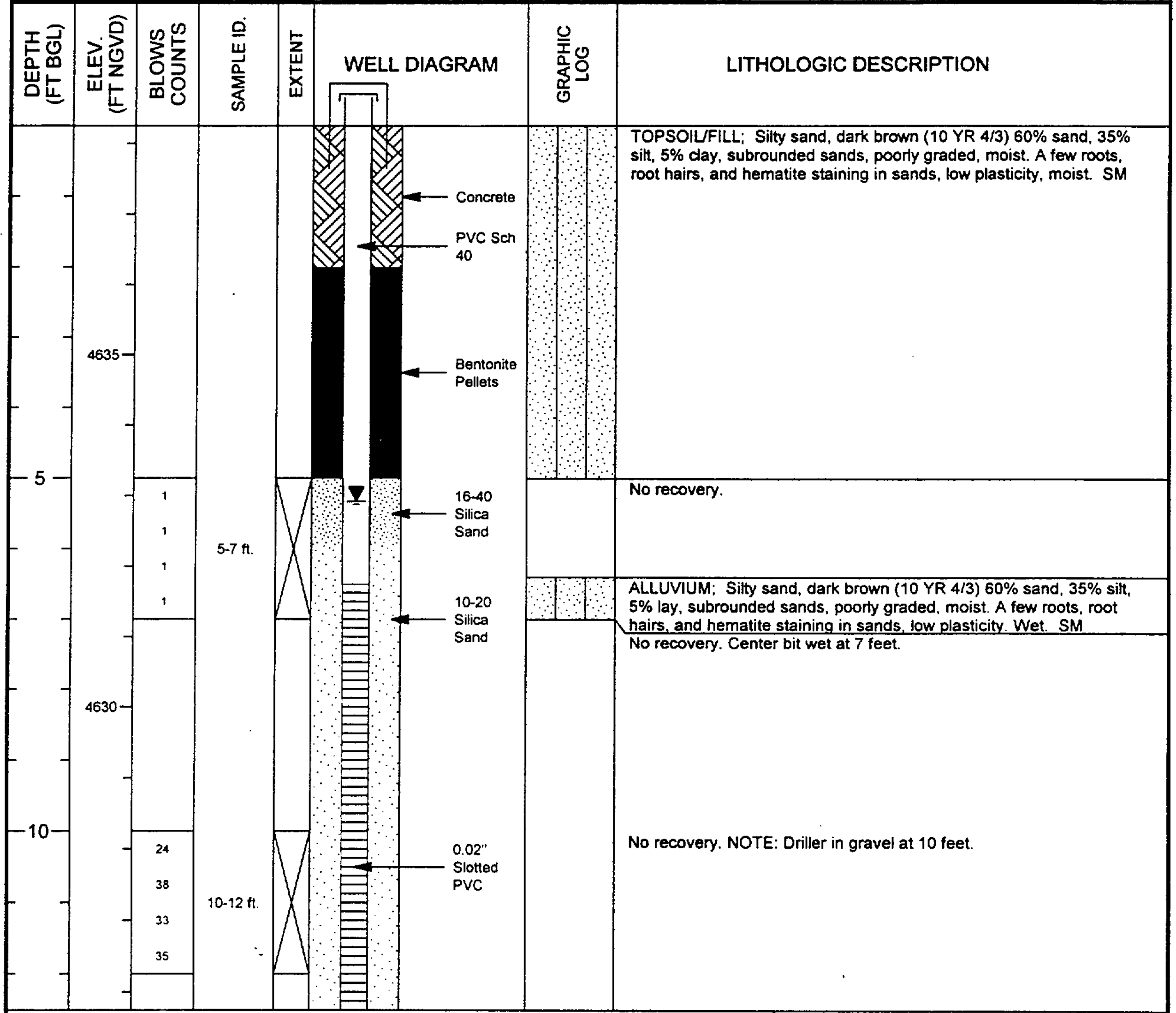
PROJECT UMTRA GROUND WATER
LOCATION GRAND JUNCTION, CO
SITE GRAND JUNCTION
WELL NUMBER 1024

NORTH COORD. (FT) 463784.93
EAST COORD. (FT) 1168174.59
HOLE DEPTH (FT) 15.30
WELL DEPTH (FT) 14.75

DATE DRILLED 11/17/97
SURFACE ELEV. (FT NGVD) 4638.25
TOP OF CASING (FT) 4640.21
MEAS. PT. ELEV. (FT) 4640.21
SLOT SIZE (IN) 0.02
BIT SIZE(S) (IN) 12.25

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-1.9	to	6.5
WELL SCREEN:	4 in. Machine Slotted PVC	6.5	to	14.5
SUMP/END CAP:	4 in. PVC Sch 40	14.5	to	14.75
SURFACE SEAL:	Concrete	0.0	to	2.0
GROUT:				
SEAL:	Bentonite Pellets	2.0	to	5.0
UPPER PACK:	16-40 Silica Sand	5.0	to	6.0
LOWER PACK:	10-20 Silica Sand	6.0	to	14.75

DRILLING METHOD HOLLOW STEM AUGER
SAMPLING METHOD SPLIT SPOON
DATE DEVELOPED 12/6/97
WATER LEVEL (FT BMP) 7.29
LOGGED BY L. Spencer
REMARKS



LITHOLOGIC DESCRIPTION

TOPSOIL/FILL; Silty sand, dark brown (10 YR 4/3) 60% sand, 35% silt, 5% clay, subrounded sands, poorly graded, moist. A few roots, root hairs, and hematite staining in sands, low plasticity, moist. SM

No recovery.

ALLUVIUM; Silty sand, dark brown (10 YR 4/3) 60% sand, 35% silt, 5% lay, subrounded sands, poorly graded, moist. A few roots, root hairs, and hematite staining in sands, low plasticity. Wet. SM

No recovery. Center bit wet at 7 feet.

No recovery. NOTE: Driller in gravel at 10 feet.

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MONITORING WELL COMPLETION LOG GRJ01-1024

PROJECT UMTRA GROUND WATER
SITE GRAND JUNCTION
WELL NUMBER 1024
DATES DRILLED 11/17/97

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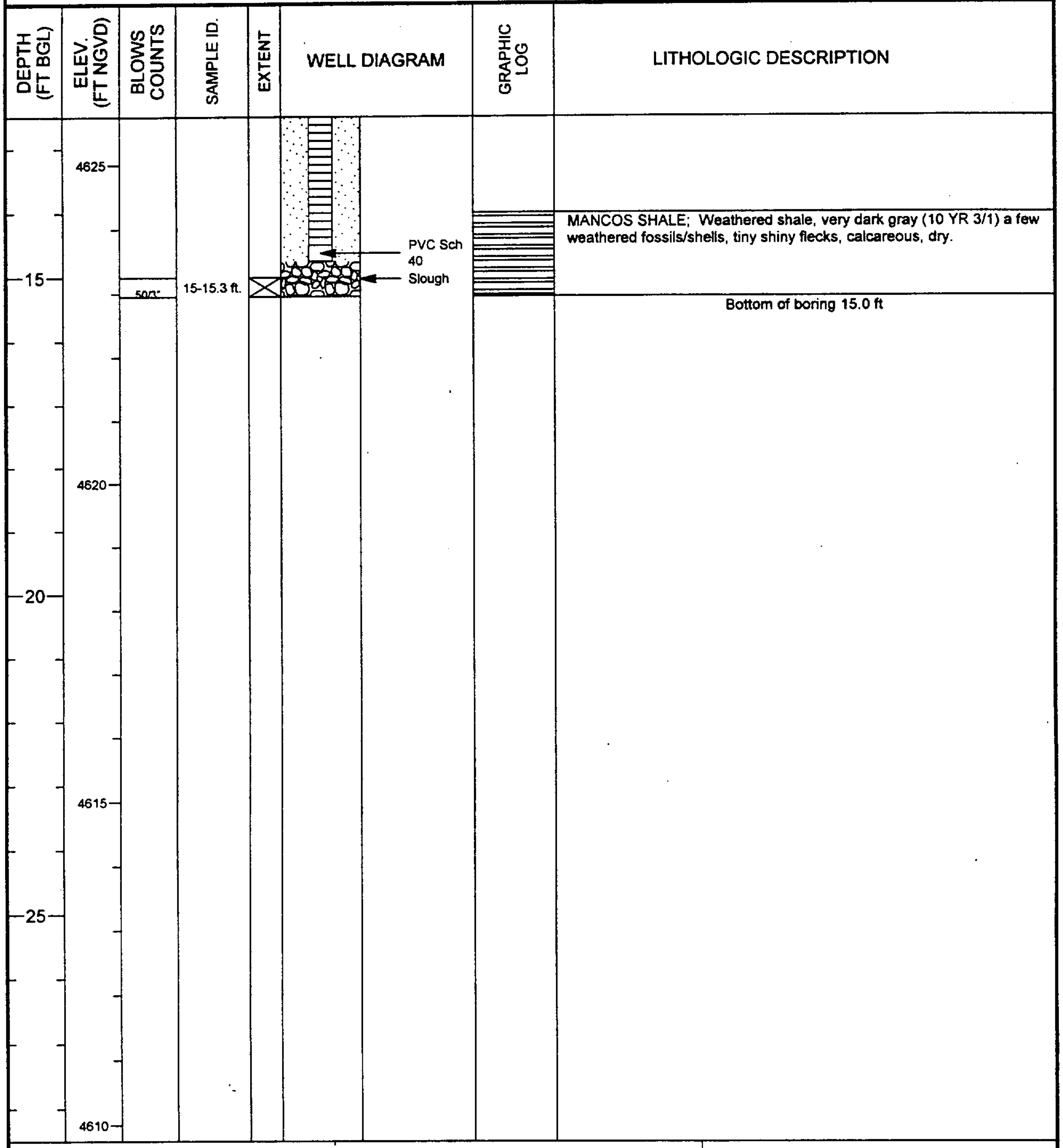

MANCOS SHALE; Weathered shale, very dark gray (10 YR 3/1) a few weathered fossils/shells, tiny shiny flecks, calcareous, dry.

Bottom of boring 15.0 ft

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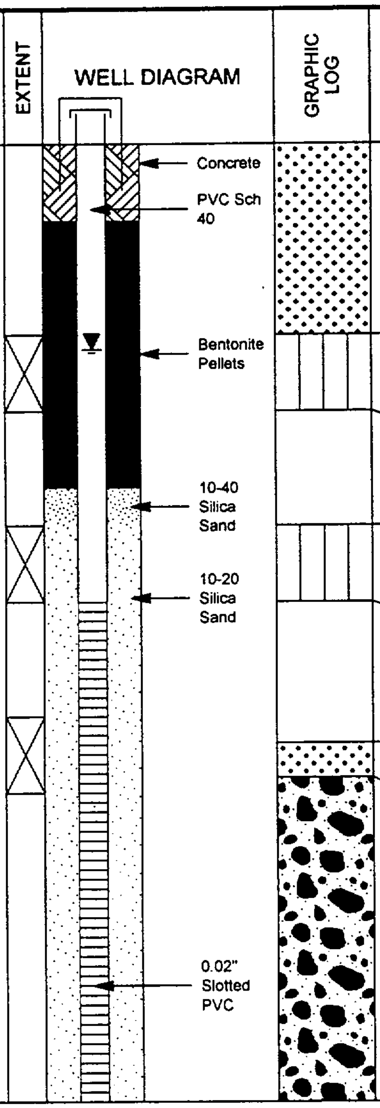
MONITORING WELL COMPLETION LOG GRJ01-1025

PROJECT	UMTRA GROUND WATER	**NORTH COORD. (FT)**	461546.00	**DATE DRILLED**	11/17/97
LOCATION	GRAND JUNCTION, CO	**EAST COORD. (FT)**	1152752.06	**SURFACE ELEV. (FT NGVD)**	4615.21
SITE	GRAND JUNCTION	**HOLE DEPTH (FT)**	35.00	**TOP OF CASING (FT)**	4617.57
WELL NUMBER	1025	**WELL DEPTH (FT)**	32.37	**MEAS. PT. ELEV. (FT)**	4617.57
				SLOT SIZE (IN)	0.02
				BIT SIZE(S) (IN)	12.25

	WELL INSTALLATION	**INTERVAL (FT)**		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-2.2	to	12.0
WELL SCREEN:	4 in. Machine Slotted PVC	12.0	to	32.0
SUMP/END CAP:	4 in. PVC Sch 40	32.0	to	32.37
SURFACE SEAL:	Concrete	0.0	to	2.0
GROUT:				
SEAL:	Bentonite Pellets	2.0	to	9.0
UPPER PACK:	16-40 Silica Sand	9.0	to	10.0
LOWER PACK:	10-20 Silica Sand	10.0	to	32.37

DRILLING METHOD HOLLOW STEM AUGER
SAMPLING METHOD SPLIT SPOON
DATE DEVELOPED 11/23/97
WATER LEVEL (FT BMP) 7.74
LOGGED BY L. Spencer
REMARKS



DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOWS COUNTS	SAMPLE ID.	LITHOLOGIC DESCRIPTION
	4615			TOPSOIL/FILL; Silty sand, yellowish brown (10 YR 5/4) 70% sand, 25% silt, 5% clay subrounded sands, poorly graded, moist. A few roots and root hairs. SW
5	4610	4 5 7 7	5-7 ft.	ALLUVIUM; Clayey silt, dark brown (10 YR 4/3) 70% silt, 20% fine grained sand, 10% clay, numerous vertical root holes, a few root hairs, low plasticity, moist. Pale brown mottles, a few, fine, distinct. (10 YR 6/3) ML
				No recovery
10	4605	2 2 4 6	10-12 ft.	Clayey silt, dark grayish brown (10 YR 4/2) water level at 13 feet, 85% silt, 10% fine grained sand, 5% clay, homogenous, vertical root holes, a few roots, patches of clear to white fine grained sand, medium plasticity, moist. A few, medium distinct gray ML
				No recovery
15	4600	13 17 48 49	15-17 ft.	Silty sand, dark brown (10 YR 4/3) 90% sand, subrounded, 10% silt, well graded, saturated. SW
				Sandy gravel, 70% gravel, 20% sand, fine to medium grain, 10% silt, subrounded, saturated, from 1/4" to cobble size. GWS
20	4595			

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MONITORING WELL COMPLETION LOG GRJ01-1025

PROJECT UMTRA GROUND WATER **WELL NUMBER** 1025

SITE GRAND JUNCTION **DATES DRILLED** 11/17/97

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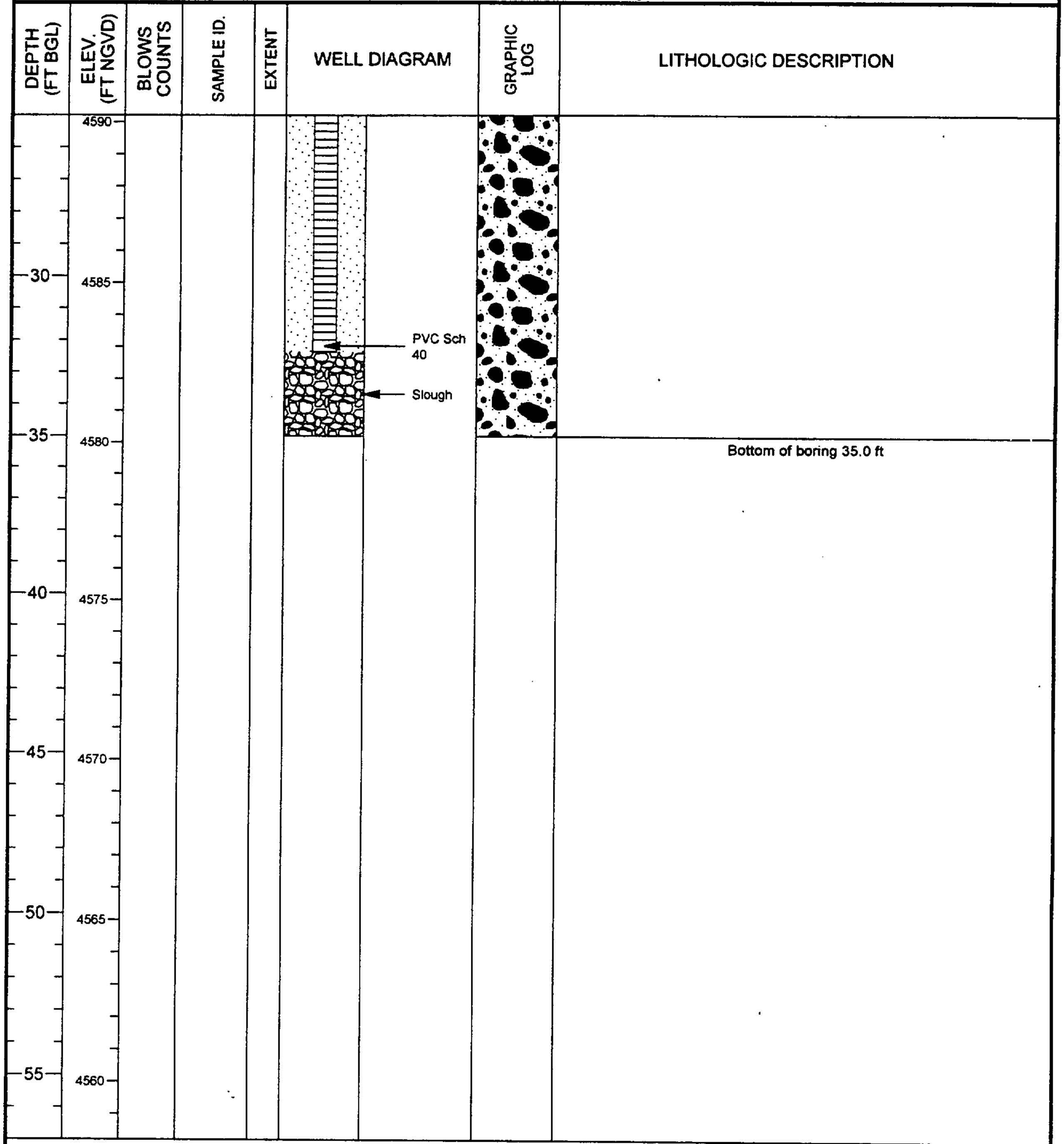
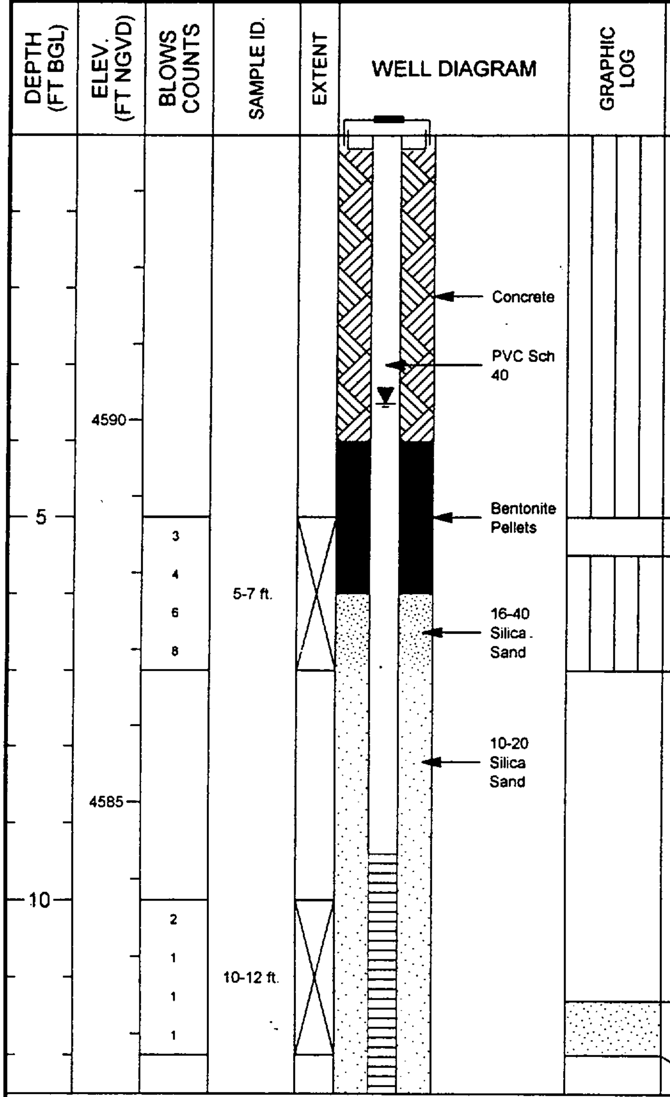


MONITORING WELL COMPLETION LOG GRJ01-1026

PROJECT	UMTRA GROUND WATER	**NORTH COORD. (FT)**	462343.40	**DATE DRILLED**	11/12/97
LOCATION	GRAND JUNCTION, CO	**EAST COORD. (FT)**	1140481.70	**SURFACE ELEV. (FT NGVD)**	4593.73
SITE	GRAND JUNCTION	**HOLE DEPTH (FT)**	27.00	**TOP OF CASING (FT)**	4593.83
WELL NUMBER	1026	**WELL DEPTH (FT)**	26.45	**MEAS. PT. ELEV. (FT)**	4593.83
				SLOT SIZE (IN)	0.02
				BIT SIZE(S) (IN)	12.25

	WELL INSTALLATION	**INTERVAL (FT)**		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	0.0	to	9.4
WELL SCREEN:	4 in. Machine Slotted PVC	9.4	to	26.2
SUMP/END CAP:	4 in. PVC Sch 40	26.2	to	26.45
SURFACE SEAL:	Concrete	0.0	to	4.0
GROUT:				
SEAL:	Bentonite Pellets	4.0	to	6.0
UPPER PACK:	16-40 Silica Sand	6.0	to	7.0
LOWER PACK:	10-20 Silica Sand	7.0	to	26.45

DRILLING METHOD HOLLOW STEM AUGER
SAMPLING METHOD SPLIT SPOON
DATE DEVELOPED 12/3/97
WATER LEVEL (FT BMP) 3.61
LOGGED BY L. Spencer
REMARKS Flush mount well



LITHOLOGIC DESCRIPTION

FILL; Sandy silt, dark brown (10 YR 4/3) 60% silt, 35% sand, 5% clay, poorly graded, subrounded, low plasticity, moist. A few roots and root hairs. ML

Slough - No recovery.

Sandy silt, grayish brown (2.5 Y 5/2) 60% silt, 35% sand, 5% clay, a few small patches of light white colored sand grains, poorly sorted, subrounded medium plasticity, moist. W. L. 10 feet. ML

No recovery.

Alluvium?

Slough - No recovery.

Sand, very fine to fine grained, brown (10 YR 4/3) 90% sand 5% silt, 5% clay, poorly graded, subrounded slight plasticity, saturated. Red, yellow and black mineral grains. SP

No recovery

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MONITORING WELL COMPLETION LOG GRJ01-1026

PROJECT	UMTRA GROUND WATER	**WELL NUMBER**	1026
SITE	GRAND JUNCTION	**DATES DRILLED**	11/12/97

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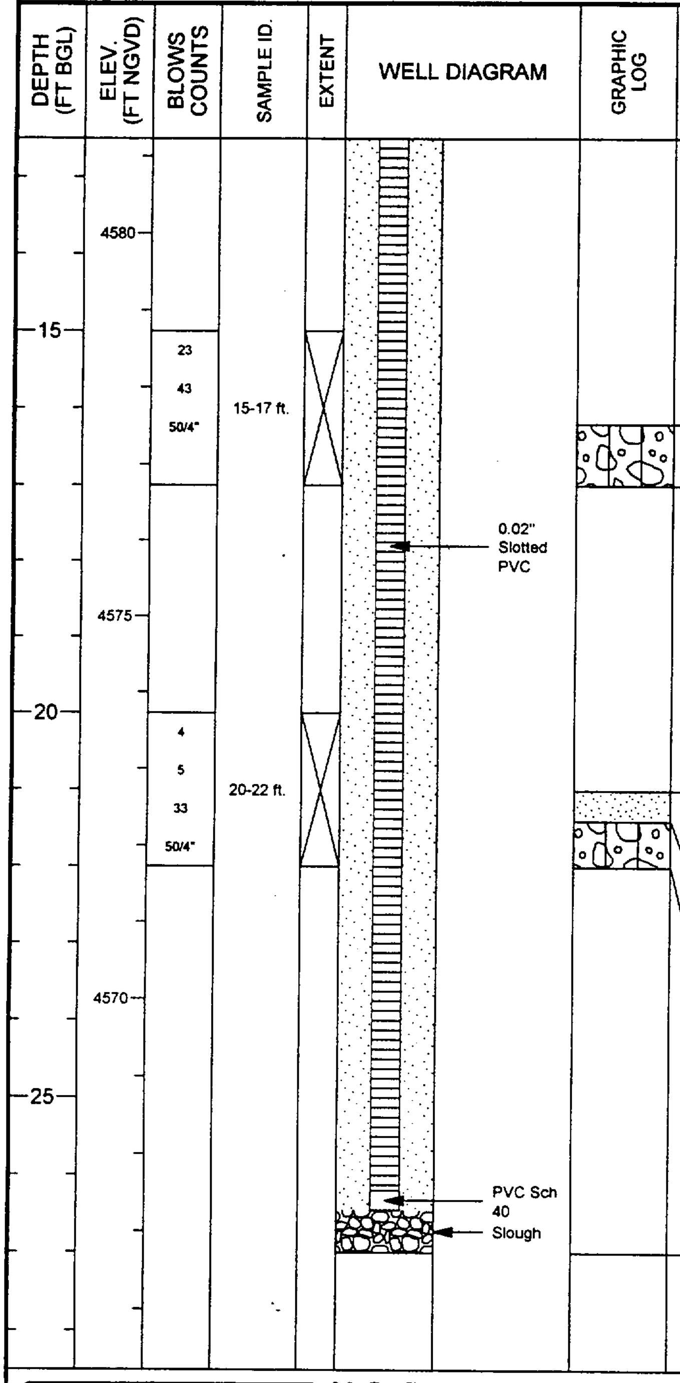


LITHOLOGIC DESCRIPTION

Slough - No recovery.

Sandy gravel, 70% gravel, 25% sand, 5% silt, brown (10 YR 4/3) from cobbles to 1/4" size, well graded, subrounded to subangular, saturated. GM

No recovery.

Sand, quartzose, brown (10 YR 4/3) fine to medium grained 100% sand, subrounded poorly graded. Red, yellow, black mineral grains; some yellowish white cherts, saturated. SP

Sandy gravel, 70% gravel, 25% sand, 5% silt, brown (10 YR 4/3) from cobbles to 1/4" size, well graded, subrounded to subangular, saturated. GM

No recovery

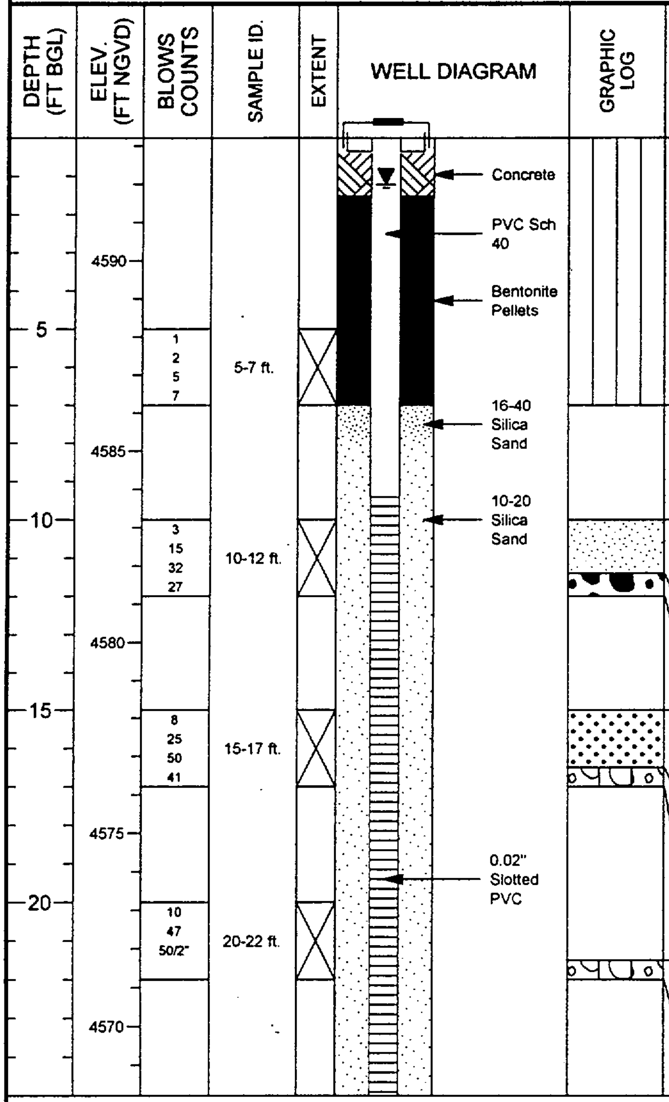
Bottom of boring 27.0 ft

MONITORING WELL COMPLETION LOG GRJ01-1027

PROJECT	UMTRA GROUND WATER	**NORTH COORD. (FT)**	462388.59	**DATE DRILLED**	11/14/97
LOCATION	GRAND JUNCTION, CO	**EAST COORD. (FT)**	1140321.44	**SURFACE ELEV. (FT NGVD)**	4593.21
SITE	GRAND JUNCTION	**HOLE DEPTH (FT)**	33.00	**TOP OF CASING (FT)**	4593.34
WELL NUMBER	1027	**WELL DEPTH (FT)**	29.77	**MEAS. PT. ELEV. (FT)**	4593.34
				SLOT SIZE (IN)	0.02
				BIT SIZE(S) (IN)	12.25

	WELL INSTALLATION	**INTERVAL (FT)**		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	0.0	to	9.4
WELL SCREEN:	4 in. Machine Slotted PVC	9.4	to	29.4
SUMP/END CAP:	4 in. PVC Sch 40	29.4	to	29.77
SURFACE SEAL:	Concrete	0.0	to	1.5
GROUT:				
SEAL:	Bentonite Pellets	1.5	to	7.0
UPPER PACK:	16-40 Silica Sand	7.0	to	8.0
LOWER PACK:	10-20 Silica Sand	8.0	to	29.77

DRILLING METHOD HOLLOW STEM AUGER
SAMPLING METHOD SPLIT SPOON
DATE DEVELOPED 12/4/97
WATER LEVEL (FT BMP) 1.35
LOGGED BY L. Spencer
REMARKS Flush mount well



LITHOLOGIC DESCRIPTION

FILL; Sandy silt, dark brown (10 YR 4/3) 60% silt, 35% sand fine grained, 5% clay, poorly graded, low plasticity, moist. A few white to clear patches of fine grained sand mixed in homogenous silt. ML

No recovery

ALLUVIUM; Sand, fine to medium grained, dark brown (10 YR 4/3) 90% sand, 5% silt, 5% clay, poorly graded, slight plasticity, subrounded, saturated. Red, yellow and black mineral grains, some tiny yellowish white chert chips. SP

Sandy gravel, 80% gravel, 20% sand, from cobbles to 1/4". Saturated, subrounded well graded. GW

No recovery

Sand, fine to medium grained, dark brown (10 YR 4/3) 90% sand, 5% silt, 5% clay, poorly graded, slight plasticity, subrounded, saturated. Red, yellow and black mineral grains, some tiny yellowish white chert chips. SW

Sandy gravel, dark brown (10 YR 4/3) 60% gravel from 1/4" to cobbles, 30% sand, fine to medium grained, and 10% silt, well graded, subrounded, saturated. GM

No recovery.

Slough - No recovery.

Sandy gravel, dark brown (10 YR 4/3) 60% gravel from 1/4" to cobbles, 30% sand, fine to medium grained, and 10% silt, well graded, subrounded, saturated. GM

No recovery

MONITORING WELL COMPLETION LOG GRJ01-1027

PROJECT	UMTRA GROUND WATER	**WELL NUMBER**	1027
SITE	GRAND JUNCTION	**DATES DRILLED**	11/14/97

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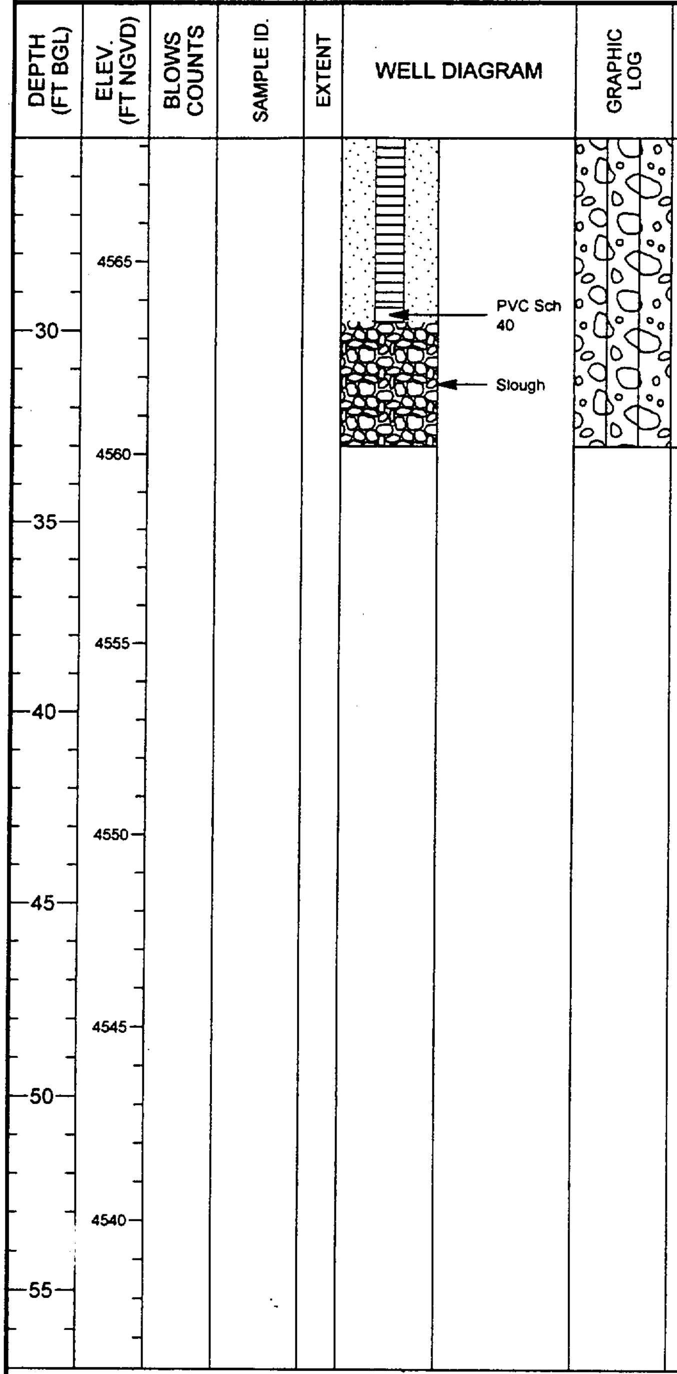


LITHOLOGIC DESCRIPTION

NOTE: Driller could feel boulders/ cobbles from approximately 25 to 33 feet. Very hard, jerky drilling.

Bottom of boring 33.0 ft

MONITORING WELL COMPLETION LOG GRJ01-1028

PROJECT UMTRA GROUND WATER
LOCATION GRAND JUNCTION, CO
SITE GRAND JUNCTION
WELL NUMBER 1028

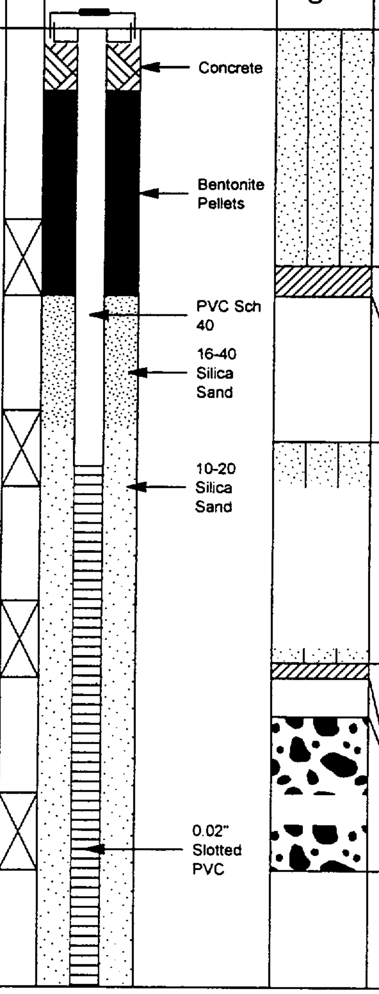
NORTH COORD. (FT) 462558.95
EAST COORD. (FT) 1140583.78
HOLE DEPTH (FT) 34.00
WELL DEPTH (FT) 31.82

DATE DRILLED 11/15/97
SURFACE ELEV. (FT NGVD) 4594.94
TOP OF CASING (FT) 4594.99
MEAS. PT. ELEV. (FT) 4594.99
SLOT SIZE (IN) 0.02
BIT SIZE(S) (IN) 12.25

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	0.0	to	11.45
WELL SCREEN:	4 in. Machine Slotted PVC	11.45	to	31.45
SUMP/END CAP:	4 in. PVC Sch 40	31.45	to	31.82
SURFACE SEAL:	Concrete	0.0	to	1.6
GROUT:				
SEAL:	Bentonite Pellets	1.6	to	7.0
UPPER PACK:	16-40 Silica Sand	7.0	to	10.4
LOWER PACK:	10-20 Silica Sand	10.4	to	31.82

DRILLING METHOD HOLLOW STEM AUGER
SAMPLING METHOD SPLIT SPOON
DATE DEVELOPED 12/5/97
WATER LEVEL (FT BMP)
LOGGED BY L. Spencer
REMARKS Flush mount well

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOWS COUNTS	SAMPLE ID.
5	4590	1 1 2 3	5-7 ft.
10	4585	1 3 4 4	10-12 ft.
15	4580	1 1 3 3	15-17 ft.
20	4575	11 30 23 43	20-22 ft.



LITHOLOGIC DESCRIPTION

FILL; Sandy silt, dark grayish brown (10 YR 4/2) 60% silt, 30% sand, 5% gravel, 5% clay, well graded, subrounded, low plasticity, moist. A few roots and root hairs. SM

ALLUVIUM; Clayey silt, grayish brown (10 YR 5/2) 60% silt, 20% clay, 20% fine grained sand, homogenous, medium plasticity, wet. Patches of white to clear fine grained sand throughout sample. CL

No recovery

Slough - No recovery.

Silty sand, dark brown, (10 YR 4/3) 75% sand fine grained, 20% silt, 5% clay, homogenous, tiny red, black, and yellow mineral grains, subrounded, low plasticity, saturated. SM

No recovery.

Slough - No recovery.

Clayey silt, yellowish brown (10 YR 5/4) mottled with dark yellowish brown (10 YR 4/6) few, fine to medium distinct, moist, 10% sand, medium plasticity. CL

No recovery

NOTE: Driller could feel gravel at 18 feet in depth.

Slough - No recovery.

Sandy gravel, subrounded, well graded from 1/4" to cobbles, 60%, sand fined grained 30%, 10% silt, saturated. GW

No recovery.

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MONITORING WELL COMPLETION LOG GRJ01-1028

PROJECT UMTRA GROUND WATER **WELL NUMBER** 1028

SITE GRAND JUNCTION **DATES DRILLED** 11/15/97

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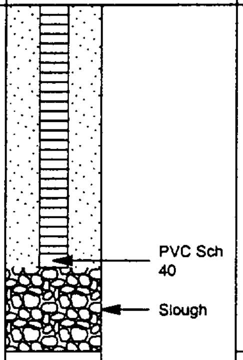


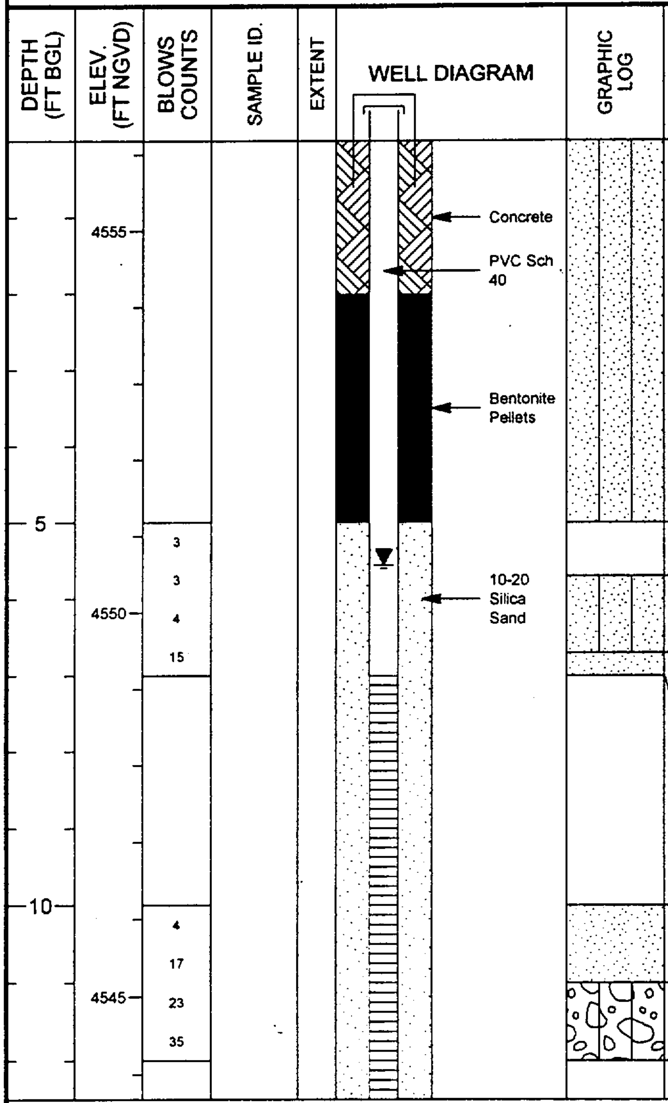
DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOWS COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							No recovery.
30	4565						
							Bottom of boring 34.0 ft
35	4560						
40	4555						
45	4550						
50	4545						
55	4540						

MONITORING WELL COMPLETION LOG GRJ01-1029

PROJECT	UMTRA GROUND WATER	**NORTH COORD. (FT)**	460999.24	**DATE DRILLED**	10/30/97
LOCATION	GRAND JUNCTION, CO	**EAST COORD. (FT)**	1128375.26	**SURFACE ELEV. (FT NGVD)**	4556.18
SITE	GRAND JUNCTION	**HOLE DEPTH (FT)**	23.50	**TOP OF CASING (FT)**	4558.55
WELL NUMBER	1029	**WELL DEPTH (FT)**	22.25	**MEAS. PT. ELEV. (FT)**	4558.55
				SLOT SIZE (IN)	0.02
				BIT SIZE(S) (IN)	12.25

	WELL INSTALLATION	**INTERVAL (FT)**		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-2.5	to	7.0
WELL SCREEN:	4 in. Machine Slotted PVC	7.0	to	22.0
SUMP/END CAP:	4 in. PVC Sch 40	22.0	to	22.25
SURFACE SEAL:	Concrete	0.0	to	2.0
GROUT:				
SEAL:	Bentonite Pellets	2.0	to	5.0
UPPER PACK:				
LOWER PACK:	10-20 Silica Sand	5.0	to	22.5

DRILLING METHOD	HOLLOW STEM AUGER
SAMPLING METHOD	
DATE DEVELOPED	12/2/97
WATER LEVEL (FT BMP)	7.93
LOGGED BY	L. Spencer
REMARKS	



LITHOLOGIC DESCRIPTION

FILL; Grayish brown, (10 YR 5/2) 60% silt, 30% very fine grained sand, 3% gravel up to 3 inches, 2% debris from landfill material (plastic, wood, metal). Well graded, subrounded medium plasticity (when water is applied) Dry. SM

Slough.

ALLUVIUM; Silty sand, dark gray (10 YR 4/1) 70% silt, 30% sand, poorly graded, saturated, slightly plastic. SM

Sand, fine grained, dark gray (10 YR 4/1) 90% sand, 10% gravel. Red, yellow, and black mineral grains poorly graded, subrounded, saturated. SP

No recovery.

Sand, medium grained, dark gray (10 YR 4/1) 90% sand, 10% silt, poorly graded, subrounded, saturated. SP

Gravel, up to 2 inches 60%, fine to medium grained sand 40%, well graded, subrounded, saturated. GM

No recovery.

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MONITORING WELL COMPLETION LOG GRJ01-1029

PROJECT UMTRA GROUND WATER
SITE GRAND JUNCTION
WELL NUMBER 1029
DATES DRILLED 10/30/97

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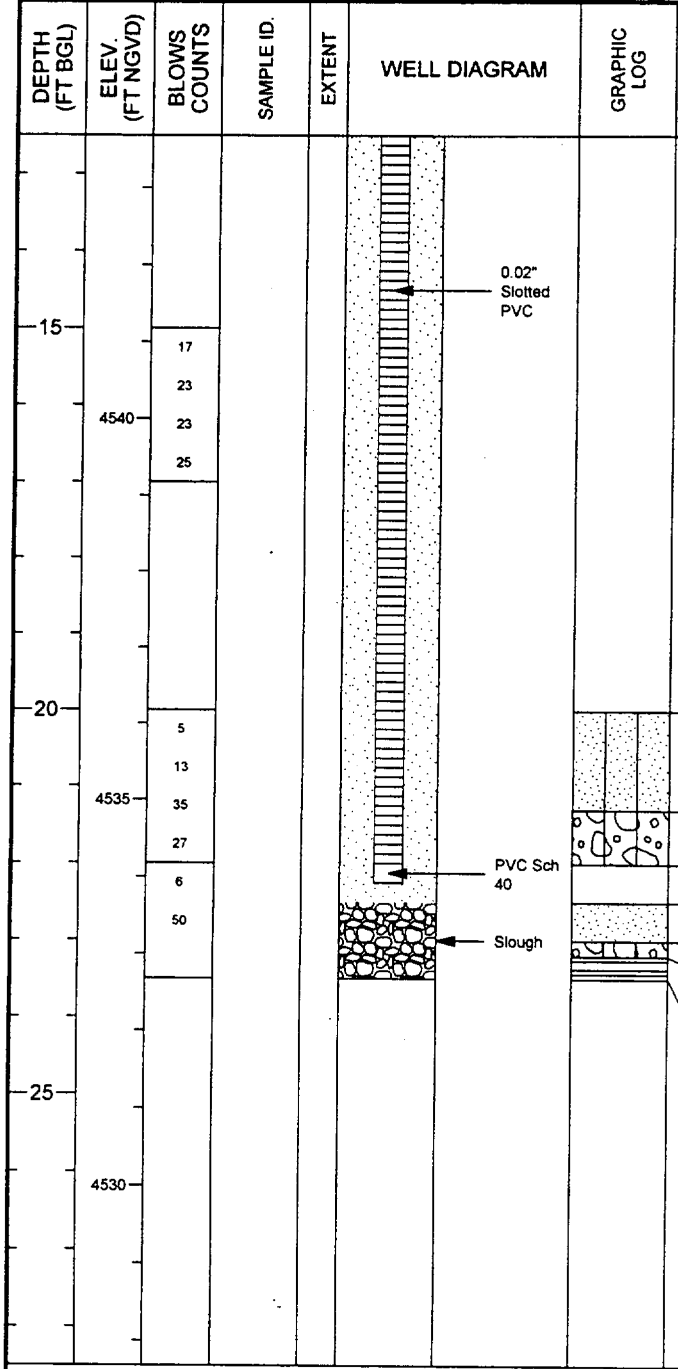


LITHOLOGIC DESCRIPTION

Slough (large cobble in shoe) - No recovery.

Sand, fine to medium grained, dark gray (10 YR 4/1) 85% sand, 5% silt, poorly graded, subrounded saturated. Red, yellow, and black (carbonaceous?) grains, white, brown, and green cherts. SM

Gravel, 10% cobbles, up to 2 inches gravel 60%, sand 30%, subrounded, well graded, saturated. GM

Slough - No recovery.

Sand, medium grained, dark gray (10 YR 4/1) saturated. SP

Gravel up to 1 inch, subrounded, saturated. GM

DAKOTA SANDSTONE; Shale, carbonaceous, weathered, gray (10 YR 3/1) wet, noncalcareous.

Bottom of boring 23.5 ft

MONITORING WELL COMPLETION LOG GRJ01-1030

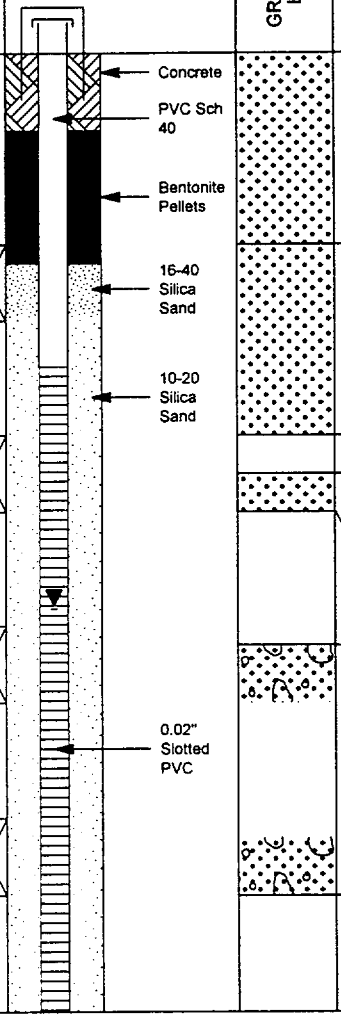
PROJECT	UMTRA GROUND WATER	**NORTH COORD. (FT)**	464339.84	**DATE DRILLED**	11/11/97
LOCATION	GRAND JUNCTION, CO	**EAST COORD. (FT)**	1125984.87	**SURFACE ELEV. (FT NGVD)**	4555.64
SITE	GRAND JUNCTION	**HOLE DEPTH (FT)**	30.50	**TOP OF CASING (FT)**	4555.93
WELL NUMBER	1030	**WELL DEPTH (FT)**	28.57	**MEAS. PT. ELEV. (FT)**	4555.93
				SLOT SIZE (IN)	0.02
				BIT SIZE(S) (IN)	12.25

	WELL INSTALLATION	**INTERVAL (FT)**		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-1.8	to	8.2
WELL SCREEN:	4 in. Machine Slotted PVC	8.2	to	28.2
SUMP/END CAP:	4 in. PVC Sch 40	28.2	to	28.57
SURFACE SEAL:	Concrete	0.0	to	2.0
GROUT:				
SEAL:	Bentonite Pellets	2.0	to	5.5
UPPER PACK:	16-40 Silica Sand	5.5	to	6.83
LOWER PACK:	10-20 Silica Sand	6.83	to	28.57

DRILLING METHOD HOLLOW STEM AUGER
SAMPLING METHOD SPLIT SPOON
DATE DEVELOPED 12/9/97
WATER LEVEL (FT BMP) 14.74
LOGGED BY L. Spencer
REMARKS

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOWS COUNTS	SAMPLE ID.
	4555		
5	4550	4 3 3 3	5-7 ft.
10	4545	1 20 30 31	10-12 ft.
15	4540	23 27 50-4"	15-17 ft.
20	4535	5 6 24 50	20-22 ft.

WELL DIAGRAM / **GRAPHIC LOG**



LITHOLOGIC DESCRIPTION

FILL; Sand, fine to medium grained, brown (7.5 YR 5/4) 60% sand, 30% gravel, 10% silt, well graded, subrounded, no plasticity, moist. SW

Sand fine to medium grained, yellowish brown (10 YR 5/4) 70% sand, 15% gravel, 15% silt, subrounded, well graded, slightly plasticity moist. SW

No Recovery.

Sand fine to medium grained, yellowish brown (10 YR 5/4) 65% sand, 20% gravel, 15% silt, subrounded, well graded, slightly plasticity moist. SW

No sample collected-hard rock drilling.

No recovery.

ALLUVIUM; Gravelly sand, grayish brown (10 YR 5/2) 55% sand, 40% gravel, subrounded, 5% silt, well graded, slight plasticity, saturated. SWG

No recovery.

No recovery

MONITORING WELL COMPLETION LOG GRJ01-1030

PROJECT UMTRA GROUND WATER **WELL NUMBER** 1030
SITE GRAND JUNCTION **DATES DRILLED** 11/11/97

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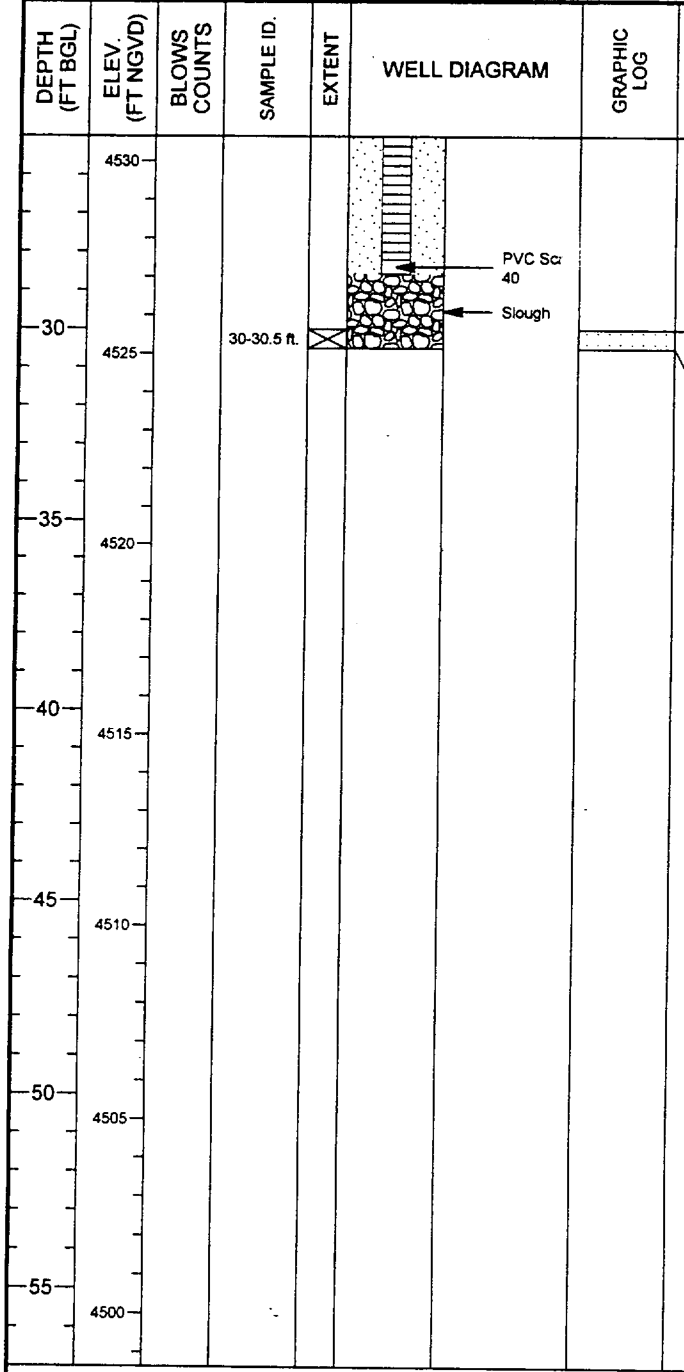


LITHOLOGIC DESCRIPTION

DAKOTA SANDSTONE; siltstone, weathered, very dark gray (10 YR 3/1) very tiny shiny flakes, soft, moist. Carbonaceous? Noncalcareous.

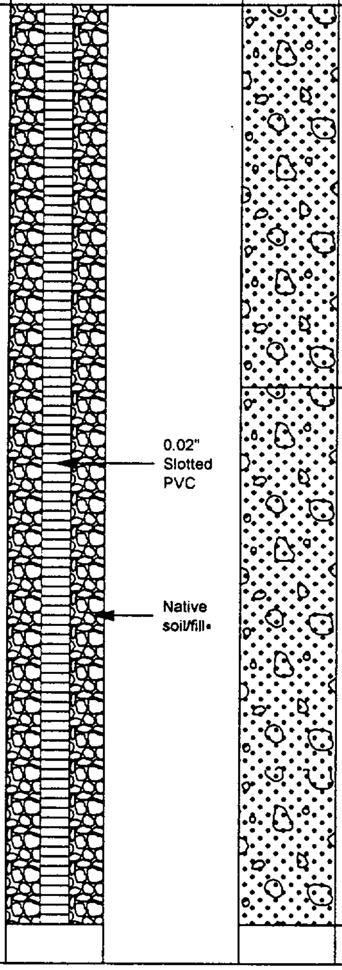
Bottom of boring 30.5 ft

MONITORING WELL COMPLETION LOG GRJ01-1031

PROJECT	UMTRA GROUND WATER	**NORTH COORD. (FT)**		**DATE DRILLED**	11/12/97
LOCATION	GRAND JUNCTION, CO	**EAST COORD. (FT)**		**SURFACE ELEV. (FT NGVD)**	
SITE	GRAND JUNCTION	**HOLE DEPTH (FT)**	12.00	**TOP OF CASING (FT)**	
WELL NUMBER	1031	**WELL DEPTH (FT)**	12.00	**MEAS. PT. ELEV. (FT)**	
				SLOT SIZE (IN)	0.02
				BIT SIZE(S) (IN)	12.25

	WELL INSTALLATION	**INTERVAL (FT)**		
SURFACE CASING:				
BLANK CASING:				
WELL SCREEN:	4 in. Machine Slotted PVC	0.0	to	12.0
SUMP/END CAP:				
SURFACE SEAL:				
GROUT:				
SEAL:				
UPPER PACK:				
LOWER PACK:				

DRILLING METHOD HOLLOW STEM AUGER
SAMPLING METHOD
DATE DEVELOPED
WATER LEVEL (FT BMP) 11.0
LOGGED BY L. Spencer
REMARKS Temporary boring for water level measurement. Abandoned 11-14-97.



DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOWS COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							FILL; Gravelly sand 60% sand, 30% gravel, 10% silt dark grayish brown (10 YR 4/2) moist, well graded. SWG
5							Fill, gravelly sand, 50% sand, 25% gravel, 10% silt, 15% clay, moist to 8.5 feet, saturated, 8.5 feet on well graded, subrounded. Water level about 9.0 feet below ground level SWG
10							

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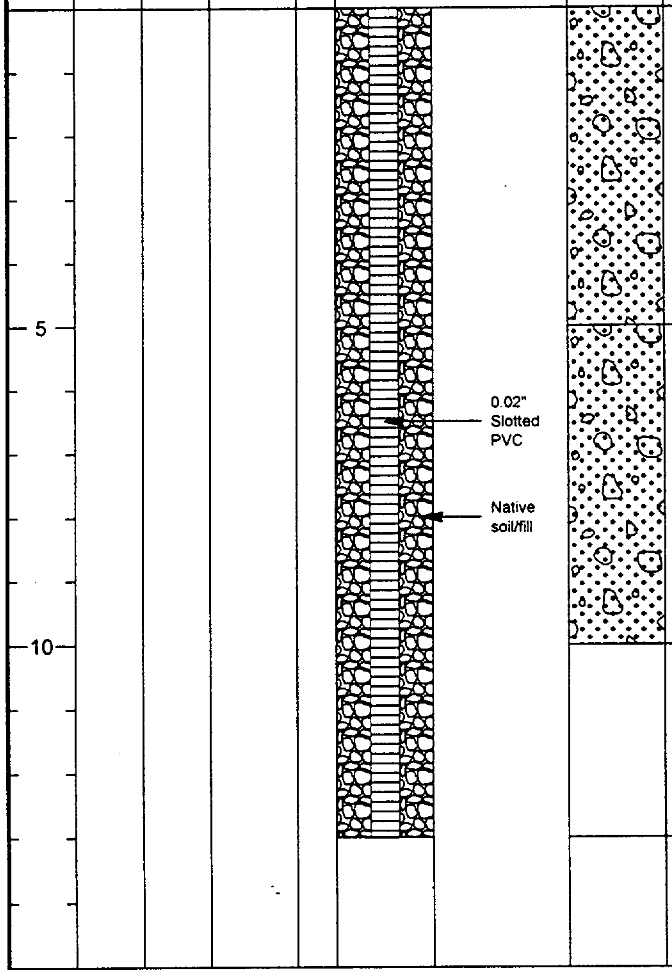
MONITORING WELL COMPLETION LOG GRJ01-1032

PROJECT UMTRA GROUND WATER
LOCATION GRAND JUNCTION, CO
SITE GRAND JUNCTION
WELL NUMBER 1032
NORTH COORD. (FT)
EAST COORD. (FT)
HOLE DEPTH (FT) 13.00
WELL DEPTH (FT)
DATE DRILLED 11/12/97
SURFACE ELEV. (FT NGVD)
TOP OF CASING (FT)
MEAS. PT. ELEV. (FT)
SLOT SIZE (IN) 0.02
BIT SIZE(S) (IN) 12.25

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:				
WELL SCREEN:	4 in. Machine Slotted PVC	0.0	to	13.0
SUMP/END CAP:				
SURFACE SEAL:				
GROUT:				
SEAL:				
UPPER PACK:				
LOWER PACK:				

DRILLING METHOD HOLLOW STEM AUGER
SAMPLING METHOD
DATE DEVELOPED
WATER LEVEL (FT BMP) 13.25
LOGGED BY L. Spencer
REMARKS Temporary boring for water level measurement. Abandoned 11-12-97.



DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOWS COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							Fill; Asphalt, gravelly sand. 60% sand, 30% gravel, 10% silt dark brown (10 YR 4/3) subrounded well graded, moist. swg
							Fill, gravelly sand. 60% sand, 30% gravel, 10% silt dark brown (10 YR 4/3) subrounded well graded, moist, water level approximately 11.0 feet below ground level SWG
							No visual sample.

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MONITORING WELL COMPLETION LOG GRJ01-1034

PROJECT UMTRA GROUND WATER
LOCATION GRAND JUNCTION, CO
SITE GRAND JUNCTION
WELL NUMBER 1034

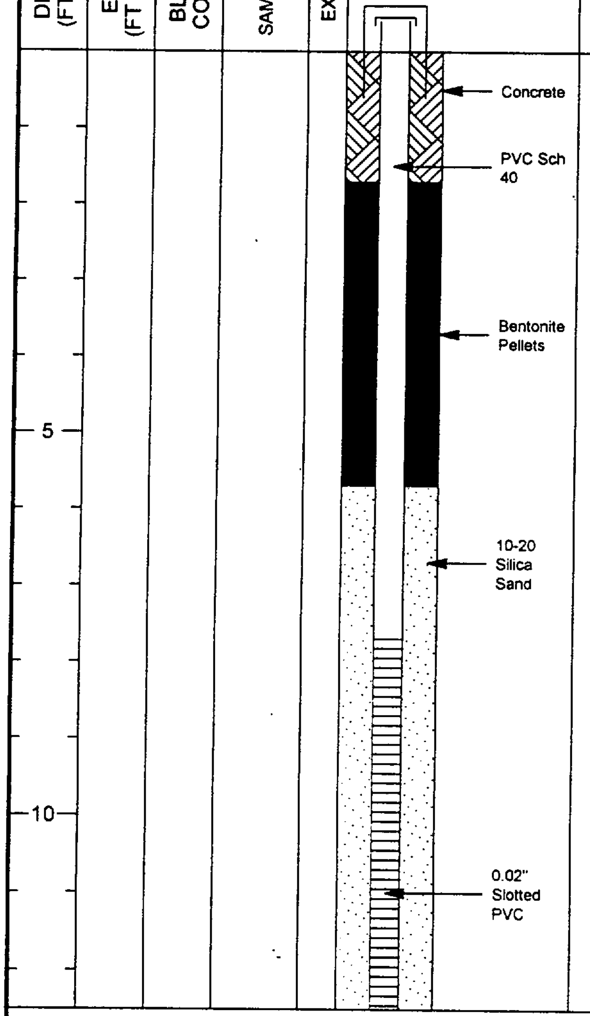
NORTH COORD. (FT)
EAST COORD. (FT)
HOLE DEPTH (FT) 18.00
WELL DEPTH (FT) 18.00

DATE DRILLED 9/3/98
SURFACE ELEV. (FT NGVD)
TOP OF CASING (FT)
MEAS. PT. ELEV. (FT)
SLOT SIZE (IN) 0.02
BIT SIZE(S) (IN) 9.33

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-1.8	to	7.7
WELL SCREEN:	4 in. Vee Wire Wrapped	7.7	to	17.7
SUMP/END CAP:	4 in. PVC Sch 40	17.7	to	18.0
SURFACE SEAL:	Concrete	0.0	to	1.7
GROUT:				
SEAL:	Bentonite Pellets	1.7	to	5.7
UPPER PACK:				
LOWER PACK:	10-20 Silica Sand	5.7	to	18.0

DRILLING METHOD ODEX - CASING ADVANCE
SAMPLING METHOD
DATE DEVELOPED
WATER LEVEL (FT BMP) 10.26
LOGGED BY R. Heydenburg
REMARKS No Samples Collected

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOWS COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
							No recovery.



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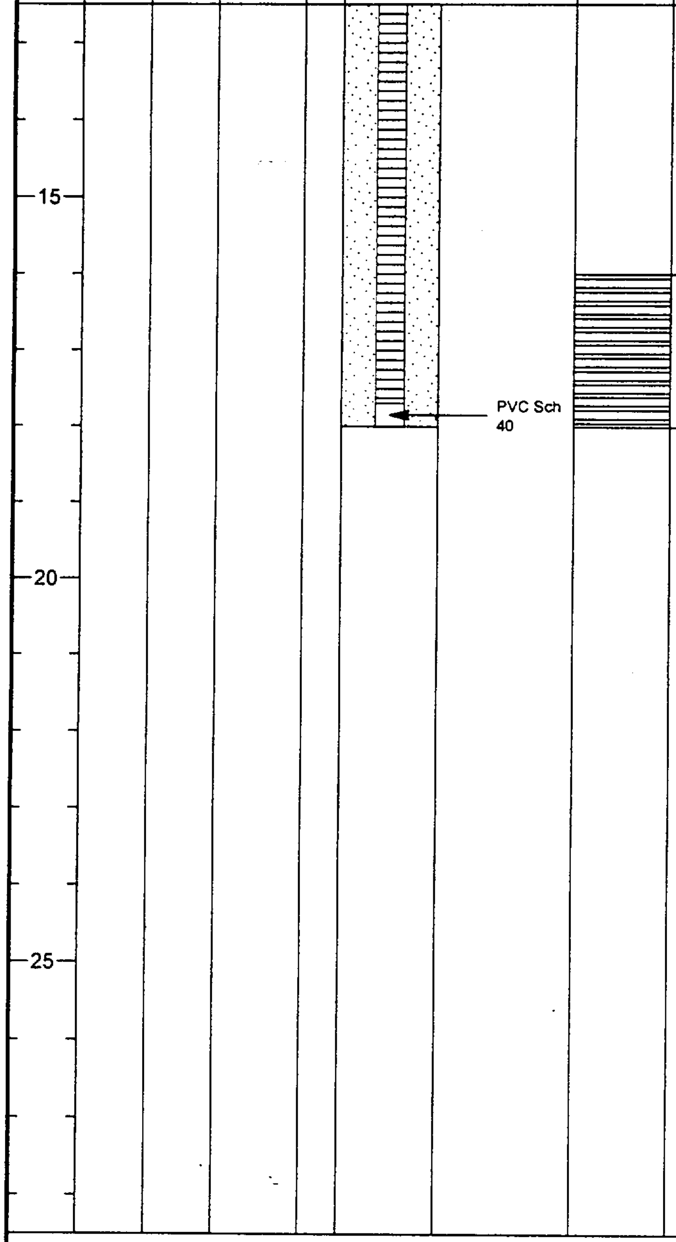
MONITORING WELL COMPLETION LOG GRJ01-1034

PROJECT	UMTRA GROUND WATER	**WELL NUMBER**	1034
SITE	GRAND JUNCTION	**DATES DRILLED**	9/3/98

Continued from Previous Page

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOWS COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION



DAKOTA SANDSTONE; Shale.

Bottom of boring at 18.0 ft

MONITORING WELL COMPLETION LOG GRJ01-1035

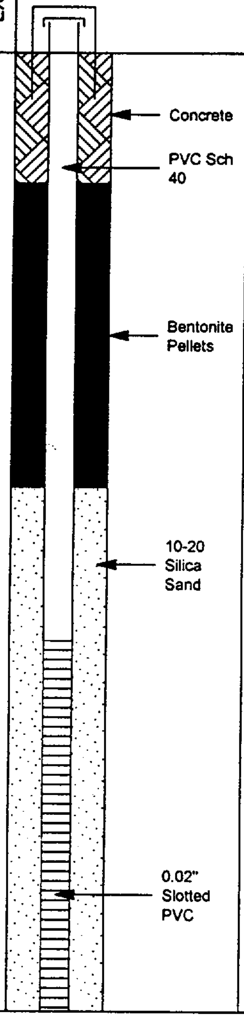
PROJECT UMTRA GROUND WATER
LOCATION GRAND JUNCTION, CO
SITE GRAND JUNCTION
WELL NUMBER 1035

NORTH COORD. (FT)
EAST COORD. (FT)
HOLE DEPTH (FT) 19.50
WELL DEPTH (FT) 18.00

DATE DRILLED 9/3/98 to 9/4/98
SURFACE ELEV. (FT NGVD)
TOP OF CASING (FT)
MEAS. PT. ELEV. (FT)
SLOT SIZE (IN) 0.02
BIT SIZE(S) (IN) 9.33

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	4 in. PVC Sch 40	-1.6	to	7.7
WELL SCREEN:	4 in. Vee Wire Wrapped	7.7	to	17.7
SUMP/END CAP:	4 in. PVC Sch 40	17.7	to	18.0
SURFACE SEAL:	Concrete	0.0	to	1.7
GROUT:				
SEAL:	Bentonite Pellets	1.7	to	5.7
UPPER PACK:				
LOWER PACK:	10-20 Silica Sand	5.7	to	18.0

DRILLING METHOD ODEX - CASING ADVANCE
SAMPLING METHOD
DATE DEVELOPED
WATER LEVEL (FT BMP) 9.96
LOGGED BY R. Heydenburg
REMARKS No samples collected

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOWS COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION
5 10							No recovery.

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MONITORING WELL COMPLETION LOG GRJ01-1035

PROJECT UMTRA GROUND WATER

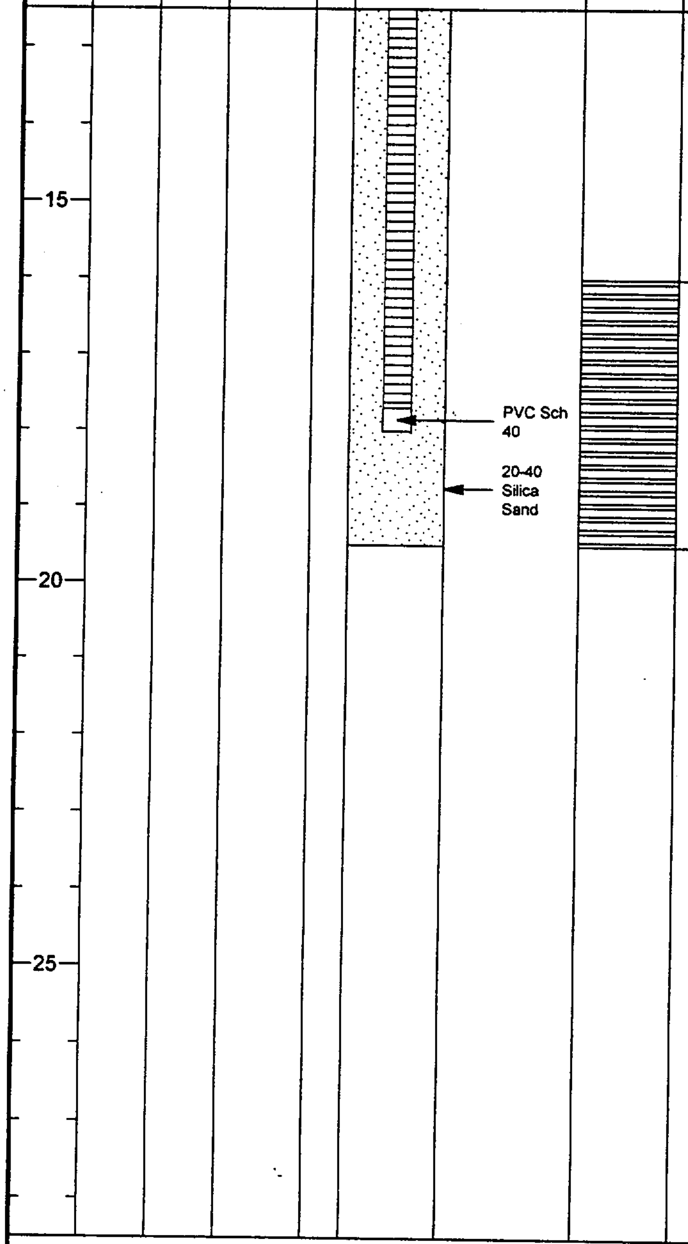
SITE GRAND JUNCTION

WELL NUMBER 1035

DATES DRILLED 9/3/98 to 9/4/98

Continued from Previous Page

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOWS COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION



DAKOTA SANDSTONE; Shale

Bottom of boring at 19.5 ft

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PAGE 2 OF 2 *1/28/99*

MONITORING WELL COMPLETION LOG GRJ01-CW21

PROJECT UMTRA GROUND WATER
LOCATION GRAND JUNCTION, CO
SITE GRAND JUNCTION
WELL NUMBER CW21

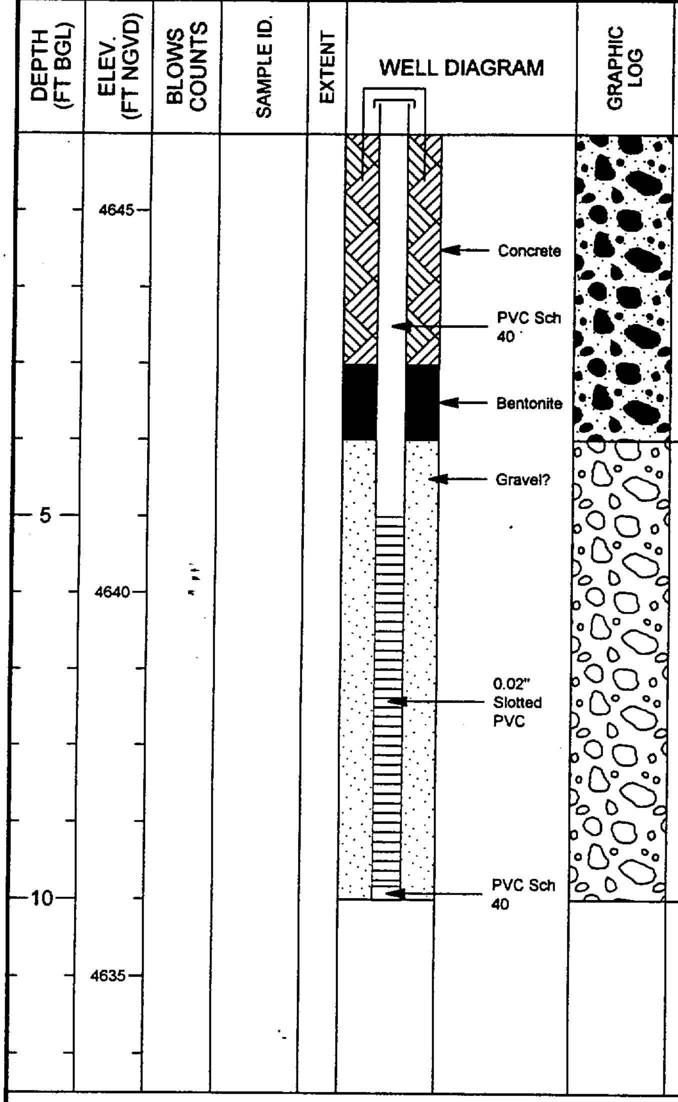
NORTH COORD. (FT) 467031.00
EAST COORD. (FT) 1170549.00
HOLE DEPTH (FT) 10.00
WELL DEPTH (FT) 10.00

DATE DRILLED 5/31/96
SURFACE ELEV. (FT NGVD) 4646.00
TOP OF CASING (FT) 4647.79
MEAS. PT. ELEV. (FT) 4647.79
SLOT SIZE (IN) 0.02
BIT SIZE(S) (IN) 4.8

	WELL INSTALLATION	INTERVAL (FT)		
SURFACE CASING:				
BLANK CASING:	2 in. PVC Sch 40	-1.8	to	5.0
WELL SCREEN:	2 in. Machine Slotted PVC	5.0	to	9.83
SUMP/END CAP:	2 in. PVC Sch 40	9.83	to	10.0
SURFACE SEAL:	Concrete	0.0	to	3.0
GROUT:				
SEAL:	Bentonite	3.0	to	4.0
UPPER PACK:				
LOWER PACK:	Gravel?	4.0	to	10.0

DRILLING METHOD
SAMPLING METHOD
DATE DEVELOPED
WATER LEVEL (FT BMP)
LOGGED BY
REMARKS Clifton water district well

DEPTH (FT BGL)	ELEV. (FT NGVD)	BLOWS COUNTS	SAMPLE ID.	EXTENT	WELL DIAGRAM	GRAPHIC LOG	LITHOLOGIC DESCRIPTION



Sandy gravel with cobbles, brown GWS

Sandy gravel with boulders and cobbles, hard drilling. GP

Bottom of boring at 10.0 ft

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PAGE 1 OF 1 1/28/99

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Appendix C

Monitoring Well Static Water Locations

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STATIC GROUND WATER LEVELS (USEE700) FOR SITE GRJ01, GRAND JUNCTION
REPORT DATE: 12/1/98 15:18:39 PM

LOCATION CODE	FLOW CODE	TOP OF CASING ELEVATION (FT NGVD)	MEASUREMENT		DEPTH FROM TOP OF CASING (FT)	GROUND WATER ELEVATION (FT NGVD)
			DATE	TIME		
0588	U	4570.33	01/17/83	12:00	5.58	4564.75
		4570.33	02/01/83	10:00	5.68	4564.65
		4570.33	02/22/83	16:30	5.68	4564.65
		4570.33	01/11/84	10:25	3.98	4566.35
		4570.33	05/05/85	12:00	-0.10	4570.43
		4570.33	05/17/85	13:41	1.13	4569.20
		4570.33	07/10/85	09:19	2.95	4567.38
		4570.33	09/04/85	15:00	4.09	4566.24
		4570.33	07/23/86	17:25	3.23	4567.10
		4570.33	03/06/89	09:15	4.05	4566.28
		4570.33	01/28/91	11:25	4.18	4566.15
		4570.33	08/27/91	14:04	3.98	4566.35
		4570.33	11/18/91	09:30	3.78	4566.55
		4570.33	02/20/92	11:00	3.82	4566.51
		4570.33	07/15/92	16:02	3.75	4566.58
		4570.33	10/09/92	12:03	4.18	4566.15
		4570.33	02/01/93	13:15	3.73	4566.60
		4570.33	12/07/93	14:23	3.95	4566.38
		4570.33	01/28/98		3.40	4566.93
		4570.33	06/29/98	9:33:	3.02	4567.31
0590	D	4566.69	01/16/83	12:00	8.80	4557.89
		4566.69	02/02/83	10:00	8.80	4557.89
		4566.69	02/22/83	16:52	8.70	4557.99
		4566.69	06/06/83	19:12	5.70	4560.99
		4566.69	06/07/83	08:46	5.60	4561.09
		4566.69	06/10/83	10:24	5.60	4561.09
		4566.69	09/22/83	10:52	9.00	4557.69
		4566.69	09/23/83	09:36	9.00	4557.69
		4566.69	01/11/84	08:55	8.60	4558.09
		4566.69	01/14/84	16:12	8.70	4557.99
		4566.69	03/25/85	13:50	8.21	4558.48
		4566.69	05/17/85	14:48	5.88	4560.81
		4566.69	07/10/85	11:05	7.65	4559.04
		4566.69	09/09/85	13:30	9.17	4557.52
		4566.69	07/24/86	11:30	8.13	4558.56

STATIC GROUND WATER LEVELS (USEE700) FOR SITE GRJ01, GRAND JUNCTION
REPORT DATE: 12/1/98 15:18:40 PM

LOCATION CODE	FLOW CODE	TOP OF CASING ELEVATION (FT NGVD)	MEASUREMENT DATE	MEASUREMENT TIME	DEPTH FROM TOP OF CASING (FT)	GROUND WATER ELEVATION (FT NGVD)
0590	D	4566.69	03/01/89	08:00	11.25	4555.44
		4566.69	08/02/89	13:46	9.38	4557.31
		4566.69	10/30/89	14:30	8.07	4558.62
		4566.69	08/27/91	08:12	11.19	4555.50
		4566.69	11/18/91	11:00	10.05	4556.64
		4566.69	02/22/92	13:35	10.00	4556.69
		4566.69	07/16/92	13:20	10.87	4555.82
		4566.69	10/07/92	09:50	11.25	4555.44
		4566.69	02/02/93	09:35	10.05	4556.64
		4566.69	06/27/93	09:37	8.23	4558.46
		4566.69	12/07/93	13:21	9.98	4556.71
		4566.69	06/22/94	12:56	10.07	4556.62
		4566.69	01/06/95	09:20	10.07	4556.62
		4566.69	06/03/95	14:42	9.02	4557.67
		4566.69	12/17/96		10.32	4556.37
		4566.69	01/28/98		10.29	4556.40
		4566.69	06/29/98	10:19	9.19	4557.50
0713	U	4611.92	09/23/77	12:00	2.42	4609.50
		4611.92	10/28/77	12:00	5.32	4606.60
		4611.92	11/11/77	12:00	3.22	4608.70
		4611.92	12/16/77	12:00	3.22	4608.70
		4611.92	01/11/78	12:00	3.72	4608.20
		4611.92	03/06/78	12:00	3.92	4608.00
		4611.92	04/11/78	12:00	4.32	4607.60
		4611.92	05/08/78	12:00	3.32	4608.60
		4611.92	07/17/78	12:00	2.82	4609.10
		4611.92	09/28/78	12:00	2.82	4609.10
		4611.92	02/05/79	12:00	3.22	4608.70
		4611.92	05/14/79	12:00	3.32	4608.60
		4611.92	07/19/79	12:00	3.12	4608.80
		4611.92	11/29/79	12:00	4611.92	-
		4611.92	05/29/80	12:00	4.92	4607.00
		4611.92	06/17/80	12:00	4.12	4607.80
		4611.92	08/05/80	12:00	3.62	4608.30
		4611.92	11/10/80	12:00	4.32	4607.60

STATIC GROUND WATER LEVELS (USEE700) FOR SITE GRJ01, GRAND JUNCTION
REPORT DATE: 12/1/98 15:18:40 PM

LOCATION CODE	FLOW CODE	TOP OF CASING ELEVATION (FT NGVD)	MEASUREMENT DATE	MEASUREMENT TIME	DEPTH FROM TOP OF CASING (FT)	GROUND WATER ELEVATION (FT NGVD)
0713	U	4611.92	03/12/81	12:00	4.92	4607.00
		4611.92	05/21/81	12:00	3.72	4608.20
		4611.92	01/27/98		6.77	4605.15
0715	U	4633.12	09/23/77	12:00	12.92	4620.20
		4633.12	10/28/77	12:00	14.62	4618.50
		4633.12	11/11/77	12:00	15.92	4617.20
		4633.12	12/16/77	12:00	16.12	4617.00
		4633.12	01/11/78	12:00	16.72	4616.40
		4633.12	03/06/78	12:00	17.32	4615.80
		4633.12	04/11/78	12:00	18.02	4615.10
		4633.12	05/08/78	12:00	17.52	4615.60
		4633.12	07/17/78	12:00	16.42	4616.70
		4633.12	09/28/78	12:00	16.32	4616.80
		4633.12	02/05/79	12:00	18.12	4615.00
		4633.12	04/18/79	12:00	18.12	4615.00
		4633.12	04/25/79	12:00	18.42	4614.70
		4633.12	05/02/79	12:00	17.12	4616.00
		4633.12	05/09/79	12:00	17.52	4615.60
		4633.12	05/11/79	12:00	18.12	4615.00
		4633.12	05/16/79	12:00	17.72	4615.40
		4633.12	05/23/79	12:00	17.72	4615.40
		4633.12	05/30/79	12:00	17.52	4615.60
		4633.12	06/06/79	12:00	17.22	4615.90
		4633.12	06/13/79	12:00	17.32	4615.80
		4633.12	06/20/79	12:00	17.32	4615.80
		4633.12	06/27/79	12:00	17.42	4615.70
		4633.12	07/03/79	12:00	17.52	4615.60
		4633.12	07/11/79	12:00	16.92	4616.20
		4633.12	07/18/79	12:00	16.92	4616.20
		4633.12	07/26/79	12:00	16.92	4616.20
		4633.12	08/01/79	12:00	17.02	4616.10
		4633.12	08/08/79	12:00	17.02	4616.10
		4633.12	08/14/79	12:00	16.92	4616.20
		4633.12	08/22/79	12:00	16.72	4616.40
		4633.12	08/29/79	12:00	16.62	4616.50

STATIC GROUND WATER LEVELS (USEE700) FOR SITE GRJ01, GRAND JUNCTION
REPORT DATE: 12/1/98 15:18:40 PM

LOCATION CODE	FLOW CODE	TOP OF CASING ELEVATION (FT NGVD)	MEASUREMENT DATE	MEASUREMENT TIME	DEPTH FROM TOP OF CASING (FT)	GROUND WATER ELEVATION (FT NGVD)
0715	U	4633.12	09/05/79	12:00	16.62	4616.50
		4633.12	09/12/79	12:00	16.62	4616.50
		4633.12	09/19/79	12:00	16.52	4616.60
		4633.12	09/26/79	12:00	16.62	4616.50
		4633.12	05/29/80	12:00	17.92	4615.20
		4633.12	06/17/80	12:00	20.02	4613.10
		4633.12	08/04/80	12:00	17.32	4615.80
		4633.12	11/10/80	12:00	17.22	4615.90
		4633.12	03/12/81	12:00	18.92	4614.20
		4633.12	04/08/81	12:00	18.72	4614.40
		4633.12	05/[illegible]/81	12:00	18.02	4615.10
		4633.12	06/[illegible]/81	12:00	17.72	4615.40
		4633.12	07/08/81	12:00	17.22	4615.90
		4633.12	08/05/81	12:00	16.82	4616.30
		4633.12	09/23/81	12:00	16.52	4616.60
		4633.12	01/06/82	12:00	17.62	4615.50
		4633.12	01/27/98		20.72	4612.40
0724	U	4565.75	03/30/85	15:05	12.25	4553.50
		4565.75	05/05/85	12:00	11.85	4553.90
		4565.75	05/17/85	14:44	11.92	4553.83
		4565.75	07/10/85	10:57	11.50	4554.25
		4565.75	09/13/85	08:20	12.25	4553.50
		4565.75	07/23/86	16:28	11.82	4553.93
		4565.75	03/04/89	12:00	12.33	4553.42
		4565.75	08/04/89	13:00	12.18	4553.57
		4565.75	10/29/89	14:46	12.06	4553.69
		4565.75	06/27/93	09:34	11.45	4554.30
		4565.75	12/07/93	13:25	11.81	4553.94
		4565.75	06/29/98	8:36:	12.57	4553.18
0726	U	4568.59	05/05/85	12:00	12.33	4556.26
		4568.59	05/17/85	14:53	12.26	4556.33
		4568.59	07/10/85	11:09	12.37	4556.22
		4568.59	07/23/86	11:00	12.61	4555.98
		4568.59	03/02/89	08:00	12.09	4556.50
		4568.59	10/31/89	09:32	12.99	4555.60

LOCATION CODE	FLOW CODE	TOP OF CASING ELEVATION (FT NGVD)	MEASUREMENT		DEPTH FROM TOP OF CASING (FT)	GROUND WATER ELEVATION (FT NGVD)
			DATE	TIME		
0726	U	4568.59	06/27/93	09:39	14.80	4553.79
		4568.59	12/07/93	13:17	14.91	4553.68
		4568.59	12/18/96		14.86	4553.73
		4568.59	06/26/98	9:25:	12.53	4556.06
0732	D	4566.69	03/25/85	10:15	13.06	4553.63
		4566.69	05/05/85	12:00	12.07	4554.62
		4566.69	05/17/85	15:15	12.27	4554.42
		4566.69	07/11/85	13:50	12.66	4554.03
		4566.69	09/06/85	09:53	12.97	4553.72
		4566.69	07/23/86	09:42	12.40	4554.29
		4566.69	01/02/97		19.79	4546.90
		4566.69	01/27/98		18.99	4547.70
		4566.69	06/22/98	3:16:	13.96	4552.73
0735	D	4565.73	03/30/85	08:06	29.29	4536.44
		4565.73	05/05/85	12:00	28.53	4537.20
		4565.73	05/17/85	15:00	21.29	4544.44
		4565.73	07/10/85	10:52	18.58	4547.15
		4565.73	09/16/85	10:05	7.30	4558.43
		4565.73	07/24/86	13:55	6.45	4559.28
		4565.73	03/03/89	08:45	5.77	4559.96
		4565.73	08/02/89	08:41	27.12	4538.61
		4565.73	10/29/89	08:30	31.98	4533.75
		4565.73	06/27/93	09:44	7.23	4558.50
		4565.73	12/07/93	13:55	7.29	4558.44
		4565.73	12/17/96		6.77	4558.96
		4565.73	06/17/98	9:40:	11.99	4553.74
0736	D	4565.90	03/22/85	15:15	6.99	4558.91
		4565.90	05/05/85	12:00	6.85	4559.05
		4565.90	05/17/85	15:01	6.37	4559.53
		4565.90	07/10/85	10:54	6.78	4559.12
		4565.90	09/10/85	11:20	7.54	4558.36
		4565.90	07/24/86	13:58	7.15	4558.75
		4565.90	02/28/89	13:45	6.70	4559.20
		4565.90	08/01/89	14:28	7.70	4558.20
		4565.90	10/29/89	10:45	8.35	4557.55

STATIC GROUND WATER LEVELS (USEE700) FOR SITE GRJ01, GRAND JUNCTION
REPORT DATE: 12/1/98 15:18:40 PM

LOCATION CODE	FLOW CODE	TOP OF CASING ELEVATION (FT NGVD)	MEASUREMENT DATE	MEASUREMENT TIME	DEPTH FROM TOP OF CASING (FT)	GROUND WATER ELEVATION (FT NGVD)
0736	D	4565.90	01/25/91	14:35	7.85	4558.05
		4565.90	08/27/91	09:50	7.84	4558.06
		4565.90	11/18/91	16:30	7.35	4558.55
		4565.90	02/22/92	12:25	7.35	4558.55
		4565.90	07/16/92	14:22	7.76	4558.14
		4565.90	10/07/92	16:08	8.22	4557.68
		4565.90	02/02/93	10:50	7.17	4558.73
		4565.90	06/27/93	09:45	6.78	4559.12
		4565.90	12/07/93	13:54	7.49	4558.41
		4565.90	06/22/94	09:40	7.67	4558.23
		4565.90	01/06/95	13:03	7.49	4558.41
		4565.90	06/03/95	13:37	7.07	4558.83
		4565.90	12/16/96		7.65	4558.25
		4565.90	06/17/98	11:14	7.89	4558.01
0740	D	4567.86	03/22/85	14:15	6.46	4561.40
		4567.86	05/05/85	12:00	6.11	4561.75
		4567.86	05/17/85	14:38	5.92	4561.94
		4567.86	07/10/85	10:47	6.60	4561.26
		4567.86	09/09/85	10:30	7.37	4560.49
		4567.86	07/23/86	15:50	6.86	4561.00
		4567.86	02/28/89	15:25	5.83	4562.03
		4567.86	01/27/91	14:02	6.85	4561.01
		4567.86	08/20/91	08:33	8.30	4559.56
		4567.86	11/17/91	15:00	7.55	4560.31
		4567.86	02/21/92	15:32	8.40	4559.46
		4567.86	07/16/92	09:45	8.31	4559.55
		4567.86	10/07/92	11:[illegible]	8.71	4559.15
		4567.86	02/02/93	12:30	7.25	4560.61
		4567.86	06/27/93	09:25	6.64	4561.22
		4567.86	12/07/93	13:48	7.32	4560.54
		4567.86	06/22/94	09:36	7.40	4560.46
		4567.86	01/06/95	16:22	7.35	4560.51
		4567.86	06/04/95	08:11	6.88	4560.98
		4567.86	12/17/96		7.45	4560.41
		4567.86	01/28/98		7.41	4560.45

LOCATION CODE	FLOW CODE	TOP OF CASING ELEVATION (FT NGVD)	MEASUREMENT DATE	MEASUREMENT TIME	DEPTH FROM TOP OF CASING (FT)	GROUND WATER ELEVATION (FT NGVD)
0740	D	4567.86	06/23/98	10:29	7.41	4560.45
0741	C	4574.02	03/26/85	15:27	6.71	4567.31
		4574.02	05/05/85	12:00	6.90	4567.12
		4574.02	05/17/85	14:04	7.01	4567.01
		4574.02	07/10/85	09:43	7.42	4566.60
		4574.02	09/13/85	12:20	7.38	4566.64
		4574.02	07/23/86	16:16	7.07	4566.95
		4574.02	03/03/89	12:45	5.69	4568.33
		4574.02	08/04/89	08:30	7.31	4566.71
		4574.02	10/31/89	11:58	6.88	4567.14
		4574.02	01/26/91	16:00	6.18	4567.84
		4574.02	08/28/91	14:00	7.83	4566.19
		4574.02	11/19/91	14:45	7.18	4566.84
		4574.02	02/21/92	10:18	7.93	4566.09
		4574.02	07/15/92	17:07	7.70	4566.32
		4574.02	10/09/92	13:45	8.22	4565.80
		4574.02	02/03/93	10:30	7.33	4566.69
		4574.02	06/27/93	09:04	7.27	4566.75
		4574.02	12/07/93	14:03	6.91	4567.11
		4574.02	12/19/96		6.72	4567.30
		4574.02	06/17/98	2:36:	7.87	4566.15
0742	C	4574.19	03/22/85	13:10	7.33	4566.86
		4574.19	05/05/85	12:00	6.72	4567.47
		4574.19	05/17/85	14:02	6.74	4567.45
		4574.19	07/10/85	09:45	7.23	4566.96
		4574.19	09/10/85	14:50	7.48	4566.71
		4574.19	07/23/86	16:18	6.91	4567.28
		4574.19	03/03/89	11:00	6.41	4567.78
		4574.19	01/26/91	14:42	7.41	4566.78
		4574.19	08/28/91	12:55	8.17	4566.02
		4574.19	11/19/91	11:15	7.56	4566.63
		4574.19	02/21/92	09:40	7.51	4566.68
		4574.19	07/15/92	18:42	7.74	4566.45
		4574.19	10/09/92	14:24	8.23	4565.96
		4574.19	02/03/93	11:50	7.51	4566.68

STATIC GROUND WATER LEVELS (USEE700) FOR SITE GRJ01, GRAND JUNCTION
REPORT DATE: 12/1/98 15:18:41 PM

LOCATION CODE	FLOW CODE	TOP OF CASING ELEVATION (FT NGVD)	MEASUREMENT DATE	MEASUREMENT TIME	DEPTH FROM TOP OF CASING (FT)	GROUND WATER ELEVATION (FT NGVD)
0742	C	4574.19	06/27/93	09:05	7.42	4566.77
		4574.19	12/07/93	14:01	7.90	4566.29
		4574.19	06/22/94	09:24	7.73	4566.46
		4574.19	01/05/95	15:55	7.82	4566.37
		4574.19	06/03/95	10:27	7.26	4566.93
		4574.19	12/19/96		7.79	4566.40
		4574.19	06/17/98	2:59:	8.03	4566.16
0743	U	4576.10	03/21/85	14:15	8.17	4567.93
		4576.10	05/06/85	15:30	4.69	4571.41
		4576.10	05/07/85	13:00	4.57	4571.53
		4576.10	05/08/85	07:30	4.53	4571.57
		4576.10	05/09/85	10:30	4.37	4571.73
		4576.10	05/17/85	13:33	5.28	4570.82
		4576.10	07/10/85	09:11	6.98	4569.12
		4576.10	09/10/85	15:30	8.21	4567.89
		4576.10	07/23/86	17:10	7.14	4568.96
		4576.10	03/05/89	14:50	9.18	4566.92
		4576.10	08/03/89	08:45	8.61	4567.49
		4576.10	10/31/89	14:51	8.81	4567.29
		4576.10	06/13/91	10:35	6.51	4569.59
		4576.10	08/28/91	09:50	8.93	4567.17
		4576.10	11/17/91	12:30	8.36	4567.74
		4576.10	02/19/92	14:30	8.74	4567.36
		4576.10	07/15/92	12:00	8.51	4567.59
		4576.10	10/09/92	10:27	8.78	4567.32
		4576.10	02/01/93	11:30	8.32	4567.78
		4576.10	06/27/93	08:55	5.92	4570.18
		4576.10	12/07/93	14:30	8.44	4567.66
		4576.10	12/16/96		8.26	4567.84
		4576.10	01/26/98		8.20	4567.90
		4576.10	06/29/98	12:35	7.88	4568.22
0744	U	4576.15	03/21/85	11:00	8.50	4567.65
		4576.15	05/06/85	15:30	4.13	4572.02
		4576.15	05/07/85	13:00	4.08	4572.07
		4576.15	05/08/85	07:30	4.08	4572.07

STATIC GROUND WATER LEVELS (USEE700) FOR SITE GRJ01, GRAND JUNCTION
REPORT DATE: 12/1/98 15:18:41 PM

LOCATION CODE	FLOW CODE	TOP OF CASING ELEVATION (FT NGVD)	MEASUREMENT DATE	MEASUREMENT TIME	DEPTH FROM TOP OF CASING (FT)	GROUND WATER ELEVATION (FT NGVD)
0744	U	4576.15	05/09/85	10:30	3.96	4572.19
		4576.15	05/17/85	13:36	5.37	4570.78
		4576.15	07/10/85	09:13	7.47	4568.68
		4576.15	09/04/85	08:00	8.87	4567.28
		4576.15	07/23/86	17:14	7.47	4568.68
		4576.15	03/05/89	14:15	9.08	4567.07
		4576.15	08/03/89	10:20	9.02	4567.13
		4576.15	10/31/89	15:50	9.37	4566.78
		4576.15	01/27/91	08:42	9.37	4566.78
		4576.15	08/27/91	12:40	9.33	4566.82
		4576.15	11/17/91	13:25	8.92	4567.23
		4576.15	02/19/92	13:30	9.23	4566.92
		4576.15	07/15/92	10:45	9.07	4567.08
		4576.15	10/09/92	09:48	9.42	4566.73
		4576.15	02/01/93	10:25	9.03	4567.12
		4576.15	06/27/93	08:53	5.97	4570.18
		4576.15	12/07/93	14:29	8.94	4567.21
		4576.15	01/10/95	14:23	9.16	4566.99
		4576.15	12/16/96		8.73	4567.42
		4576.15	01/26/98		8.63	4567.52
		4576.15	06/29/98	1:25:	8.08	4568.07
0745	U	4580.76	03/30/85	08:50	8.16	4572.60
		4580.76	05/05/85	12:00	6.90	4573.86
		4580.76	05/17/85	13:48	6.22	4574.54
		4580.76	07/10/85	09:28	7.28	4573.48
		4580.76	09/05/85	08:50	5.48	4575.28
		4580.76	07/23/86	17:00	7.17	4573.59
		4580.76	03/05/89	10:15	8.19	4572.57
		4580.76	08/03/89	11:18	8.58	4572.18
		4580.76	11/02/89	11:30	8.12	4572.64
		4580.76	01/28/91	09:55	8.65	4572.11
		4580.76	08/27/91	17:00	8.62	4572.14
		4580.76	11/17/91	11:00	8.25	4572.51
		4580.76	02/20/92	13:39	8.55	4572.21
		4580.76	07/15/92	14:25	8.22	4572.54

STATIC GROUND WATER LEVELS (USEE700) FOR SITE GRJ01, GRAND JUNCTION
REPORT DATE: 12/1/98 15:18:41 PM

LOCATION CODE	FLOW CODE	TOP OF CASING ELEVATION (FT NGVD)	MEASUREMENT DATE	MEASUREMENT TIME	DEPTH FROM TOP OF CASING (FT)	GROUND WATER ELEVATION (FT NGVD)
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		4580.76	02/02/93	13:37	8.25	4572.51
		4580.76	06/27/93	10:58	8.41	4572.35
		4580.76	12/07/93	14:14	8.65	4572.11
		4580.76	06/22/94	08:27	8.02	4572.74
		4580.76	01/05/95	10:10	8.95	4571.81
		4580.76	06/02/95	15:13	8.18	4572.58
		4580.76	12/16/96		8.45	4572.31
		4580.76	01/26/98		8.38	4572.38
		4580.76	06/17/98	3:07:	8.77	4571.99
0746	U	4587.85	03/22/85	09:20	11.35	4576.50
		4587.85	05/05/85	12:00	9.35	4578.50
		4587.85	05/17/85	13:52	10.50	4577.35
		4587.85	07/10/85	09:33	10.25	4577.60
		4587.85	09/05/85	14:30	10.20	4577.65
		4587.85	07/23/86	16:23	10.50	4577.35
		4587.85	03/05/89	08:00	11.28	4576.57
		4587.85	08/03/89	13:36	10.73	4577.12
		4587.85	11/01/89	09:26	10.73	4577.12
		4587.85	01/26/91	08:50	11.38	4576.47
		4587.85	08/28/91	11:13	11.08	4576.77
		4587.85	11/17/91	09:30	11.01	4576.84
		4587.85	02/21/92	11:48	11.45	4576.40
		4587.85	07/16/92	15:37	10.61	4577.24
		4587.85	10/07/92	13:49	11.14	4576.71
		4587.85	02/03/93	09:08	11.11	4576.74
		4587.85	06/27/93	11:19	10.71	4577.14
		4587.85	12/07/93	14:09	11.14	4576.71
		4587.85	06/22/94	08:45	10.84	4577.01
		4587.85	01/05/95	13:55	10.88	4576.97
		4587.85	06/02/95	16:33	10.29	4577.56
		4587.85	12/16/96		10.98	4576.87
		4587.85	01/26/98		11.30	4576.55
		4587.85	06/17/98	2:21:	11.33	4576.52
1000	O	4566.80	01/07/95	08:20	2.98	4563.82

STATIC GROUND WATER LEVELS (USEE700) FOR SITE GRJ01, GRAND JUNCTION
REPORT DATE: 12/1/98 15:18:41 PM

LOCATION CODE	FLOW CODE	TOP OF CASING ELEVATION (FT NGVD)	MEASUREMENT DATE	MEASUREMENT TIME	DEPTH FROM TOP OF CASING (FT)	GROUND WATER ELEVATION (FT NGVD)
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		4566.80	06/03/95	09:12	1.29	4565.51
		4566.80	12/17/96		3.23	4563.57
		4566.80	01/28/98		2.93	4563.87
		4566.80	06/25/98	10:00	4.44	4562.36
1001	O	4569.69	01/07/95	11:45	5.77	4563.92
		4569.69	06/03/95	16:03	3.93	4565.76
		4569.69	12/17/96		5.83	4563.86
		4569.69	06/24/98	10:20	7.30	4562.39
1002	O	4572.62	01/07/95	13:36	8.26	4564.36
		4572.62	01/08/95	11:05	8.41	4564.21
		4572.62	06/03/95	07:40	6.88	4565.74
		4572.62	06/05/95	08:42	6.18	4566.44
		4572.62	12/17/96		8.36	4564.26
		4572.62	06/24/98	3:11:	9.66	4562.96
1010		4570.05	01/28/98		15.57	4554.48
		4570.05	06/19/98	12:25	15.20	4554.85
1011		4567.67	01/28/98		8.72	4558.95
		4567.67	06/25/98	2:51:	7.34	4560.33
1012		4568.61	06/25/98	1:33:	6.41	4562.20
1013		4573.60	06/24/98	2:35:	10.65	4562.95
1014		4574.27	06/24/98	9:20:	9.52	4564.75
1015		4573.54	06/22/98	4:18:	7.17	4566.37
1016		4571.87	06/29/98	11:13	7.11	4564.76
1017		4572.72	06/22/98	10:35	5.71	4567.01
1018		4575.91	06/19/98	12:45	7.71	4568.20
1019		4580.99	06/19/98	11:49	6.67	4574.32
1020		4582.90	01/26/98		8.70	4574.20
		4582.90	06/22/98	9:19:	6.93	4575.97
1021		4586.42	01/26/98		6.35	4580.07
		4586.42	06/23/98	9:20:	4.32	4582.10
1022		4562.76	06/23/98	1:54:	5.23	4557.53

STATIC GROUND WATER LEVELS (USEE700) FOR SITE GRJ01, GRAND JUNCTION
REPORT DATE: 12/1/98 15:18:41 PM

LOCATION CODE	FLOW CODE	TOP OF CASING ELEVATION (FT NGVD)	MEASUREMENT DATE	MEASUREMENT TIME	DEPTH FROM TOP OF CASING (FT)	GROUND WATER ELEVATION (FT NGVD)
1023		4630.22	01/22/98		8.42	4621.80
		4630.22	06/18/98	9:45:	8.00	4622.22
1024		4640.21	01/22/98		9.35	4630.86
		4640.21	06/18/98	1:30:	5.65	4634.56
1025		4617.57	01/22/98		11.95	4605.62
		4617.57	06/18/98	8:28:	9.78	4607.79
1026		4593.83	01/23/98		8.32	4585.51
		4593.83	06/19/98	8:54:	7.17	4586.66
1027		4593.34	01/23/98		8.32	4585.02
		4593.34	06/19/98	10:06	7.06	4586.28
1028		4594.99	01/23/98		8.14	4586.85
		4594.99	06/18/98	3:13:	7.38	4587.61
1029		4558.55	01/27/98		8.73	4549.82
		4558.55	06/29/98	2:26:	7.99	4550.56
1030		4555.93	01/27/98		14.59	4541.34
		4555.93	06/22/98	10:58	12.97	4542.96

RECORDS: SELECTED FROM USEE700 WHERE site_code='GRJ01' AND location_code in('1035','1034','1030','1029','1028','1027','1026','1025','1024','1023','1022','1021','1020','1019','1018','1017','1016','1015','1014','1013','1012','1011','1010','1002','1001','1000','0746','0745','0744','0743','0742','0741','0740','0736','0735','0732','0726','0724','0715','0713','0590','0588')

FLOW CODES:
C CROSS GRADIENT
D DOWN GRADIENT
O ON-SITE
U UPGRADIENT

Appendix D

Calculation Set for Ground Water

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Calculation No.: U0043900

Technical Task Cover Sheet

Discipline Hydrogeology **Number of Sheets** ~~170~~ 169

Project:

UMTRA Ground Water Project

Site:

Grand Junction, Colorado Processing Site (GRJ-01)

Subject:

Hydraulic parameter calculation – based on aquifer pumping test data.

Sources of Data:

Field data from aquifer pumping tests in monitor wells 0590, 1002, 1013, 1018, 1034, and 1035.

Data analyzed using **AquiferTest** (Version 2.52) by Waterloo Hydrogeologic, Inc.

See references at end of this report.

Task Order No. **MAC99-05** **File Index No.** ________

Proj. No. UGW-511-0008-06-000 **Calc. No.** U0043900 **Supersedes Calc. No.** ________

Calculated by	Date	Checked by	Date	Approved by	Date	DOE Concurrence (if required)	Date
RJ Weydenburg	14 Jan 99	D. Metzler P. Hg 984	1/21 1999		1/24/99		

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U.S. Department of Energy Grand Junction Office

1.0 Introduction

The hydrogeology and hydraulic parameters of the alluvial aquifer at the Grand Junction processing site (GRJ-01) were further characterized for the final Site Observational Work Plan (SOWP). A series of new monitor wells were installed during September 1997 and September 1998 and hydraulic parameters were estimated from data collected during aquifer pumping tests and slug tests. Analyses of the aquifer pumping tests are shown in this calculation set and are incorporated into the SOWP. Slug test analyses are not included in this report because of the limited nature and extent of the tests.

2.0 Hydrogeologic Setting

The three main hydrogeologic units beneath the Grand Junction site include the unconfined alluvial aquifer, the underlying aquitard composed primarily of shale units in the Cretaceous Dakota Sandstone, and the confined aquifer in sandstones of the Dakota Sandstone. The alluvial aquifer is considered the uppermost aquifer at the site. Surface components of the hydrologic system in the area include the Colorado River south of the site and irrigation canals and ditches north of the site.

The alluvial aquifer is composed of unconsolidated clays, silts, sands, gravels, and cobbles. Ground water is present under unconfined conditions in the alluvial aquifer, with depth to ground water ranging from zero near the river to approximately 20 ft at the northern end of the site. The saturated thickness of the aquifer ranges from 5 to 20 ft. Ground water generally flows to the southwest towards the Colorado River at a horizontal hydraulic gradient of approximately 0.004. The alluvial aquifer is recharged by infiltration of precipitation directly on the site, leakage from upgradient irrigation canals and ditches in the area, and infiltration of river water during spring runoff in the Colorado River. Seasonal fluctuations in water levels beneath the site range from 2 to 5 ft in response to changes in river stage and infiltration. Limited amounts of recharge also occur as upward leakage of ground water from the underlying confined Dakota Sandstone aquifer. Ground water discharge is primarily limited to drainage into the river during low stage. Some discharge also occurs as evapotranspiration from vegetation growing in areas of shallow ground water depth near the Colorado River.

3.0 Procedures

3.1 Aquifer Pumping Tests

3.1.1 Field Procedures

Aquifer pumping and recovery tests were performed in selected monitor wells at the site to estimate the hydraulic conductivity in the alluvial aquifer. Single-well pumping tests were run in monitor wells 1013, 1015, 1017, 1019, and 746 during January and February 1998. Additional single well pumping tests were conducted in wells 590, 1001, 1018 during August 1998. Multiple-well pumping tests were run in monitor wells 1034 and 1035 during September 1998, with drawdown response and recovery of water levels measured in three adjacent observation wells (1002, 1013, and 1034/1035). All observation wells were within a 50-ft radius of the pumping wells. This calculation focuses on the multiple-well pumping tests in wells 1034 and 1035 since the most reliable data are obtained from drawdown and recovery in observation wells. Recovery data collected from the single-well tests in 0590 and 1018 appeared reasonable, so these tests are also included. All of the wells tested were drilled to the contact with the underlying Dakota Sandstone and were fully screened in the alluvial aquifer. Saturated thickness of the aquifer in the wells ranged from 6 to 9 ft. No formal step-drawdown tests performed, but preliminary tests were run to determine optimal pumping rates. During the tests, the wells were pumped at a constant rate as much as practicable. Locations of monitor wells used in the aquifer pumping tests are shown in Figure 1 and hydrogeologic cross sections are shown in Figure 2. Monitor well information is shown in Table 1.

The wells were pumped using an above ground suction lift pump with the end of the 2-inch diameter intake line in the bottom of each well pumped. The discharge line was fitted with a control valve (to control the pump discharge) immediately followed by a flow meter to monitor the flow rate (in gpm) during the pumping period. A pressure transducer was placed in each pumping and observation well to measure drawdown during the discharge phase of the pumping test and recovery of the water level after the pump was shut off. The transducer was connected to an In-Situ Inc. HERMIT datalogger at the surface, or was a self-contained TROLL datalogger in some of the wells. Water was discharged some distance away from the pumping well so the aquifer was not recharged during the test. The pumping tests were generally run for a period of 12 to 14 hours with the recovery measured until water levels had substantially returned to pre-test levels.

3.1.2 Analytical Methods

The hydraulic parameters of transmissivity (T) and hydraulic conductivity (K) were determined for the unconfined alluvial aquifer using drawdown data from the pumping phase of the test from observation wells adjacent to pumping wells 1034 and 1035, and recovery data from all pumping and observation wells. Drawdown data from the pumping wells are generally not reliable because of turbulent conditions in the well. Data analyses were completed using curve-matching techniques available through the **AquiferTest** software package (Röhrich and Waterloo Hydrogeologic, Inc., version 2.52). Field data from the aquifer pumping tests were converted into Microsoft® EXCEL files for input into **AquiferTest**. Observation well drawdown data were analyzed using the Theis method (Theis 1935) and the Cooper and Jacob time-drawdown method (Cooper and Jacob 1946). All data collected during the recovery phase of the tests were analyzed using the Theis and Jacob recovery method (Theis 1935). Standard assumptions for the methods of aquifer test calculations are available in the references and documentation in **AquiferTest**.

3.2 Slug Tests

Slug tests were performed in 13 monitor wells and hydraulic conductivity was estimated where possible (water levels in some of the wells recovered too rapidly for meaningful estimation). Slug tests provide only a rough approximation of hydraulic conductivity, and the values should be considered as order-of-magnitude estimates. Also, the area of influence of a slug test extends only a short distance from the borehole, and results should not be inferred to be valid at any distance away from the area of influence. Consequently, slug test estimates are not used in the evaluation because of their limited extent and also because of the more reliable estimates from the aquifer pumping test analyses. Hydraulic conductivity values from slug tests are summarized in Table 2 and calculations are on file in the Grand Junction Office.

4.0 Results

Many variables determine hydraulic conductivity values in an aquifer system, so the results are an approximation that provides a general idea of the characteristics of the alluvial aquifer. Results of aquifer pumping test calculations (estimations) of hydraulic parameters are summarized in Table 2 with detailed results in Table 3.

4.1 Pumping Well 1034

The aquifer pumping test in monitor well 1034 was started at 1030 on 28 September 1998 and was run for 717 min (11.95 hr) at a constant rate of 4 gpm (Figure 3). The pump was off for about 7 min from 95-102 min. The water level recovered to within 0.2 ft during this time. When the pump was started again, the drawdown maintained a similar trend throughout the rest of the test. There was a slight increase in drawdown at about 530 min into the test that possibly represented a boundary condition or a change in lithologic character. The maximum drawdown during the test was about 4 ft with a water column in the well of about 10 ft. Estimated hydraulic conductivity from the recovery phase of the test was 202 ft/day.

The water level response in observation well 1002 was slow and steady during the pumping phase with a slow recovery after the pump was turned off. The maximum drawdown in 1002 during the test was about 0.32 ft. Estimated hydraulic conductivity ranged from 68 to 94 ft/day.

The water level in observation well 1013 responded rapidly during the pumping phase of the test with a maximum drawdown of about 0.40 during the test. Recovery was also relatively rapid. Estimated hydraulic conductivity ranged from 43 to 76 ft/day.

Since there was practically no response in observation well 1035 (maximum of 0.06 ft) these data were not used in the analyses.

4.2 Pumping Well 1035

The aquifer pumping test in monitor well 1035 was started at 1000 on 29 September 1998 and was run for 707 min (11.78 hr) at a variable rate (Figure 4). The initial discharge rate was 8 gpm for the first 257 minutes of the test, at which time the well pumped dry, and the rate was adjusted to 6 gpm. The discharge rate was somewhat irregular during the initial period of the test. The maximum drawdown during the early part of the test was about 8.5 ft with a water column in the well of about 10 ft. At the adjusted discharge rate later in the test, the maximum drawdown was less than 3 ft. Estimated hydraulic conductivity from the recovery phase of the test was 282 ft/day.

The water level response in observation well 1002 was slow and steady during the pumping phase with slow recovery. The maximum drawdown was about 0.13 ft. Estimated hydraulic conductivity ranged from 136 to 177 ft/day.

There was good water level response in observation well 1013 during the pumping phase with a maximum drawdown of 0.16 ft at both discharge rates. Estimated hydraulic conductivity ranged from 242 to 303 ft/day.

The water level in observation well 1034 also responded rapidly during the pumping phase with a maximum drawdown of 0.40 ft. The drawdown varied with the different discharge rates in the pumping well. Estimated hydraulic conductivity ranged from 88 to 286 ft/day.

4.3 Pumping Well 0590

The aquifer pumping test in monitor well 0590 was started at 0935 on 10 August 1998 and was run for 840 min at a constant rate of 30 gpm (Figure 5). In spite of the relatively high discharge rate the recovery was relatively slow. This indicates that the major source of water in the well was from the Colorado River, approximately 75 ft south of the well. The recovery period of the test represents a lower than expected hydraulic conductivity of 68 ft/day.

4.4 Pumping Well 1018

The aquifer pumping test in monitor well 1018 was started at 1335 on 11 August 1998 and was run for 820 min at a constant rate of 1 gpm (Figure 6). Recovery was relatively rapid in this well and the estimated hydraulic conductivity was 18 ft/day.

5.0 Conclusions

Data collected from aquifer pumping tests in alluvial aquifer wells in the west (0590), central (1034/1035), and east (1018) portions of the site indicate transmissivity ranging from 161 to 2434 ft^2/day. Hydraulic conductivity ranges from 18 to 304 ft/day based on saturated thickness in the alluvial aquifer ranging from 6 to 9 ft in the different wells. As expected, the values of hydraulic conductivity are variable across the site, even in the relative proximity of wells 1034 and 1035. Variation in these values is a result of several factors:

- Lateral and vertical lithologic changes typically found in an alluvial depositional environment -- including possible impact of old channels in the alluvium.
- Colorado River as a boundary condition -- particularly in the vicinity of 0590 (about 60 ft from the river).
- Well construction and screen type may cause variable well efficiency and response to pumping stress (e.g. screen type in 1035 has greater area of exposure to the aquifer than in 1034).

A general statement regarding "precision and bias" of methods used for calculation of aquifer parameters from aquifer pumping tests is quoted from ASTM D 5270 (ASTM 1994):

> *"It is generally not practicable to specify the precision of these test methods because the response of aquifer systems during aquifer tests is dependent upon ambient system stresses. No statement can be made about bias because no true reference values exist".*

6.0 References

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Bouwer, H. and H.C. Rice, 1976. A Slug Test for Determining Hydraulic Conductivity for Unconfined Aquifers with Completely or Partially Penetrating wells: Water Resources Research, v. 12, no. 3, p. 423-428.

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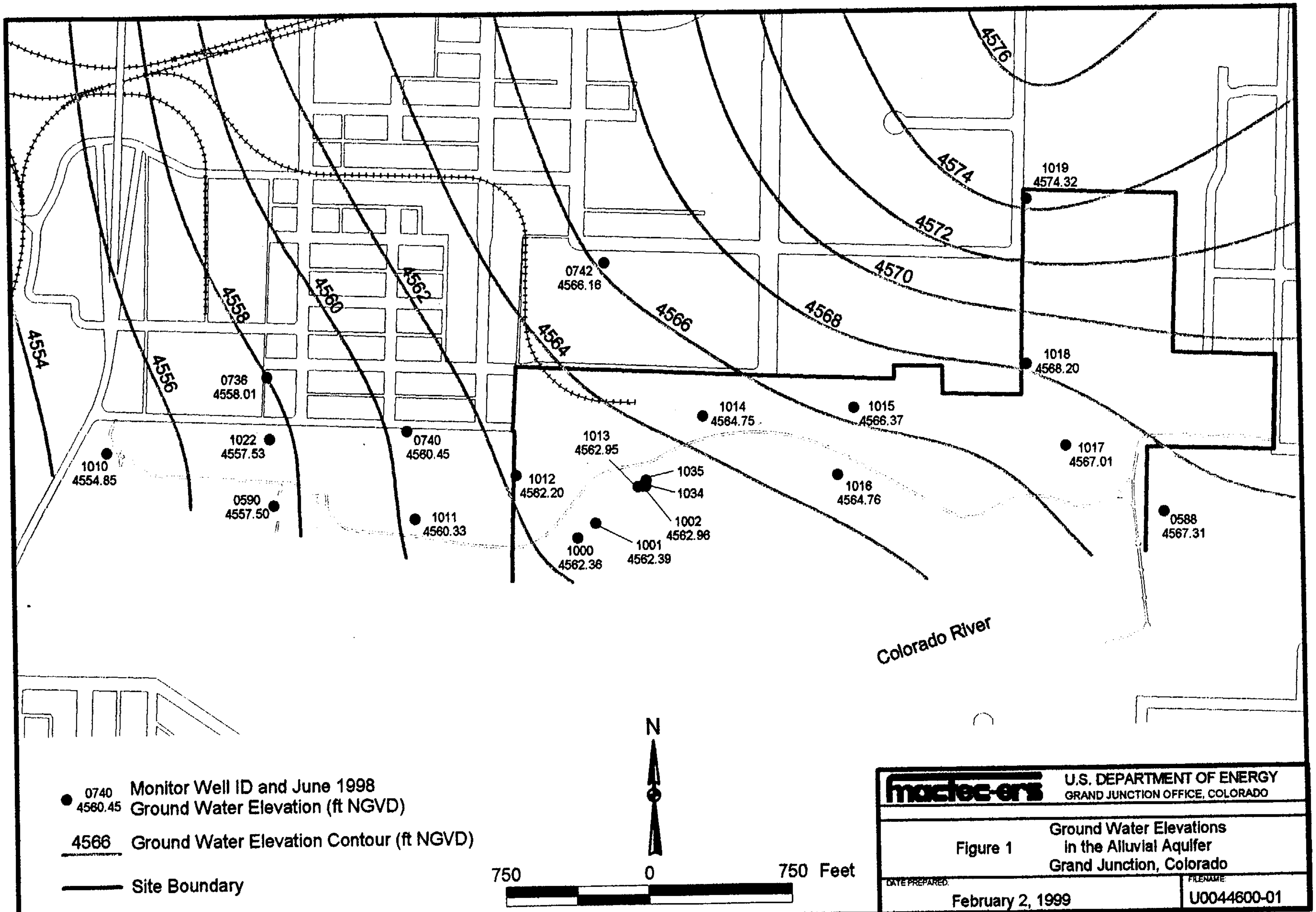
Kruseman, G.P., and N.A. de Ridder, 1990. *Analysis and Evaluation of Pumping Test Data*, Second Edition, ILRI Publication 47: International Institute for Land reclamation and Improvements, Wageningen, Netherlands, 377 p.

Lohman, S.W., 1970. *Ground-Water Hydraulics*: U.S. Geological Survey Professional Paper 708, 70 p.

Neuman, S.P., 1975. Analysis of Pumping Test Data from Anisotropic Unconfined Aquifers Considering Delayed Gravity Response: Water Resources Research, v. 11, no. 2, p. 329-342.

Röhrich, T. and Waterloo Hydrogeologic, Inc., no date. User's Manual for **AquiferTest** - Version 2.52.

Theis, C.V., 1936. The Relationship Between the Lowering of the Piezometric Surface and the Rate and Duration of Discharge of a Well Using Groundwater Storage: Trans. American Geophysical Union, v. 16, p. 519-524.



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U.S. DEPARTMENT OF ENERGY
GRAND JUNCTION OFFICE, COLORADO

Figure 1

Ground Water Elevations
in the Alluvial Aquifer
Grand Junction, Colorado

DATE PREPARED:
February 2, 1999

FILENAME:
U0044600-01

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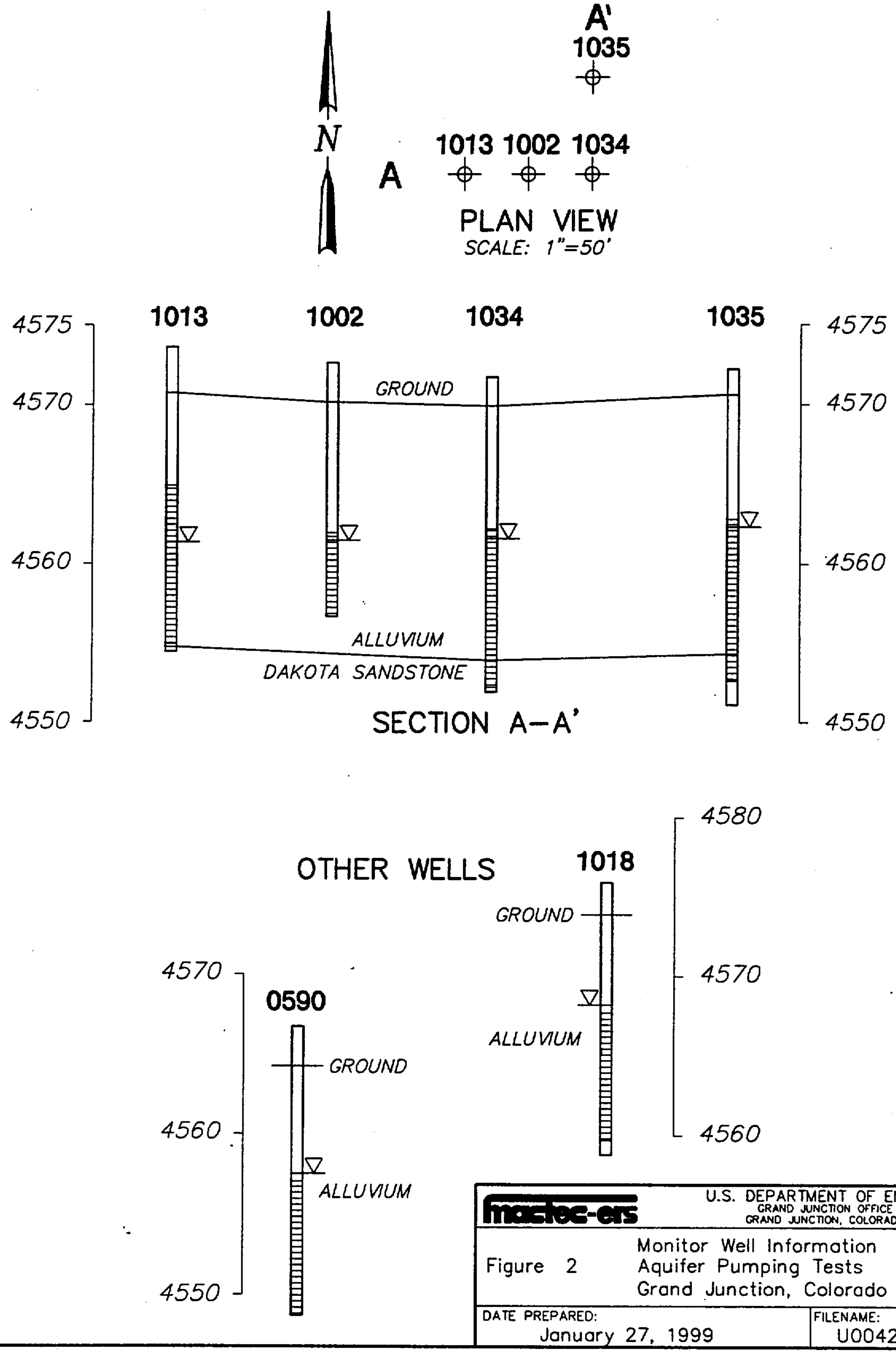

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U.S. DEPARTMENT OF ENERGY
GRAND JUNCTION OFFICE
GRAND JUNCTION, COLORADO

Figure 2

Monitor Well Information
Aquifer Pumping Tests
Grand Junction, Colorado

DATE PREPARED:	FILENAME:
January 27, 1999	U0042000

Figure 3

AQUIFER TEST DATA --- PUMPING WELL 1034 --- 09/28/98
GRAND JUNCTION, CO

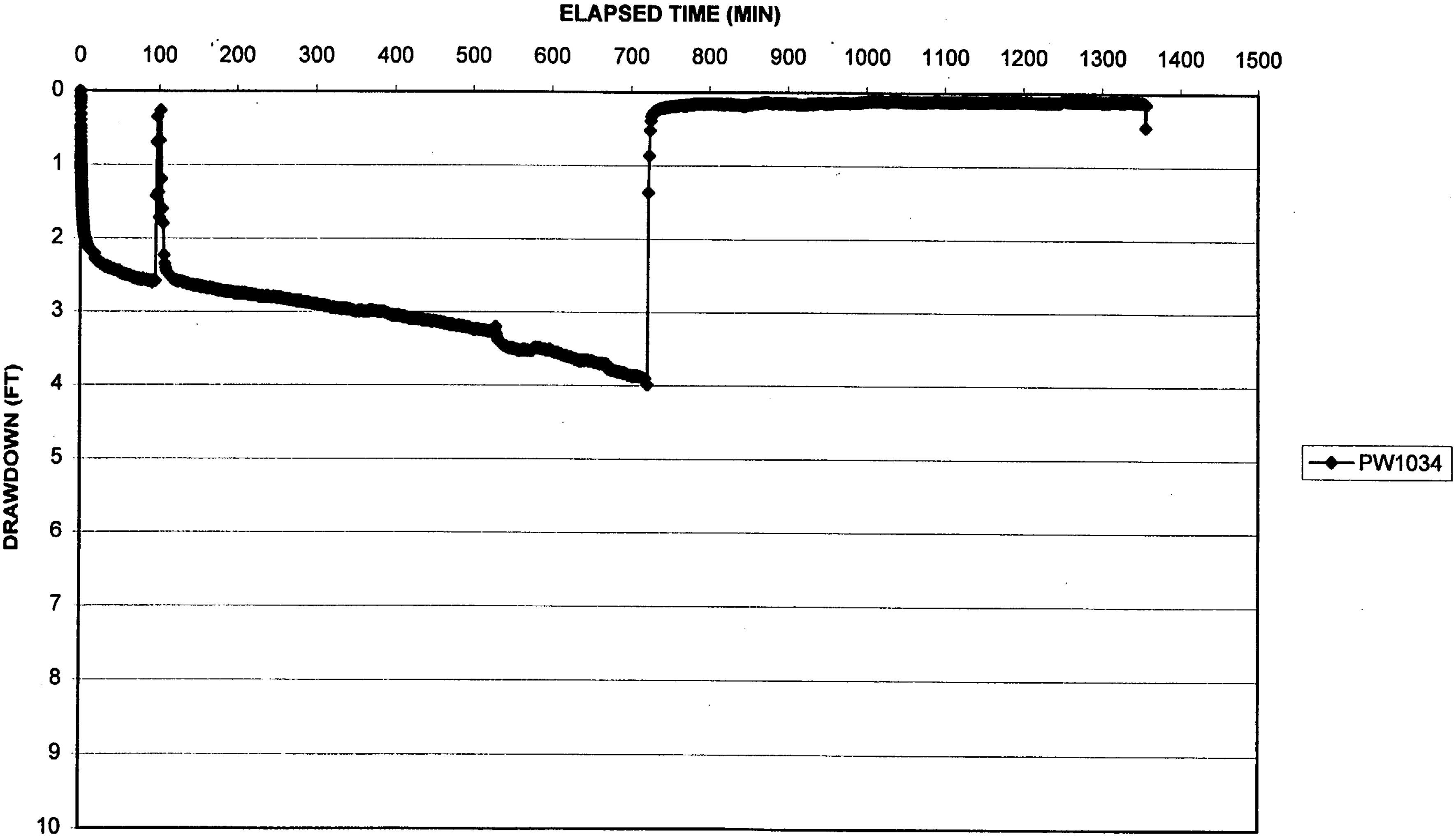
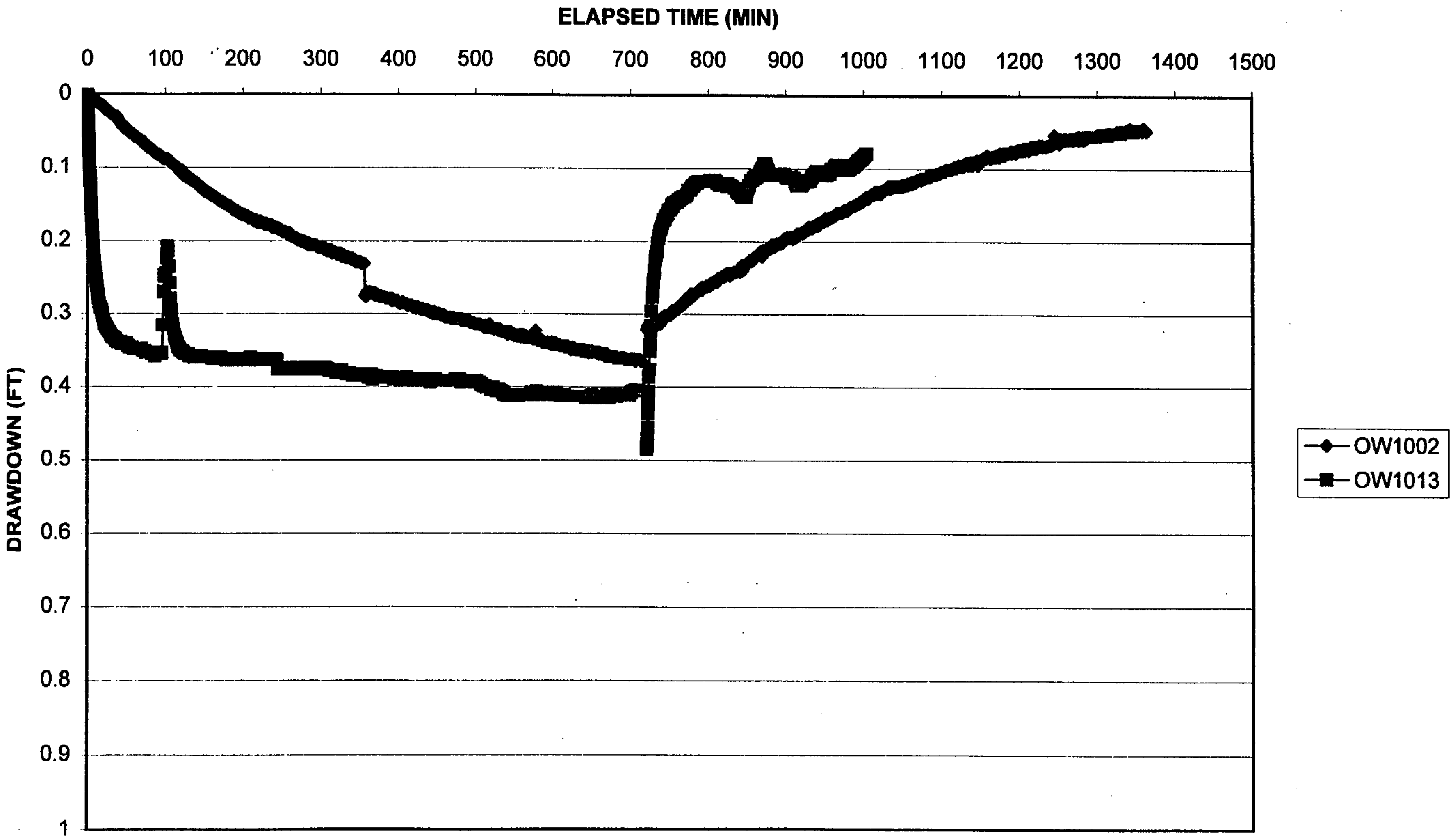


Figure 3 (cont)

AQUIFER TEST DATA --- PUMPING WELL 1034 --- 09/28/98
GRAND JUNCTION, CO



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14 january 1999

Figure 4

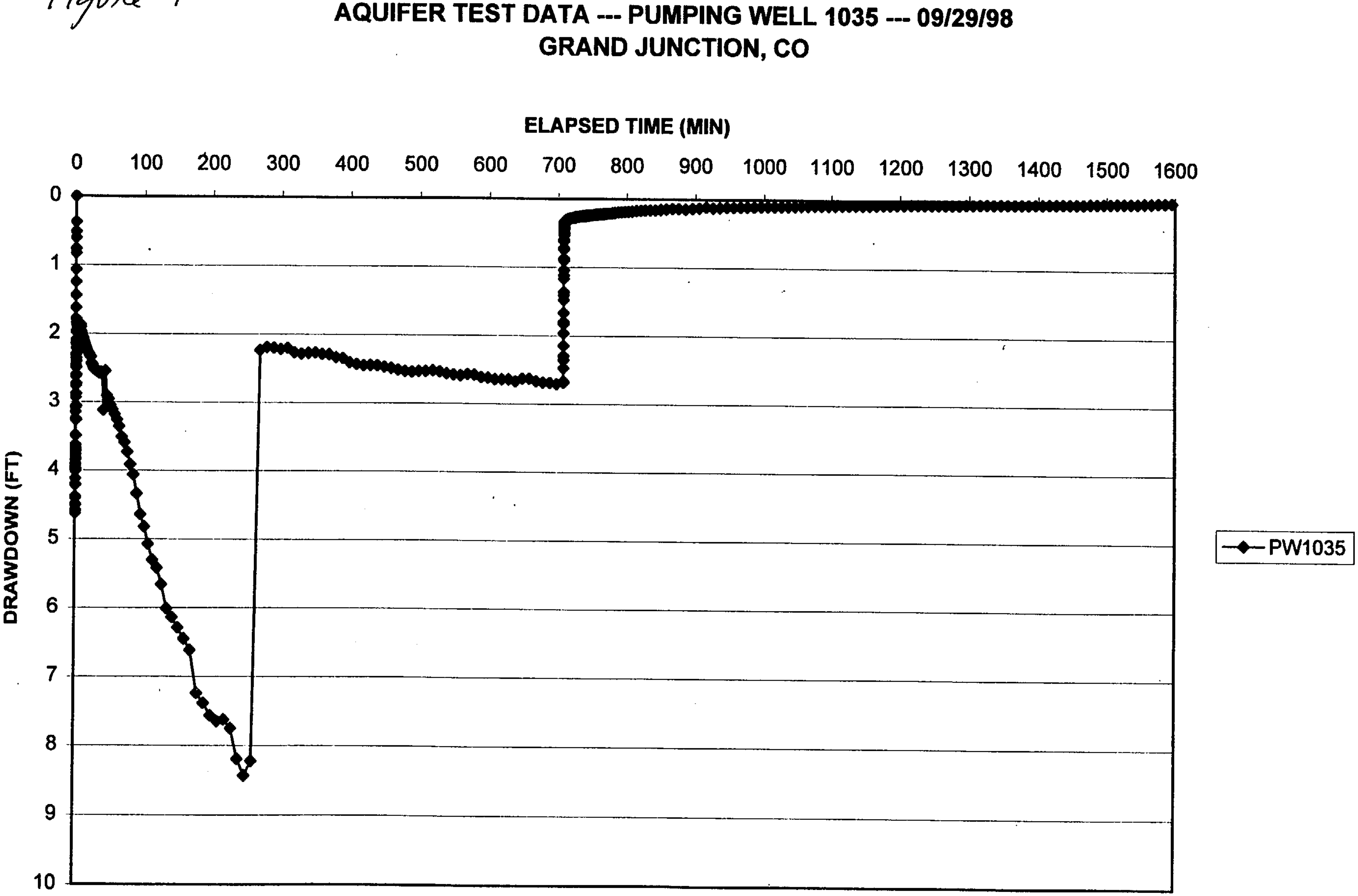

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Figure 4 (cont)

AQUIFER TEST DATA --- PUMPING WELL 1035 --- 09/29/98
GRAND JUNCTION, CO

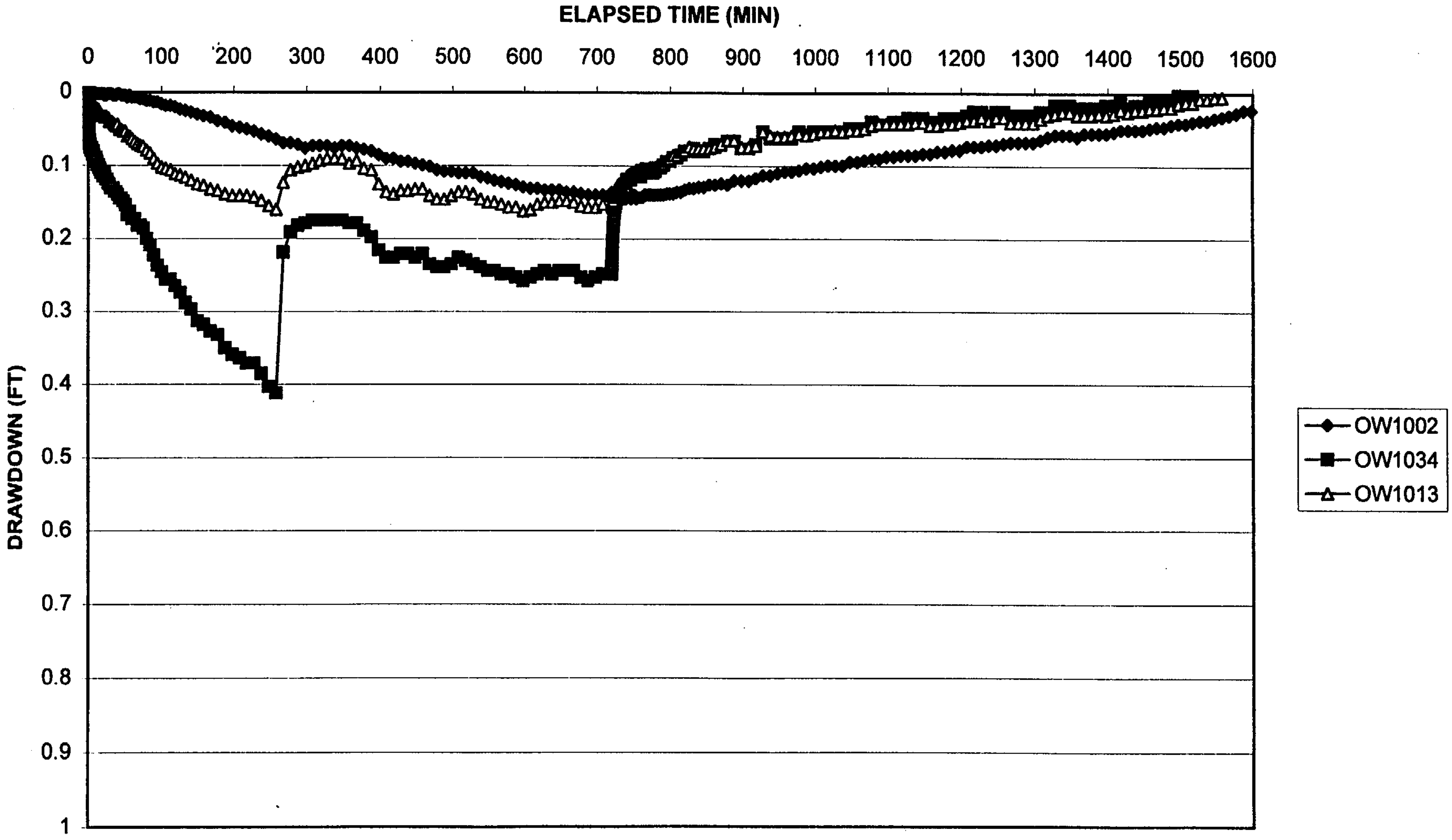

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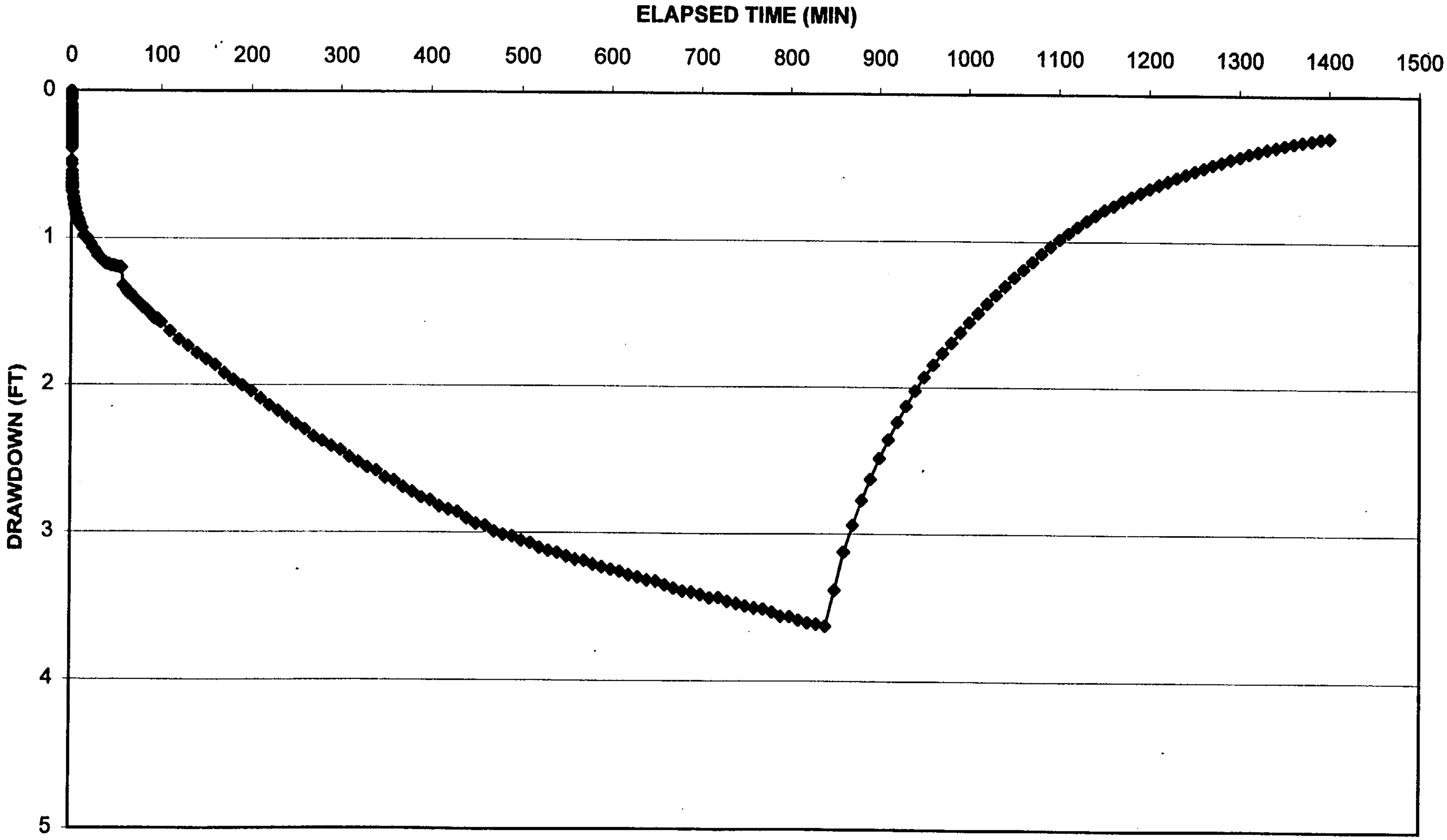
Figure 5

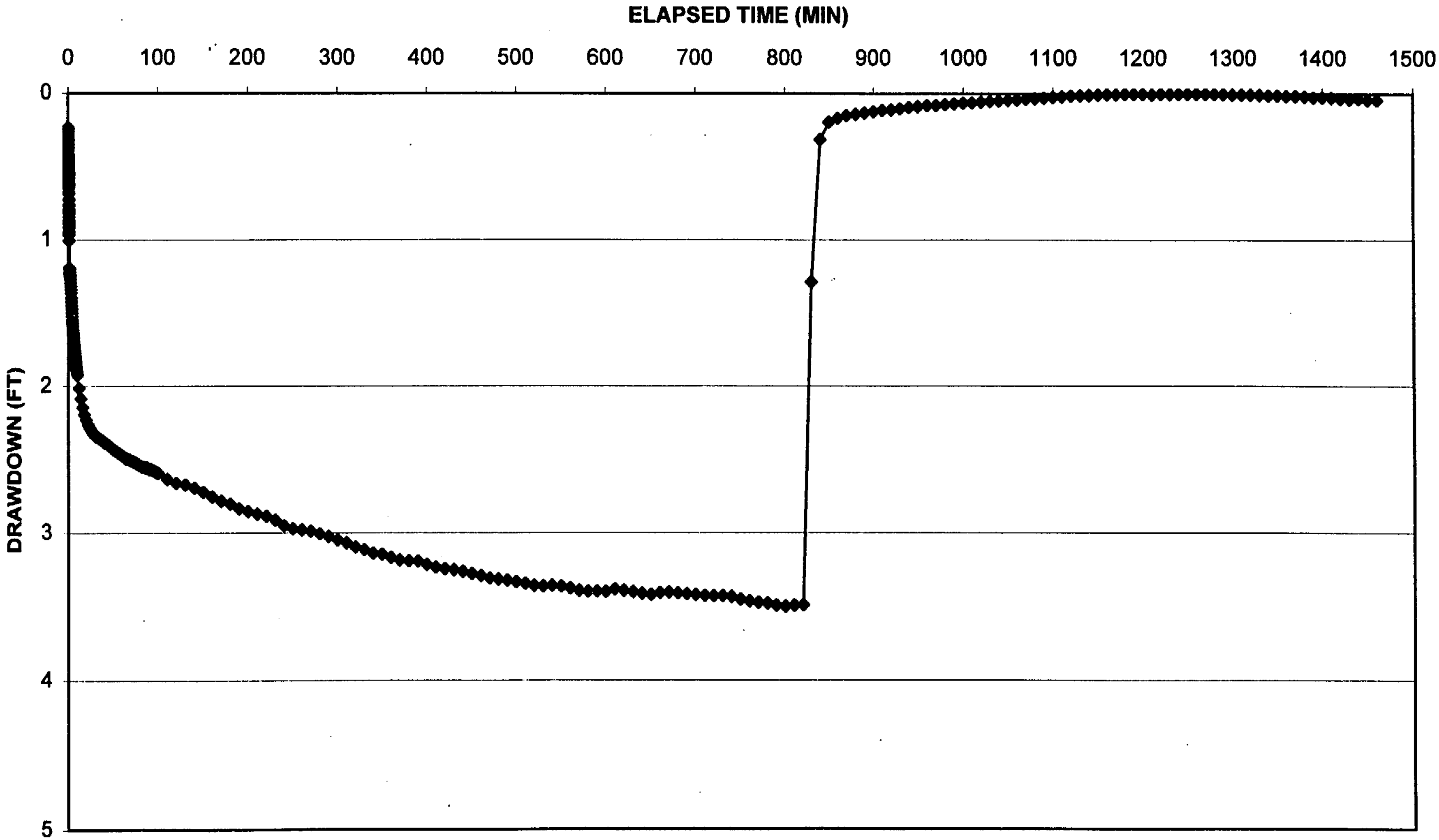
AQUIFER TEST DATA --- PUMPING WELL 0590 --- 08/10/98
GRAND JUNCTION, CO



590pt.xls.chart3
14 januar

Figure 6

AQUIFER TEST DATA --- PUMPING WELL 1018 --- 08/11/98
GRAND JUNCTION, CO



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14 january 1999

Table 1

Monitor Well Information
Grand Junction, CO

MW	Date	Grnd elev ft	TOC elev ft	Drlg meth	TD ft	BH R - ft	Casing r - ft	Scrn lngth ft	Scrn top/btm ft	Filter top/btm ft	Pntrn f/p	Aq Tkn ft	Sat Tkn b - ft	SWL ft - bgs	Wtr clmn
590	Jan-83	4564.22	4566.69	NA	15.5	0.55	0.17	8.3	7.2-15.5	3.3-15.5	f	~10	~6	6.72	~6
746	Mar-85	4585.84	4587.85	NA	24	0.50	0.17							9.32	
1001	Sep-94	4567.22	4569.69	HS	12	0.33	0.17	5	6.6-11.6	5.0-12.0	~f	~10	~6.5	4.83	~6.5
1002	Sep-94	4570.16	4572.62	HS	13.5	0.33	0.17	5	8.5-13.5	5.0-13.5	f	~10	~5.7 (6)	**8.67**	5.7
1013	Oct-97	4570.74	4573.60	HS	16.3	0.51	0.17	10	5.8-15.8	4.5-16.0	f	~10	8	**9.37**	8
1015	Nov-97	4571.77	4573.54	HS	16.7	0.55	0.17	8	8.4-16.4	5.8-16.7	~f	~10	10	5.40	10
1017	Nov-97	4570.45	4572.72	HS	13.3	0.55	0.17	5	7.7-12.7	4.0-12.4	p	~10	9.5	3.44	10
1018	Nov-97	4573.90	4575.91	HS	15.1	0.55	0.17	8	6.2-14.2	5.5-14.5	f	~10	9	5.70	9
1019	Nov-97	4582.97	4580.99	HS	27	0.55	0.17	20	6.7-26.7	4.8-27.0	~f	~20	20	4.71	21
1034	Sep-98	4569.90	4571.70	CA	18	0.39	0.17	10	7.7-17.7	5.7-18	f	~10	7.6 (8)	**8.31**	9.6
1035	Sep-98	4570.60	4572.20	CA	19.5	0.39	0.17	10	7.7-17.7	5.7-19.5	f	~10	7.7 (8)	**8.29**	9.8
1034	pumping well													Jun-98	
1034	observation well													**Sep-98**	
746	other single well tests														

MW	monitor well	TD	total depth	Aq Tkn	aquifer thickness
Grnd	ground	BH	borehole radius [R]	Sat Tkn	saturated thickness [b]
Elev	ft NGVD	Casing	casing radius [r]	SWL	static water level
TOC	top of PVC casing	Scrn	screen length	bgs	below ground surface
Drlg	drilling method	Filter	filter pack	Wtr	water column in well
NA	not available	Pntrn	penetration		
HS	hollow stem auger	f	full		
CA	casing advance	p	partial		

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Table 2

Summary of Hydraulic Parameters in the Alluvial Aquifer
Grand Junction, CO

Well	P/O/S	D/R	Q	t	b	T	K	Notes
			gpm	min	ft	ft^2/day	ft/day	
1034	P	R	4	717	8	1613	202	Factory slotted screen
1002	O	D			6	556	93	
1002	O	R			6	408	68	
1013	O	D			8	450	56	
1013	O	R			8	340	43	
1035	O	D			8	N/R	N/R	Response <1 ft
1035	P	R	8 to 6	707	8	2261	282	Continuous-wrapped V-wire screen
1002	O	D			6	942	157	
1002	O	R			6	969	161	
1013	O	D			8	1987	249	
1013	O	R			8	2434	304	
1034	O	D			8	1120	140	
1034	O	R			8	2290	287	
590	P	R	30	840	6	408	68	
1018	P	R	1	820	9	161	18	
1012	S						11	Onsite
1013	S						2	"
1014	S						2	"
1015	S						4	"
1016	S						2	"
1018	S						5	"
1019	S						1	"
1021	S						1	Background
1023	S						12	"
1025	S						4	"
1026	S						4	Resource Center
1027	S						3	"
1028	S						5	"
								P pumping well
								O observation well
								S slug test
								D discharge
								R recovery
								Q discharge rate
								t duration of test
								b saturated thickness
								T transmissivity
								K hydraulic conductivity
								N/R not reliable

Table 3

Hydraulic Parameters in the Alluvial Aquifer
Grand junction, CO

PW	OW	Date	Pntrn	Q	b	t	t'	P/R	Method	T	K	Notes
		start	f/p	gpm		min	t + min			ft^2/day	ft/day	
1034		9/28/98	f	4	8	717	~1400	P	Theis		N/R	Not reliable - turbulence in pumping well
								R	T/J	1612.80	201.60	
	1002				6			P	Theis	545.76	91.01	Slow response and slow recovery
								P	C/J	565.92	94.46	
								R	T/J	407.52	67.97	
	1013				8			P	Theis	433.44	54.14	Good response and quick recovery
								P	Hantush	306.72	38.30	
								P	C/J	610.56	76.32	
								R	T/J	339.84	42.62	
	1035				8			P	Theis		N/R	Not reliable - insignificant response (<0.1 ft)
								R	T/J		N/R	" "

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(Cont)

Hydraulic Paramete n the Alluvial Aquifer
Grand junction, CO

PW	OW	Date start	Pntrn f/p	Q gpm	b	t min	t' t + min	P/R	Method	T ft^2/day	K ft/day	Notes
1035		9/29/98	f	8 to 6	8	707	~1600	P	Theis		N/R	Not reliable - turbulence in pumping well
								R	T/J	2260.80	282.24	
	1002				6			P	Theis	817.92	136.37	
								P	C/J	1067.04	177.12	
								R	T/J	969.12	161.28	
	1013				8			P	Theis	2044.80	256.32	
								P	C/J	1929.60	241.92	
								R	T/J	2433.60	303.84	
	1034				8			P	Theis	1627.20	203.04	
								P	Hantush	1029.60	128.74	
								P	C/J	704.16	88.13	
								R	T/J	2289.60	286.56	

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13 jan 1999

Table 3 (cont)

Hydraulic Parameters in the Alluvial Aquifer
Grand junction, CO

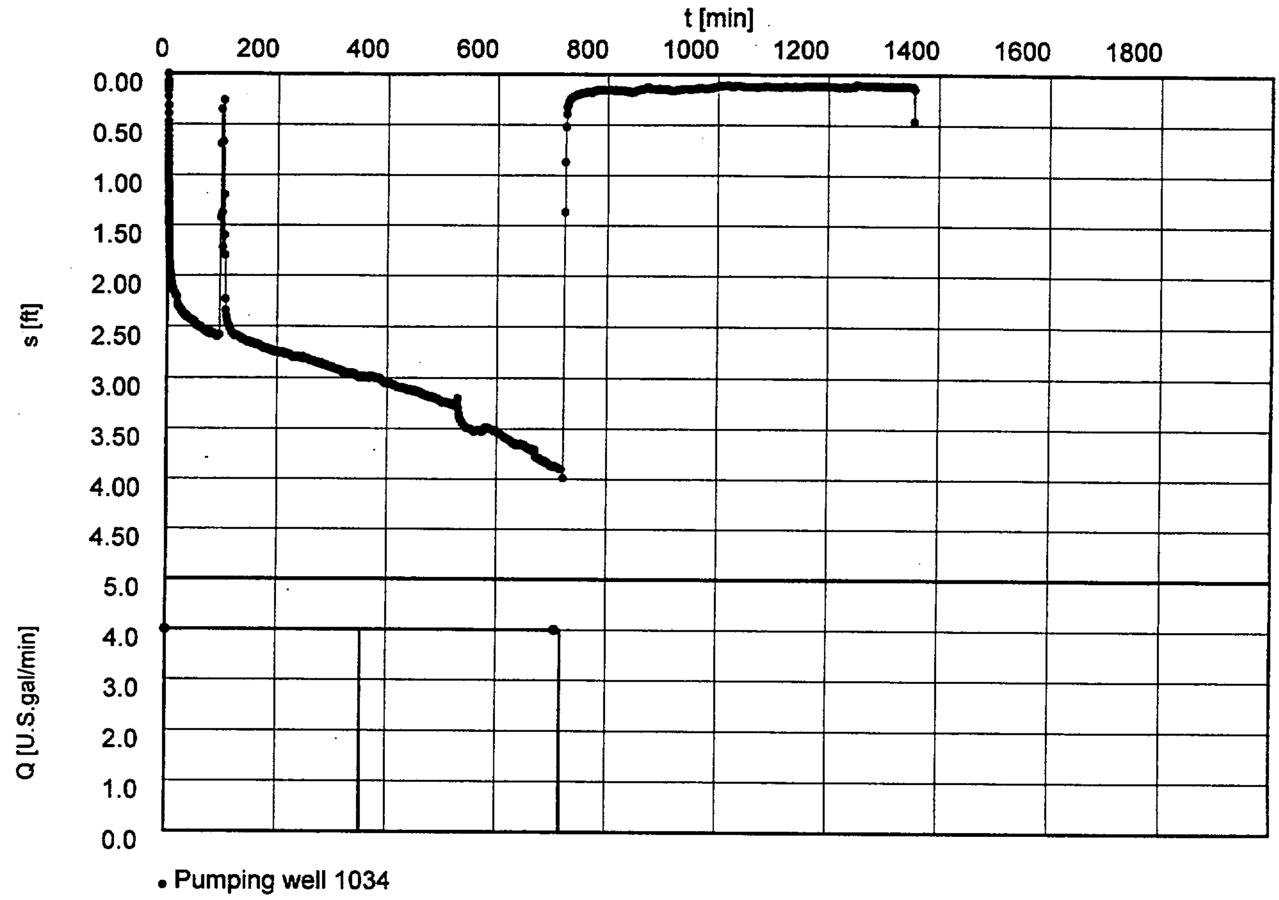
PW	OW	Date	Pntrn	Q	b	t	t'	P/R	Method	T	K	Notes
		start	f/p	gpm		min	t + min			ft²/day	ft/day	
590		8/10/98	f	30	6	840	~1400	P	Theis		N/R	Not reliable - turbulence in pumping well
								R	T/J	407.52	67.97	
1018		8/11/98	f	1	9	820	~30	P	Theis		N/R	Not reliable - turbulence in pumping well
								R	T/J	161.28	17.86	Quick recovery - data at 10 min intervals

PUMPING WELL 1034

RECOVERY DATA ANALYSES

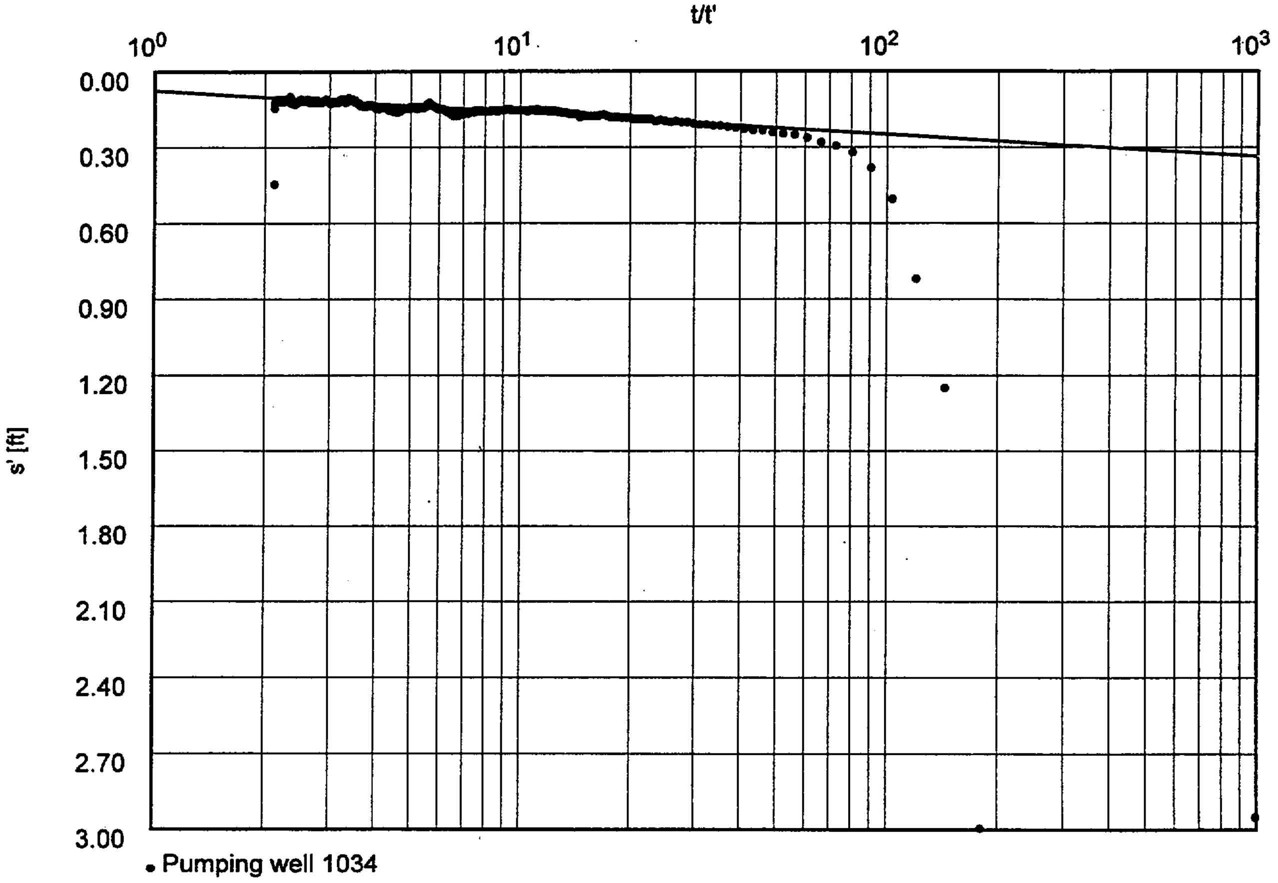
MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Time-Drawdown plot with discharge	1034PR2.HYT, Page 1 Project: UGW -- Grand Junction Evaluated by: RJH Date: 11/19/98

Pumping Test No. 1034 Recovery Test	Test conducted on: 09/28/98
Pumping Well 1034	
Discharge 4.00 U.S.gal/min	



MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1034PR2.HYT, Page 1 Project: UGW – Grand Junction Evaluated by: RJH Date: 11/19/98

Pumping Test No. 1034 Recovery Test	Test conducted on: 09/28/98
Pumping Well 1034	
Discharge 4.00 U.S.gal/min	
	Pumping test duration: 717.00 min



Transmissivity [ft²/min]: 1.12×10^0 1612.80 ft²/day

Hydraulic conductivity [ft/min]: 1.40×10^{-1} 201.60 ft/day

Aquifer thickness [ft]: 8.00

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1034PR2.HYT, Page 2 Project: UGW -- Grand Junction Evaluated by: RJH Date: 11/19/98

Pumping Test No. 1034 Recovery Test	Test conducted on: 09/28/98
Pumping Well 1034	Pumping well 1034
Discharge 4.00 U.S.gal/min	Distance from the pumping well 1.00 ft
Static water level: 10.20 ft below datum	Pumping test duration: 717.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
1	0.72	14.10	3.90	2.95
2	4.00	14.19	3.99	2.99
3	5.00	11.57	1.37	1.25
4	6.00	11.07	0.87	0.82
5	7.00	10.72	0.52	0.50
6	8.00	10.59	0.39	0.38
7	9.00	10.53	0.33	0.32
8	10.00	10.50	0.30	0.29
9	11.00	10.49	0.29	0.28
10	12.00	10.47	0.27	0.26
11	13.00	10.46	0.26	0.25
12	14.00	10.45	0.25	0.25
13	15.00	10.45	0.25	0.24
14	16.00	10.44	0.24	0.23
15	17.00	10.44	0.24	0.23
16	18.00	10.43	0.23	0.23
17	19.00	10.43	0.23	0.22
18	20.00	10.42	0.22	[illegible]
19	21.00	10.42	0.22	[illegible]
20	22.00	10.42	0.22	[illegible]
21	23.00	10.41	0.21	0.21
22	24.00	10.41	0.21	0.21
23	25.00	10.41	0.21	0.21
24	26.00	10.40	0.20	0.20
25	27.00	10.40	0.20	0.20
26	28.00	10.40	0.20	0.20
27	29.00	10.40	0.20	0.20
28	30.00	10.40	0.20	0.20
29	31.00	10.40	0.20	0.19
30	32.00	10.40	0.20	0.20
31	33.00	10.39	0.19	0.19
32	34.00	10.39	0.19	0.19
33	35.00	10.39	0.19	0.19
34	36.00	10.39	0.19	0.19
35	37.00	10.39	0.19	0.19
36	38.00	10.39	0.19	0.18
37	39.00	10.39	0.19	0.18
38	40.00	10.39	0.19	0.18
39	41.00	10.38	0.18	0.18
40	42.00	10.38	0.18	0.18
41	43.00	10.38	0.18	0.18
42	44.00	10.38	0.18	0.18
43	45.00	10.37	0.17	[illegible]
44	46.00	10.37	0.17	[illegible]
45	47.00	10.38	0.18	[illegible]
46	48.00	10.38	0.18	0.18
47	49.00	10.38	0.18	0.18
48	50.00	10.38	0.18	0.18
49	51.00	10.38	0.18	0.18
50	52.00	10.37	0.17	0.17

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1034PR2.HYT, Page 3 Project: UGW -- Grand Junction Evaluated by: RJH Date: 11/19/98

Pumping Test No. 1034 Recovery Test	Test conducted on: 09/28/98
Pumping Well 1034	Pumping well 1034
Discharge 4.00 U.S.gal/min	Distance from the pumping well 1.00 ft
Static water level: 10.20 ft below datum	Pumping test duration: 717.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
51	53.00	10.38	0.18	0.18
52	54.00	10.37	0.17	0.17
53	55.00	10.37	0.17	0.17
54	56.00	10.37	0.17	0.17
55	57.00	10.37	0.17	0.17
56	58.00	10.37	0.17	0.16
57	59.00	10.37	0.17	0.16
58	60.00	10.37	0.17	0.16
59	61.00	10.36	0.16	0.16
60	62.00	10.36	0.16	0.16
61	63.00	10.36	0.16	0.15
62	64.00	10.36	0.16	0.16
63	65.00	10.36	0.16	0.15
64	66.00	10.36	0.16	0.15
65	67.00	10.36	0.16	0.15
66	68.00	10.36	0.16	0.15
67	69.00	10.36	0.16	0.15
68	70.00	10.36	0.16	0.15
69	71.00	10.35	0.15	0.15
70	72.00	10.36	0.16	0.15
71	73.00	10.36	0.16	0.15
72	74.00	10.36	0.16	0.15
73	75.00	10.36	0.16	0.15
74	76.00	10.36	0.16	0.16
75	77.00	10.36	0.16	0.15
76	78.00	10.36	0.16	0.15
77	79.00	10.36	0.16	0.15
78	80.00	10.36	0.16	0.15
79	81.00	10.36	0.16	0.15
80	82.00	10.36	0.16	0.15
81	83.00	10.36	0.16	0.15
82	84.00	10.36	0.16	0.15
83	85.00	10.36	0.16	0.15
84	86.00	10.35	0.15	0.15
85	87.00	10.35	0.15	0.15
86	88.00	10.35	0.15	0.15
87	89.00	10.36	0.16	0.15
88	90.00	10.36	0.16	0.15
89	91.00	10.36	0.16	0.15
90	92.00	10.36	0.16	0.15
91	93.00	10.36	0.16	0.15
92	94.00	10.36	0.16	0.16
93	95.00	10.36	0.16	0.15
94	96.00	10.36	0.16	0.15
95	97.00	10.36	0.16	0.15
96	98.00	10.36	0.16	0.15
97	99.00	10.36	0.16	0.16
98	100.00	10.36	0.16	0.16
99	101.00	10.36	0.16	0.16
100	102.00	10.36	0.16	0.16

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1034PR2.HYT, Page 4 Project: UGW -- Grand Junction Evaluated by: RJH Date: 11/19/98

Pumping Test No. 1034 Recovery Test	Test conducted on: 09/28/98
Pumping Well 1034	Pumping well 1034
Discharge 4.00 U.S.gal/min	Distance from the pumping well 1.00 ft
Static water level: 10.20 ft below datum	Pumping test duration: 717.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
101	103.00	10.36	0.16	0.16
102	104.00	10.36	0.16	0.16
103	105.00	10.36	0.16	0.15
104	106.00	10.36	0.16	0.15
105	107.00	10.36	0.16	0.15
106	108.00	10.36	0.16	0.16
107	109.00	10.36	0.16	0.16
108	110.00	10.36	0.16	0.15
109	111.00	10.37	0.17	0.16
110	112.00	10.36	0.16	0.16
111	113.00	10.36	0.16	0.16
112	114.00	10.37	0.17	0.16
113	115.00	10.37	0.17	0.16
114	116.00	10.37	0.17	0.17
115	117.00	10.37	0.17	0.16
116	118.00	10.37	0.17	0.17
117	119.00	10.37	0.17	0.16
118	120.00	10.37	0.17	[illegible]
119	121.00	10.37	0.17	[illegible]
120	122.00	10.37	0.17	[illegible]
121	123.00	10.37	0.17	0.17
122	124.00	10.37	0.17	0.17
123	125.00	10.38	0.18	0.18
124	126.00	10.37	0.17	0.17
125	127.00	10.38	0.18	0.18
126	128.00	10.37	0.17	0.17
127	129.00	10.38	0.18	0.18
128	130.00	10.37	0.17	0.17
129	131.00	10.37	0.17	0.17
130	132.00	10.37	0.17	0.17
131	133.00	10.37	0.17	0.16
132	134.00	10.37	0.17	0.16
133	135.00	10.36	0.16	0.16
134	136.00	10.36	0.16	0.16
135	137.00	10.36	0.16	0.15
136	138.00	10.36	0.16	0.15
137	139.00	10.35	0.15	0.15
138	140.00	10.35	0.15	0.15
139	141.00	10.35	0.15	0.15
140	142.00	10.35	0.15	0.15
141	143.00	10.35	0.15	0.15
142	144.00	10.35	0.15	0.15
143	145.00	10.35	0.15	[illegible]
144	146.00	10.35	0.15	[illegible]
145	147.00	10.35	0.15	0.15
146	148.00	10.34	0.14	0.14
147	149.00	10.34	0.14	0.14
148	150.00	10.34	0.14	0.14
149	151.00	10.34	0.14	0.14
150	152.00	10.33	0.13	0.13

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1034PR2.HYT, Page 5 Project: UGW -- Grand Junction Evaluated by: RJH Date: 11/19/98

Pumping Test No. 1034 Recovery Test	Test conducted on: 09/28/98
Pumping Well 1034	Pumping well 1034
Discharge 4.00 U.S.gal/min	Distance from the pumping well 1.00 ft
Static water level: 10.20 ft below datum	Pumping test duration: 717.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
151	153.00	10.33	0.13	0.13
152	154.00	10.33	0.13	0.13
153	155.00	10.32	0.12	0.12
154	156.00	10.33	0.13	0.13
155	157.00	10.33	0.13	0.13
156	158.00	10.33	0.13	0.13
157	159.00	10.34	0.14	0.14
158	160.00	10.34	0.14	0.14
159	161.00	10.34	0.14	0.14
160	162.00	10.35	0.15	0.15
161	163.00	10.35	0.15	0.15
162	164.00	10.35	0.15	0.15
163	165.00	10.35	0.15	0.15
164	166.00	10.34	0.14	0.14
165	167.00	10.34	0.14	0.14
166	168.00	10.34	0.14	0.14
167	169.00	10.34	0.14	0.14
168	170.00	10.34	0.14	0.14
169	171.00	10.35	0.15	0.15
170	172.00	10.35	0.15	0.15
171	173.00	10.34	0.14	0.14
172	174.00	10.35	0.15	0.15
173	175.00	10.34	0.14	0.14
174	176.00	10.35	0.15	0.15
175	177.00	10.34	0.14	0.14
176	178.00	10.34	0.14	0.14
177	179.00	10.35	0.15	0.15
178	180.00	10.34	0.14	0.14
179	181.00	10.35	0.15	0.15
180	182.00	10.35	0.15	0.15
181	183.00	10.35	0.15	0.15
182	184.00	10.35	0.15	0.15
183	185.00	10.35	0.15	0.15
184	186.00	10.35	0.15	0.15
185	187.00	10.35	0.15	0.15
186	188.00	10.35	0.15	0.15
187	189.00	10.35	0.15	0.15
188	190.00	10.35	0.15	0.15
189	191.00	10.35	0.15	0.15
190	192.00	10.35	0.15	0.15
191	193.00	10.35	0.15	0.15
192	194.00	10.36	0.16	0.15
193	195.00	10.36	0.16	0.16
194	196.00	10.36	0.16	0.16
195	197.00	10.36	0.16	0.16
196	198.00	10.36	0.16	0.16
197	199.00	10.37	0.17	0.16
198	200.00	10.37	0.17	0.16
199	201.00	10.37	0.17	0.16
200	202.00	10.36	0.16	0.16

MACTEC-ERS
2597 B 3/4 Road
Grand Junction, CO 81503
970/248-6040

Pumping test analysis
Recovery method after
THEIS & JACOB
Unconfined aquifer

1034PR2.HYT, Page 6
Project: UGW -- Grand Junction
Evaluated by: RJH
Date: 11/19/98

Pumping Test No. 1034 Recovery Test
Test conducted on: 09/28/98
Pumping Well 1034
Pumping well 1034
Discharge 4.00 U.S.gal/min
Distance from the pumping well 1.00 ft
Static water level: 10.20 ft below datum
Pumping test duration: 717.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
201	203.00	10.36	0.16	0.16
202	204.00	10.36	0.16	0.16
203	205.00	10.36	0.16	0.16
204	206.00	10.36	0.16	0.16
205	207.00	10.36	0.16	0.16
206	208.00	10.35	0.15	0.15
207	209.00	10.36	0.16	0.15
208	210.00	10.35	0.15	0.15
209	211.00	10.35	0.15	0.15
210	212.00	10.35	0.15	0.15
211	213.00	10.35	0.15	0.15
212	214.00	10.36	0.16	0.15
213	215.00	10.35	0.15	0.15
214	216.00	10.35	0.15	0.15
215	217.00	10.35	0.15	0.15
216	218.00	10.35	0.15	0.15
217	219.00	10.35	0.15	0.15
218	220.00	10.34	0.14	[illegible]
219	221.00	10.35	0.15	[illegible]
220	222.00	10.34	0.14	0.14
221	223.00	10.34	0.14	0.14
222	224.00	10.34	0.14	0.14
223	225.00	10.34	0.14	0.14
224	226.00	10.34	0.14	0.14
225	227.00	10.34	0.14	0.14
226	228.00	10.35	0.15	0.15
227	229.00	10.34	0.14	0.14
228	230.00	10.35	0.15	0.15
229	231.00	10.35	0.15	0.15
230	232.00	10.35	0.15	0.15
231	233.00	10.35	0.15	0.15
232	234.00	10.35	0.15	0.15
233	235.00	10.35	0.15	0.15
234	236.00	10.35	0.15	0.15
235	237.00	10.34	0.14	0.14
236	238.00	10.34	0.14	0.14
237	239.00	10.35	0.15	0.15
238	240.00	10.34	0.14	0.14
239	241.00	10.34	0.14	0.14
240	242.00	10.34	0.14	0.14
241	243.00	10.34	0.14	0.14
242	244.00	10.34	0.14	0.14
243	245.00	10.34	0.14	[illegible]
244	246.00	10.34	0.14	[illegible]
245	247.00	10.33	0.13	0.13
246	248.00	10.33	0.13	0.13
247	249.00	10.34	0.14	0.14
248	250.00	10.33	0.13	0.13
249	251.00	10.34	0.14	0.14
250	252.00	10.33	0.13	0.13

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1034PR2.HYT, Page 7 Project: UGW – Grand Junction Evaluated by: RJH	Date: 11/19/98

Pumping Test No. 1034 Recovery Test	Test conducted on: 09/28/98
Pumping Well 1034	Pumping well 1034
Discharge 4.00 U.S.gal/min	Distance from the pumping well 1.00 ft
Static water level: 10.20 ft below datum	Pumping test duration: 717.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
251	253.00	10.33	0.13	0.13
252	254.00	10.33	0.13	0.13
253	255.00	10.33	0.13	0.13
254	256.00	10.34	0.14	0.14
255	257.00	10.34	0.14	0.14
256	258.00	10.34	0.14	0.14
257	259.00	10.34	0.14	0.14
258	260.00	10.34	0.14	0.14
259	261.00	10.34	0.14	0.14
260	262.00	10.34	0.14	0.14
261	263.00	10.34	0.14	0.14
262	264.00	10.34	0.14	0.14
263	265.00	10.34	0.14	0.14
264	266.00	10.34	0.14	0.14
265	267.00	10.34	0.14	0.14
266	268.00	10.34	0.14	0.14
267	269.00	10.34	0.14	0.14
268	270.00	10.33	0.13	0.13
269	271.00	10.34	0.14	0.14
270	272.00	10.33	0.13	0.13
271	273.00	10.33	0.13	0.13
272	274.00	10.33	0.13	0.13
273	275.00	10.33	0.13	0.13
274	276.00	10.32	0.12	0.12
275	277.00	10.33	0.13	0.13
276	278.00	10.33	0.13	0.13
277	279.00	10.32	0.12	0.12
278	280.00	10.32	0.12	0.12
279	281.00	10.32	0.12	0.12
280	282.00	10.32	0.12	0.12
281	283.00	10.32	0.12	0.12
282	284.00	10.31	0.11	0.11
283	285.00	10.32	0.12	0.12
284	286.00	10.31	0.11	0.11
285	287.00	10.31	0.11	0.11
286	288.00	10.32	0.12	0.12
287	289.00	10.31	0.11	0.11
288	290.00	10.31	0.11	0.11
289	291.00	10.31	0.11	0.11
290	292.00	10.31	0.11	0.11
291	293.00	10.31	0.11	0.11
292	294.00	10.31	0.11	0.11
293	295.00	10.31	0.11	0.11
294	296.00	10.31	0.11	0.11
295	297.00	10.31	0.11	0.11
296	298.00	10.31	0.11	0.11
297	299.00	10.31	0.11	0.11
298	300.00	10.31	0.11	0.11
299	301.00	10.30	0.10	0.10
300	302.00	10.31	0.11	0.11

Pumping Test No. 1034 Recovery Test	Test conducted on: 09/28/98
Pumping Well 1034	Pumping well 1034
Discharge 4.00 U.S.gal/min	Distance from the pumping well 1.00 ft
Static water level: 10.20 ft below datum	Pumping test duration: 717.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
301	303.00	10.31	0.11	0.11
302	304.00	10.31	0.11	0.11
303	305.00	10.31	0.11	0.11
304	306.00	10.32	0.12	0.12
305	307.00	10.32	0.12	0.12
306	308.00	10.32	0.12	0.12
307	309.00	10.32	0.12	0.12
308	310.00	10.32	0.12	0.12
309	311.00	10.32	0.12	0.12
310	312.00	10.32	0.12	0.12
311	313.00	10.31	0.11	0.11
312	314.00	10.31	0.11	0.11
313	315.00	10.31	0.11	0.11
314	316.00	10.31	0.11	0.11
315	317.00	10.31	0.11	0.11
316	318.00	10.31	0.11	0.11
317	319.00	10.31	0.11	0.11
318	320.00	10.31	0.11	[illegible]
319	321.00	10.31	0.11	
320	322.00	10.31	0.11	[illegible]
321	323.00	10.31	0.11	0.11
322	324.00	10.31	0.11	0.11
323	325.00	10.31	0.11	0.11
324	326.00	10.31	0.11	0.11
325	327.00	10.31	0.11	0.11
326	328.00	10.32	0.12	0.12
327	329.00	10.32	0.12	0.12
328	330.00	10.32	0.12	0.12
329	331.00	10.32	0.12	0.12
330	332.00	10.32	0.12	0.12
331	333.00	10.32	0.12	0.12
332	334.00	10.32	0.12	0.12
333	335.00	10.32	0.12	0.12
334	336.00	10.32	0.12	0.12
335	337.00	10.32	0.12	0.12
336	338.00	10.32	0.12	0.12
337	339.00	10.32	0.12	0.12
338	340.00	10.32	0.12	0.12
339	341.00	10.32	0.12	0.12
340	342.00	10.32	0.12	0.12
341	343.00	10.32	0.12	0.12
342	344.00	10.32	0.12	0.12
343	345.00	10.32	0.12	[illegible]
344	346.00	10.32	0.12	
345	347.00	10.32	0.12	0.12
346	348.00	10.32	0.12	0.12
347	349.00	10.32	0.12	0.12
348	350.00	10.32	0.12	0.12
349	351.00	10.32	0.12	0.12
350	352.00	10.33	0.13	0.13

MACTEC-ERS
2597 B 3/4 Road
Grand Junction, CO 81503
970/248-6040

Pumping test analysis
Recovery method after
THEIS & JACOB
Unconfined aquifer

1034PR2.HYT, Page 9
Project: UGW -- Grand Junction
Evaluated by: RJH
Date: 11/19/98

Pumping Test No. 1034 Recovery Test
Test conducted on: 09/28/98
Pumping Well 1034
Pumping well 1034
Discharge 4.00 U.S.gal/min
Distance from the pumping well 1.00 ft
Static water level: 10.20 ft below datum
Pumping test duration: 717.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
351	353.00	10.33	0.13	0.13
352	354.00	10.32	0.12	0.12
353	355.00	10.33	0.13	0.13
354	356.00	10.32	0.12	0.12
355	357.00	10.33	0.13	0.13
356	358.00	10.32	0.12	0.12
357	359.00	10.32	0.12	0.12
358	360.00	10.32	0.12	0.12
359	361.00	10.32	0.12	0.12
360	362.00	10.32	0.12	0.12
361	363.00	10.32	0.12	0.12
362	364.00	10.32	0.12	0.12
363	365.00	10.32	0.12	0.12
364	366.00	10.32	0.12	0.12
365	367.00	10.32	0.12	0.12
366	368.00	10.31	0.11	0.11
367	369.00	10.31	0.11	0.11
368	370.00	10.31	0.11	0.11
369	371.00	10.31	0.11	0.11
370	372.00	10.31	0.11	0.11
371	373.00	10.31	0.11	0.11
372	374.00	10.31	0.11	0.11
373	375.00	10.31	0.11	0.11
374	376.00	10.31	0.11	0.11
375	377.00	10.32	0.12	0.12
376	378.00	10.32	0.12	0.12
377	379.00	10.32	0.12	0.12
378	380.00	10.32	0.12	0.12
379	381.00	10.32	0.12	0.12
380	382.00	10.32	0.12	0.12
381	383.00	10.32	0.12	0.12
382	384.00	10.32	0.12	0.12
383	385.00	10.32	0.12	0.12
384	386.00	10.32	0.12	0.12
385	387.00	10.32	0.12	0.12
386	388.00	10.32	0.12	0.12
387	389.00	10.32	0.12	0.12
388	390.00	10.32	0.12	0.12
389	391.00	10.32	0.12	0.12
390	392.00	10.32	0.12	0.12
391	393.00	10.32	0.12	0.12
392	394.00	10.32	0.12	0.12
393	395.00	10.32	0.12	0.12
394	396.00	10.32	0.12	0.12
395	397.00	10.32	0.12	0.12
396	398.00	10.32	0.12	0.12
397	399.00	10.32	0.12	0.12
398	400.00	10.32	0.12	0.12
399	401.00	10.32	0.12	0.12
400	402.00	10.32	0.12	0.12

MACTEC-ERS
2597 B 3/4 Road
Grand Junction, CO 81503
970/248-6040

Pumping test analysis
Recovery method after
THEIS & JACOB
Unconfined aquifer

1034PR2.HYT, Page 10
Project: UGW – Grand Junction
Evaluated by: RJH
Date: 11/19/98

Pumping Test No. 1034 Recovery Test
Test conducted on: 09/28/98
Pumping Well 1034
Pumping well 1034
Discharge 4.00 U.S.gal/min
Distance from the pumping well 1.00 ft
Static water level: 10.20 ft below datum
Pumping test duration: 717.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
401	403.00	10.32	0.12	0.12
402	404.00	10.32	0.12	0.12
403	405.00	10.31	0.11	0.11
404	406.00	10.31	0.11	0.11
405	407.00	10.31	0.11	0.11
406	408.00	10.31	0.11	0.11
407	409.00	10.31	0.11	0.11
408	410.00	10.32	0.12	0.12
409	411.00	10.32	0.12	0.12
410	412.00	10.32	0.12	0.12
411	413.00	10.32	0.12	0.12
412	414.00	10.32	0.12	0.12
413	415.00	10.32	0.12	0.12
414	416.00	10.32	0.12	0.12
415	417.00	10.32	0.12	0.12
416	418.00	10.32	0.12	0.12
417	419.00	10.32	0.12	0.12
418	420.00	10.32	0.12	[illegible]
419	421.00	10.32	0.12	[illegible]
420	422.00	10.31	0.11	0.11
421	423.00	10.32	0.12	0.12
422	424.00	10.32	0.12	0.12
423	425.00	10.32	0.12	0.12
424	426.00	10.32	0.12	0.12
425	427.00	10.32	0.12	0.12
426	428.00	10.32	0.12	0.12
427	429.00	10.32	0.12	0.12
428	430.00	10.32	0.12	0.12
429	431.00	10.32	0.12	0.12
430	432.00	10.32	0.12	0.12
431	433.00	10.32	0.12	0.12
432	434.00	10.32	0.12	0.12
433	435.00	10.32	0.12	0.12
434	436.00	10.32	0.12	0.12
435	437.00	10.32	0.12	0.12
436	438.00	10.32	0.12	0.12
437	439.00	10.31	0.11	0.11
438	440.00	10.31	0.11	0.11
439	441.00	10.31	0.11	0.11
440	442.00	10.31	0.11	0.11
441	443.00	10.31	0.11	0.11
442	444.00	10.31	0.11	0.11
443	445.00	10.31	0.11	[illegible]
444	446.00	10.31	[illegible]	[illegible]
445	447.00	10.31	0.11	0.11
446	448.00	10.31	0.11	0.11
447	449.00	10.31	0.11	0.11
448	450.00	10.31	0.11	0.11
449	451.00	10.32	0.12	0.12
450	452.00	10.32	0.12	0.12

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1034PR2.HYT, Page 11 Project: UGW – Grand Junction Evaluated by: RJH Date: 11/19/98

Pumping Test No. 1034 Recovery Test	Test conducted on: 09/28/98
Pumping Well 1034	Pumping well 1034
Discharge 4.00 U.S.gal/min	Distance from the pumping well 1.00 ft
Static water level: 10.20 ft below datum	Pumping test duration: 717.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
451	453.00	10.31	0.11	0.11
452	454.00	10.32	0.12	0.12
453	455.00	10.31	0.11	0.11
454	456.00	10.31	0.11	0.11
455	457.00	10.31	0.11	0.11
456	458.00	10.31	0.11	0.11
457	459.00	10.31	0.11	0.11
458	460.00	10.32	0.12	0.12
459	461.00	10.31	0.11	0.11
460	462.00	10.32	0.12	0.12
461	463.00	10.32	0.12	0.12
462	464.00	10.31	0.11	0.11
463	465.00	10.32	0.12	0.12
464	466.00	10.32	0.12	0.12
465	467.00	10.31	0.11	0.11
466	468.00	10.31	0.11	0.11
467	469.00	10.32	0.12	0.12
468	470.00	10.31	0.11	0.11
469	471.00	10.31	0.11	0.11
470	472.00	10.32	0.12	0.12
471	473.00	10.31	0.11	0.11
472	474.00	10.31	0.11	0.11
473	475.00	10.31	0.11	0.11
474	476.00	10.31	0.11	0.11
475	477.00	10.31	0.11	0.11
476	478.00	10.31	0.11	0.11
477	479.00	10.32	0.12	0.12
478	480.00	10.31	0.11	0.11
479	481.00	10.32	0.12	0.12
480	482.00	10.32	0.12	0.12
481	483.00	10.32	0.12	0.12
482	484.00	10.32	0.12	0.12
483	485.00	10.31	0.11	0.11
484	486.00	10.32	0.12	0.12
485	487.00	10.32	0.12	0.12
486	488.00	10.32	0.12	0.12
487	489.00	10.32	0.12	0.12
488	490.00	10.32	0.12	0.12
489	491.00	10.32	0.12	0.12
490	492.00	10.32	0.12	0.12
491	493.00	10.32	0.12	0.12
492	494.00	10.32	0.12	0.12
493	495.00	10.32	0.12	0.12
494	496.00	10.32	0.12	0.12
495	497.00	10.32	0.12	0.12
496	498.00	10.32	0.12	0.12
497	499.00	10.33	0.13	0.13
498	500.00	10.33	0.13	0.13
499	501.00	10.33	0.13	0.13
500	502.00	10.33	0.13	0.13

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1034PR2.HYT, Page 12 Project: UGW -- Grand Junction Evaluated by: RJH Date: 11/19/98

Pumping Test No. 1034 Recovery Test	Test conducted on: 09/28/98
Pumping Well 1034	Pumping well 1034
Discharge 4.00 U.S.gal/min	Distance from the pumping well 1.00 ft
Static water level: 10.20 ft below datum	Pumping test duration: 717.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
501	503.00	10.33	0.13	0.13
502	504.00	10.33	0.13	0.13
503	505.00	10.33	0.13	0.13
504	506.00	10.33	0.13	0.13
505	507.00	10.33	0.13	0.13
506	508.00	10.33	0.13	0.13
507	509.00	10.32	0.12	0.12
508	510.00	10.33	0.13	0.13
509	511.00	10.33	0.13	0.13
510	512.00	10.33	0.13	0.13
511	513.00	10.33	0.13	0.13
512	514.00	10.32	0.12	0.12
513	515.00	10.32	0.12	0.12
514	516.00	10.32	0.12	0.12
515	517.00	10.33	0.13	0.13
516	518.00	10.33	0.13	0.13
517	519.00	10.33	0.13	0.13
518	520.00	10.33	0.13	[illegible]
519	521.00	10.33	0.13	[illegible]
520	522.00	10.33	0.13	0.13
521	523.00	10.33	0.13	0.13
522	524.00	10.32	0.12	0.12
523	525.00	10.32	0.12	0.12
524	526.00	10.33	0.13	0.13
525	527.00	10.33	0.13	0.13
526	528.00	10.33	0.13	0.13
527	529.00	10.33	0.13	0.13
528	530.00	10.32	0.12	0.12
529	531.00	10.32	0.12	0.12
530	532.00	10.31	0.11	0.11
531	533.00	10.30	0.10	0.10
532	534.00	10.30	0.10	0.10
533	535.00	10.30	0.10	0.10
534	536.00	10.30	0.10	0.10
535	537.00	10.30	0.10	0.10
536	538.00	10.30	0.10	0.10
537	539.00	10.30	0.10	0.10
538	540.00	10.31	0.11	0.11
539	541.00	10.31	0.11	0.11
540	542.00	10.31	0.11	0.11
541	543.00	10.31	0.11	0.11
542	544.00	10.31	0.11	0.11
543	545.00	10.31	0.11	[illegible]
544	546.00	10.31	0.11	[illegible]
545	547.00	10.31	0.11	0.11
546	548.00	10.31	0.11	0.11
547	549.00	10.31	0.11	0.11
548	550.00	10.31	0.11	0.11
549	551.00	10.31	0.11	0.11
550	552.00	10.31	0.11	0.11

MACTEC-ERS
2597 B 3/4 Road
Grand Junction, CO 81503
970/248-6040

Pumping test analysis
Recovery method after
THEIS & JACOB
Unconfined aquifer

Project: UGW -- Grand Junction

Evaluated by: RJH

Date: 11/19/98

Pumping Test No. 1034 Recovery Test	Test conducted on: 09/28/98
Pumping Well 1034	Pumping well 1034
Discharge 4.00 U.S.gal/min	Distance from the pumping well 1.00 ft
Static water level: 10.20 ft below datum	Pumping test duration: 717.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
551	553.00	10.32	0.12	0.12
552	554.00	10.31	0.11	0.11
553	555.00	10.31	0.11	0.11
554	556.00	10.32	0.12	0.12
555	557.00	10.31	0.11	0.11
556	558.00	10.31	0.11	0.11
557	559.00	10.31	0.11	0.11
558	560.00	10.31	0.11	0.11
559	561.00	10.31	0.11	0.11
560	562.00	10.31	0.11	0.11
561	563.00	10.31	0.11	0.11
562	564.00	10.31	0.11	0.11
563	565.00	10.31	0.11	0.11
564	566.00	10.31	0.11	0.11
565	567.00	10.31	0.11	0.11
566	568.00	10.32	0.12	0.12
567	569.00	10.31	0.11	0.11
568	570.00	10.31	0.11	0.11
569	571.00	10.32	0.12	0.12
570	572.00	10.32	0.12	0.12
571	573.00	10.31	0.11	0.11
572	574.00	10.32	0.12	0.12
573	575.00	10.32	0.12	0.12
574	576.00	10.32	0.12	0.12
575	577.00	10.32	0.12	0.12
576	578.00	10.32	0.12	0.12
577	579.00	10.32	0.12	0.12
578	580.00	10.31	0.11	0.11
579	581.00	10.32	0.12	0.12
580	582.00	10.32	0.12	0.12
581	583.00	10.32	0.12	0.12
582	584.00	10.32	0.12	0.12
583	585.00	10.32	0.12	0.12
584	586.00	10.32	0.12	0.12
585	587.00	10.32	0.12	0.12
586	588.00	10.32	0.12	0.12
587	589.00	10.32	0.12	0.12
588	590.00	10.32	0.12	0.12
589	591.00	10.32	0.12	0.12
590	592.00	10.32	0.12	0.12
591	593.00	10.32	0.12	0.12
592	594.00	10.32	0.12	0.12
593	595.00	10.31	0.11	0.11
594	596.00	10.31	0.11	0.11
595	597.00	10.32	0.12	0.12
596	598.00	10.32	0.12	0.12
597	599.00	10.31	0.11	0.11
598	600.00	10.32	0.12	0.12
599	601.00	10.31	0.11	0.11
600	602.00	10.32	0.12	0.12

MACTEC-ERS
2597 B 3/4 Road
Grand Junction, CO 81503
970/248-6040

Pumping test analysis
Recovery method after
THEIS & JACOB
Unconfined aquifer

1034PR2.HYT, Page 14
Project: UGW -- Grand Junction
Evaluated by: RJH
Date: 11/19/98

Pumping Test No. 1034 Recovery Test
Test conducted on: 09/28/98

Pumping Well 1034
Pumping well 1034

Discharge 4.00 U.S.gal/min
Distance from the pumping well 1.00 ft

Static water level: 10.20 ft below datum
Pumping test duration: 717.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
601	603.00	10.32	0.12	0.12
602	604.00	10.32	0.12	0.12
603	605.00	10.32	0.12	0.12
604	606.00	10.32	0.12	0.12
605	607.00	10.32	0.12	0.12
606	608.00	10.32	0.12	0.12
607	609.00	10.32	0.12	0.12
608	610.00	10.32	0.12	0.12
609	611.00	10.32	0.12	0.12
610	612.00	10.32	0.12	0.12
611	613.00	10.31	0.11	0.11
612	614.00	10.32	0.12	0.12
613	615.00	10.32	0.12	0.12
614	616.00	10.31	0.11	0.11
615	617.00	10.31	0.11	0.11
616	618.00	10.31	0.11	0.11
617	619.00	10.31	0.11	0.11
618	620.00	10.31	0.11	[illegible]
619	621.00	10.32	0.12	[illegible]
620	622.00	10.32	0.12	0.12
621	623.00	10.32	0.12	0.12
622	624.00	10.32	0.12	0.12
623	625.00	10.32	0.12	0.12
624	626.00	10.32	0.12	0.12
625	627.00	10.31	0.11	0.11
626	628.00	10.32	0.12	0.12
627	629.00	10.32	0.12	0.12
628	630.00	10.32	0.12	0.12
629	631.00	10.32	0.12	0.12
630	632.00	10.32	0.12	0.12
631	633.00	10.32	0.12	0.12
632	634.00	10.32	0.12	0.12
633	635.00	10.32	0.12	0.12
634	636.00	10.32	0.12	0.12
635	637.00	10.33	0.13	0.13
636	638.00	10.66	0.46	0.44
637	639.00	10.35	0.15	0.15

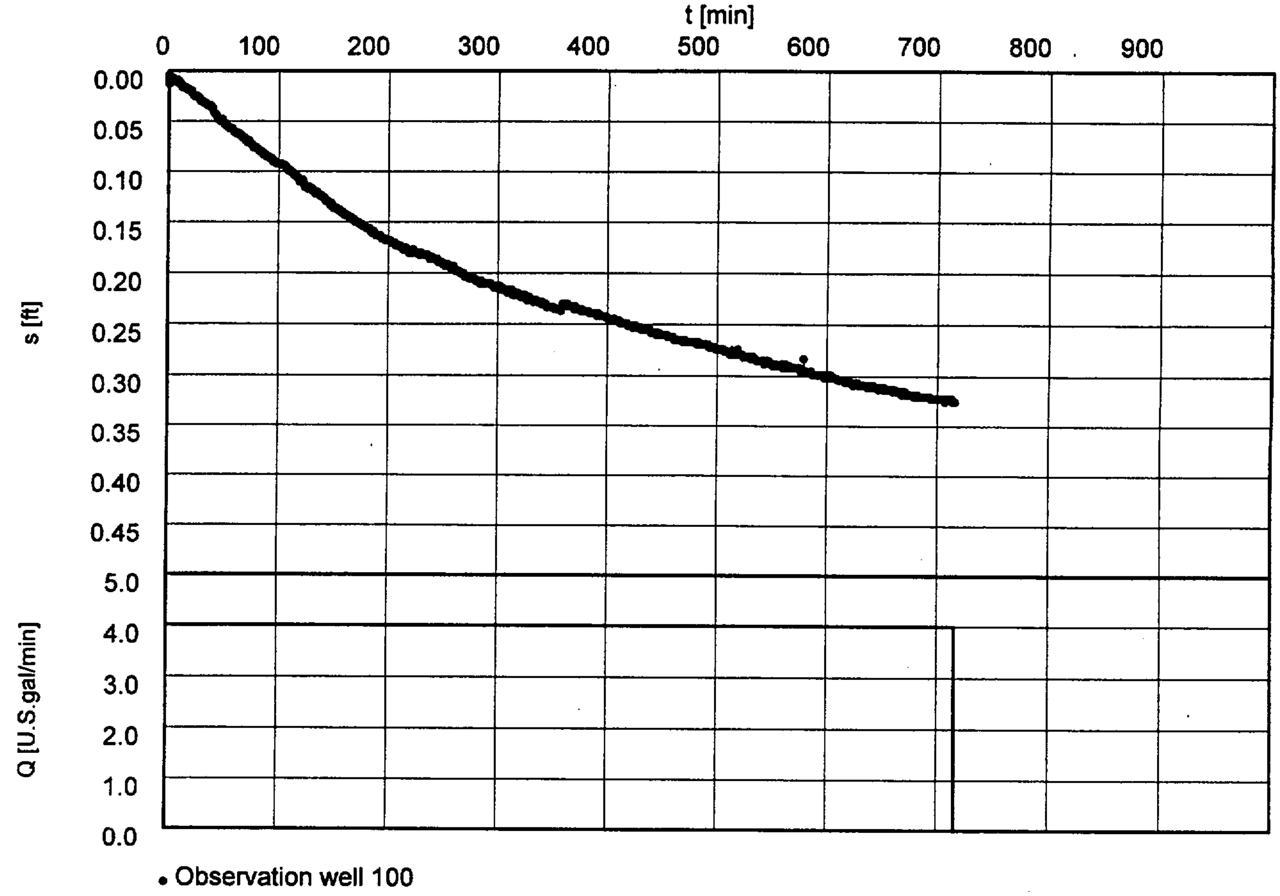
PUMPING WELL 1034

OBSERVATION WELL 1002

DRAWDOWN AND RECOVERY DATA ANALYSES

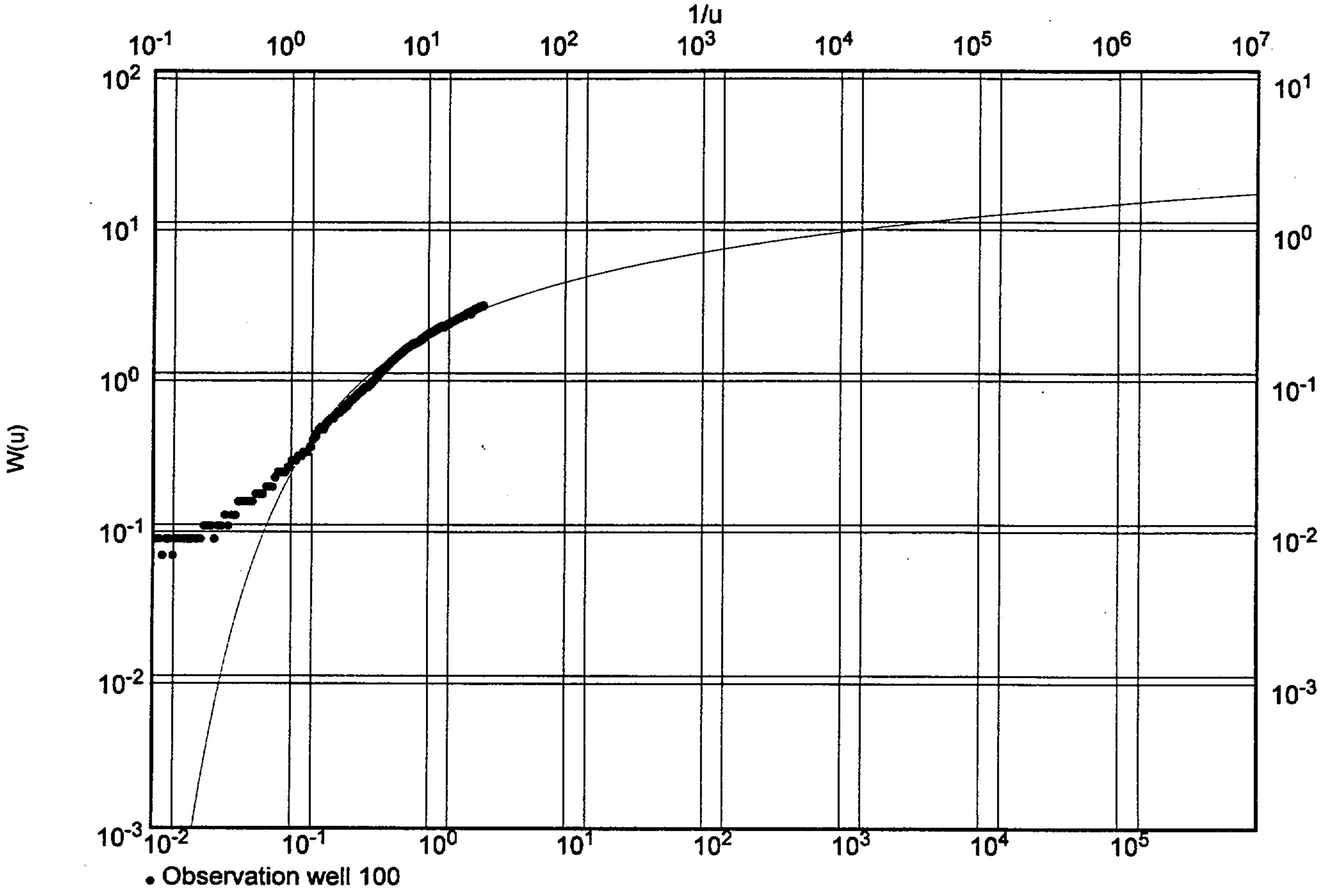
MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Time-Drawdown plot with discharge	1002OA2.HYT, Page 1 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/19/98

Pumping Test No. 1034 Aquifer Test	Test conducted on: 09/28/98
Observation Well 1002	
Discharge 4.00 U.S.gal/min	



MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Theis analysis method Unconfined aquifer	1002OA2.HYT, Page 1 Project: UGW -- Grand Junction, CO Evaluated by: RJH · Date: 11/19/98

Pumping Test No. 1034 Aquifer Test	Test conducted on: 09/28/98
Observation Well 1002	
Discharge 4.00 U.S.gal/min	



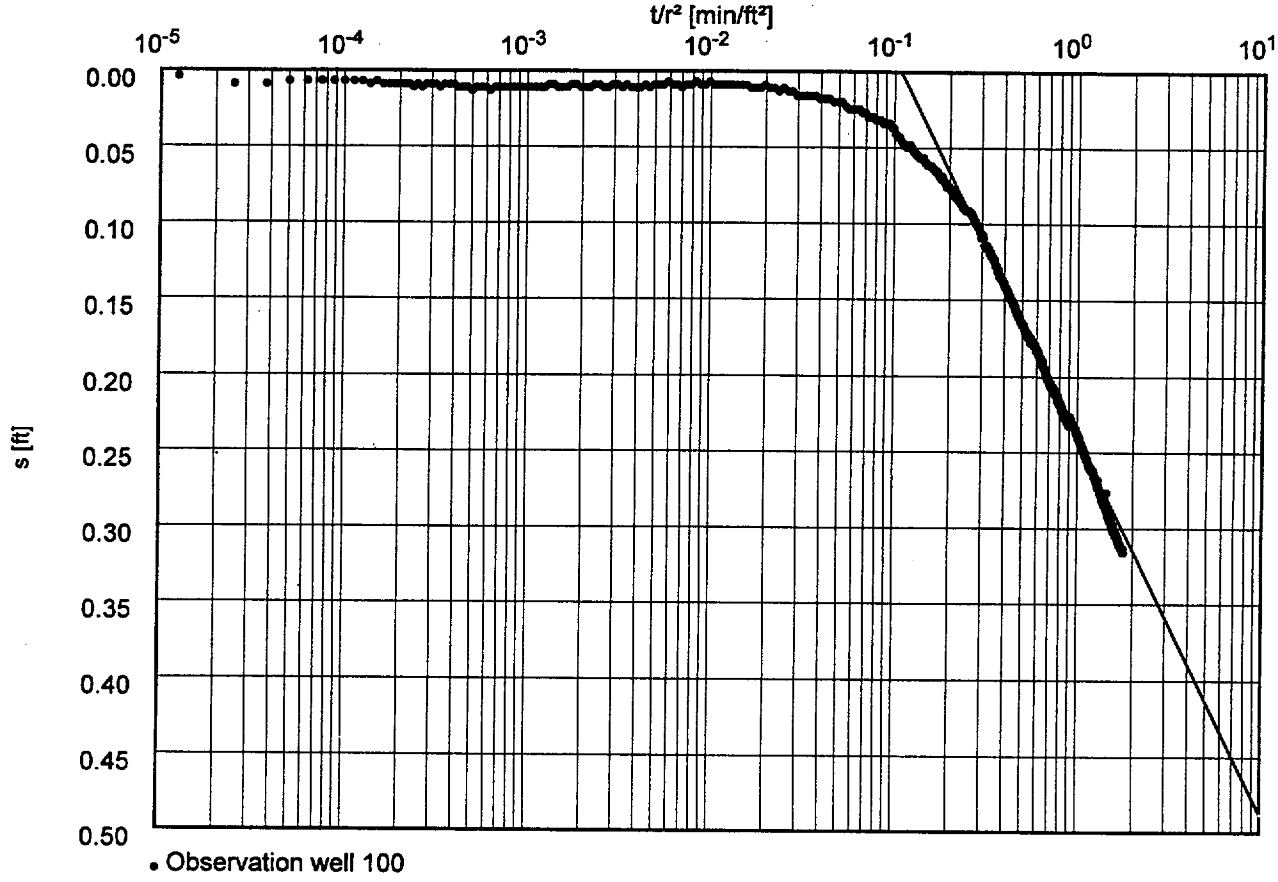
Transmissivity [ft²/min]: 3.79×10^{-1} 545.76 ft²/day

Hydraulic conductivity [ft/min]: 6.32×10^{-2} 91.01 ft/day

Aquifer thickness [ft]: 6.00

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Distance-Time-Drawdown-method after COOPER & JACOB Unconfined aquifer	1002OA2.HYT, Page 1 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/19/98

Pumping Test No. 1034 Aquifer Test	Test conducted on: 09/28/98
Observation Well 1002	
Discharge 4.00 U.S.gal/min	



Transmissivity [ft²/min]: 3.93×10^{-1} 565.92 ft²/day

Hydraulic conductivity [ft/min]: 6.56×10^{-2} 94.46 ft/day

Aquifer thickness [ft]: 6.00

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Theis analysis method Unconfined aquifer	1002OA2.HYT, Page 2 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/19/98

Pumping Test No. 1034 Aquifer Test	Test conducted on: 09/28/98
Observation Well 1002	Observation well 1002
Discharge 4.00 U.S.gal/min	Distance from the pumping well 20.00 ft

Static water level: 11.03 ft below datum

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
2	0.01	11.03	0.00	0.00
3	0.01	11.04	0.01	0.01
4	0.02	11.04	0.01	0.01
5	0.02	11.04	0.01	0.01
6	0.03	11.04	0.01	0.01
7	0.03	11.04	0.01	0.01
8	0.04	11.04	0.01	0.01
9	0.04	11.04	0.01	0.01
10	0.05	11.04	0.01	0.01
11	0.05	11.04	0.01	0.01
12	0.06	11.04	0.01	0.01
13	0.06	11.04	0.01	0.01
14	0.07	11.04	0.01	0.01
15	0.07	11.04	0.01	0.01
16	0.08	11.04	0.01	0.01
17	0.08	11.04	0.01	0.01
18	0.09	11.04	0.01	0.01
19	0.09	11.04	0.01	0.01
20	0.10	11.04	0.01	0.01
21	0.10	11.04	0.01	0.01
22	0.11	11.04	0.01	0.01
23	0.11	11.04	0.01	0.01
24	0.12	11.04	0.01	0.01
25	0.13	11.04	0.01	0.01
26	0.13	11.04	0.01	0.01
27	0.14	11.04	0.01	0.01
28	0.15	11.04	0.01	0.01
29	0.16	11.04	0.01	0.01
30	0.17	11.04	0.01	0.01
31	0.18	11.04	0.01	0.01
32	0.19	11.04	0.01	0.01
33	0.20	11.04	0.01	0.01
34	0.21	11.04	0.01	0.01
35	0.22	11.04	0.01	0.01
36	0.24	11.04	0.01	0.01
37	0.25	11.04	0.01	0.01
38	0.26	11.04	0.01	0.01
39	0.28	11.04	0.01	0.01
40	0.30	11.04	0.01	0.01
41	0.31	11.04	0.01	0.01
42	0.33	11.04	0.01	0.01
43	0.35	11.04	0.01	0.01
44	0.37	11.04	0.01	0.01
45	0.40	11.04	0.01	0.01
46	0.42	11.04	0.01	0.01
47	0.44	11.04	0.01	0.01
48	0.47	11.04	0.01	0.01
49	0.50	11.04	0.01	0.01
50	0.52	11.04	0.01	0.01

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Theis analysis method Unconfined aquifer	1002OA2.HYT, Page 3 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/19/98

Pumping Test No. 1034 Aquifer Test	Test conducted on: 09/28/98
Observation Well 1002	Observation well 1002
Discharge 4.00 U.S.gal/min	Distance from the pumping well 20.00 ft

Static water level: 11.03 ft below datum

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
51	0.55	11.04	0.01	0.01
52	0.59	11.04	0.01	0.01
53	0.62	11.04	0.01	0.01
54	0.66	11.04	0.01	0.01
55	0.70	11.04	0.01	0.01
56	0.74	11.04	0.01	0.01
57	0.78	11.04	0.01	0.01
58	0.83	11.04	0.01	0.01
59	0.88	11.04	0.01	0.01
60	0.93	11.04	0.01	0.01
61	0.98	11.04	0.01	0.01
62	1.04	11.04	0.01	0.01
63	1.10	11.04	0.01	0.01
64	1.17	11.04	0.01	0.01
65	1.24	11.04	0.01	0.01
66	1.31	11.04	0.01	0.01
67	1.39	11.04	0.01	0.01
68	1.47	11.04	0.01	[illegible]
69	1.56	11.04	0.01	[illegible]
70	1.65	11.04	0.01	0.01
71	1.75	11.04	0.01	0.01
72	1.86	11.04	0.01	0.01
73	1.97	11.04	0.01	0.01
74	2.08	11.04	0.01	0.01
75	2.21	11.04	0.01	0.01
76	2.34	11.04	0.01	0.01
77	2.48	11.04	0.01	0.01
78	2.63	11.04	0.01	0.01
79	2.79	11.04	0.01	0.01
80	2.95	11.04	0.01	0.01
81	3.13	11.04	0.01	0.01
82	3.32	11.04	0.01	0.01
83	3.51	11.04	0.01	0.01
84	3.72	11.04	0.01	0.01
85	3.95	11.04	0.01	0.01
86	4.18	11.04	0.01	0.01
87	4.43	11.04	0.01	0.01
88	4.69	11.04	0.01	0.01
89	4.97	11.04	0.01	0.01
90	5.27	11.04	0.01	0.01
91	5.58	11.04	0.01	0.01
92	5.91	11.04	0.01	0.01
93	6.27	11.04	0.01	[illegible]
94	6.64	11.04	0.01	[illegible]
95	7.03	11.04	0.01	0.01
96	7.45	11.04	0.01	0.01
97	7.90	11.04	0.01	0.01
98	8.37	11.04	0.01	0.01
99	8.86	11.04	0.01	0.01
100	9.39	11.04	0.01	0.01

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Theis analysis method Unconfined aquifer	1002OA2.HYT, Page 4 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/19/98

Pumping Test No. 1034 Aquifer Test	Test conducted on: 09/28/98
Observation Well 1002	Observation well 1002
Discharge 4.00 U.S.gal/min	Distance from the pumping well 20.00 ft

Static water level: 11.03 ft below datum

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
101	9.95	11.04	0.01	0.01
102	10.54	11.04	0.01	0.01
103	11.17	11.04	0.01	0.01
104	11.83	11.05	0.02	0.02
105	12.53	11.05	0.02	0.02
106	13.28	11.05	0.02	0.02
107	14.07	11.05	0.02	0.02
108	14.91	11.05	0.02	0.02
109	15.79	11.05	0.02	0.02
110	16.73	11.05	0.02	0.02
111	17.72	11.05	0.02	0.02
112	18.72	11.05	0.02	0.02
113	19.72	11.05	0.02	0.02
114	20.72	11.05	0.02	0.02
115	21.72	11.05	0.02	0.02
116	22.72	11.05	0.02	0.02
117	23.72	11.05	0.02	0.02
118	24.72	11.05	0.02	0.02
119	25.72	11.05	0.02	0.02
120	26.72	11.06	0.03	0.03
121	27.72	11.06	0.03	0.03
122	28.72	11.06	0.03	0.03
123	29.72	11.06	0.03	0.03
124	30.72	11.06	0.03	0.03
125	31.72	11.06	0.03	0.03
126	32.72	11.06	0.03	0.03
127	33.72	11.06	0.03	0.03
128	34.72	11.06	0.03	0.03
129	35.72	11.06	0.03	0.03
130	36.72	11.06	0.03	0.03
131	37.72	11.06	0.03	0.03
132	38.72	11.07	0.04	0.04
133	39.72	11.07	0.04	0.04
134	40.72	11.07	0.04	0.04
135	41.72	11.07	0.04	0.04
136	42.72	11.07	0.04	0.04
137	43.72	11.08	0.05	0.05
138	44.72	11.08	0.05	0.05
139	45.72	11.08	0.05	0.05
140	46.72	11.08	0.05	0.05
141	47.72	11.08	0.05	0.05
142	48.72	11.08	0.05	0.05
143	49.72	11.08	0.05	0.05
144	50.72	11.08	0.05	0.05
145	51.72	11.08	0.05	0.05
146	52.72	11.09	0.06	0.05
147	53.72	11.09	0.06	0.05
148	54.72	11.09	0.06	0.06
149	55.72	11.09	0.06	0.06
150	56.72	11.09	0.06	0.06

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Theis analysis method Unconfined aquifer	1002OA2.HYT, Page 5 Project: UGW – Grand Junction, CO Evaluated by: RJH Date: 11/19/98

Pumping Test No. 1034 Aquifer Test	Test conducted on: 09/28/98
Observation Well 1002	Observation well 1002
Discharge 4.00 U.S.gal/min	Distance from the pumping well 20.00 ft

Static water level: 11.03 ft below datum

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
151	57.72	11.09	0.06	0.06
152	58.72	11.09	0.06	0.06
153	59.72	11.09	0.06	0.06
154	60.72	11.09	0.06	0.06
155	61.72	11.09	0.06	0.06
156	62.72	11.09	0.06	0.06
157	63.72	11.09	0.06	0.06
158	64.72	11.09	0.06	0.06
159	65.72	11.09	0.06	0.06
160	66.72	11.10	0.07	0.07
161	67.72	11.10	0.07	0.07
162	68.72	11.10	0.07	0.07
163	69.72	11.10	0.07	0.07
164	70.72	11.10	0.07	0.07
165	71.72	11.10	0.07	0.07
166	72.72	11.10	0.07	0.07
167	73.72	11.10	0.07	0.07
168	74.72	11.10	0.07	[illegible]
169	75.72	11.10	0.07	[illegible]
170	76.72	11.11	0.08	0.08
171	77.72	11.11	0.08	0.08
172	78.72	11.11	0.08	0.08
173	79.72	11.11	0.08	0.08
174	80.72	11.11	0.08	0.08
175	81.72	11.11	0.08	0.08
176	82.72	11.11	0.08	0.08
177	83.72	11.11	0.08	0.08
178	84.72	11.11	0.08	0.08
179	85.72	11.11	0.08	0.08
180	86.72	11.11	0.08	0.08
181	87.72	11.11	0.08	0.08
182	88.72	11.12	0.09	0.08
183	89.72	11.12	0.09	0.08
184	90.72	11.12	0.09	0.08
185	91.72	11.12	0.09	0.09
186	92.72	11.12	0.09	0.09
187	93.72	11.12	0.09	0.09
188	94.72	11.12	0.09	0.09
189	95.72	11.12	0.09	0.09
190	96.72	11.12	0.09	0.09
191	97.72	11.12	0.09	0.09
192	98.72	11.12	0.09	0.09
193	99.72	11.12	0.09	[illegible]
194	100.72	11.12	0.09	[illegible]
195	101.72	11.12	0.09	0.09
196	102.72	11.12	0.09	0.09
197	103.72	11.12	0.09	0.09
198	104.72	11.12	0.09	0.09
199	105.72	11.12	0.09	0.09
200	106.72	11.13	0.10	0.10

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Theis analysis method Unconfined aquifer	1002OA2.HYT, Page 6 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/19/98

Pumping Test No. 1034 Aquifer Test	Test conducted on: 09/28/98
Observation Well 1002	Observation well 1002
Discharge 4.00 U.S.gal/min	Distance from the pumping well 20.00 ft
Static water level: 11.03 ft below datum	

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
201	107.72	11.13	0.10	0.10
202	108.72	11.13	0.10	0.10
203	109.72	11.13	0.10	0.10
204	110.72	11.13	0.10	0.10
205	111.72	11.13	0.10	0.10
206	112.72	11.13	0.10	0.10
207	113.72	11.13	0.10	0.10
208	114.72	11.13	0.10	0.10
209	115.72	11.13	0.10	0.10
210	116.72	11.14	0.11	0.11
211	117.72	11.14	0.11	0.11
212	118.72	11.14	0.11	0.11
213	119.72	11.14	0.11	0.11
214	120.72	11.14	0.11	0.11
215	121.72	11.14	0.11	0.11
216	122.72	11.14	0.11	0.11
217	123.72	11.15	0.12	0.11
218	124.72	11.15	0.12	0.11
219	125.72	11.15	0.12	0.11
220	126.72	11.15	0.12	0.12
221	127.72	11.15	0.12	0.11
222	128.72	11.15	0.12	0.12
223	129.72	11.15	0.12	0.12
224	130.72	11.15	0.12	0.12
225	131.72	11.15	0.12	0.12
226	132.72	11.15	0.12	0.12
227	133.72	11.15	0.12	0.12
228	134.72	11.15	0.12	0.12
229	135.72	11.15	0.12	0.12
230	136.72	11.15	0.12	0.12
231	137.72	11.15	0.12	0.12
232	138.72	11.15	0.12	0.12
233	139.72	11.15	0.12	0.12
234	140.72	11.16	0.13	0.12
235	141.72	11.16	0.13	0.12
236	142.72	11.16	0.13	0.13
237	143.72	11.16	0.13	0.13
238	144.72	11.16	0.13	0.13
239	145.72	11.16	0.13	0.13
240	146.72	11.16	0.13	0.13
241	147.72	11.16	0.13	0.13
242	148.72	11.16	0.13	0.13
243	149.72	11.17	0.14	0.13
244	150.72	11.17	0.14	0.13
245	151.72	11.17	0.14	0.13
246	152.72	11.17	0.14	0.13
247	153.72	11.17	0.14	0.14
248	154.72	11.17	0.14	0.14
249	155.72	11.17	0.14	0.14
250	156.72	11.17	0.14	0.14

MACTEC-ERS
2597 B 3/4 Road
Grand Junction, CO 81503
970/248-6040

Pumping test analysis
Theis analysis method
Unconfined aquifer

Project: UGW -- Grand Junction, CO

Evaluated by: RJH | Date: 11/19/98

Pumping Test No. 1034 Aquifer Test	Test conducted on: 09/28/98
Observation Well 1002	Observation well 1002
Discharge 4.00 U.S.gal/min	Distance from the pumping well 20.00 ft

Static water level: 11.03 ft below datum

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
251	157.72	11.17	0.14	0.14
252	158.72	11.17	0.14	0.14
253	159.72	11.17	0.14	0.14
254	160.72	11.17	0.14	0.14
255	161.72	11.17	0.14	0.14
256	162.72	11.17	0.14	0.14
257	163.72	11.18	0.15	0.14
258	164.72	11.18	0.15	0.14
259	165.72	11.18	0.15	0.14
260	166.72	11.18	0.15	0.15
261	167.72	11.18	0.15	0.15
262	168.72	11.18	0.15	0.15
263	169.72	11.18	0.15	0.15
264	170.72	11.18	0.15	0.15
265	171.72	11.18	0.15	0.15
266	172.72	11.18	0.15	0.15
267	173.72	11.18	0.15	0.15
268	174.72	11.18	0.15	[illegible]
269	175.72	11.18	0.15	[illegible]
270	176.72	11.18	0.15	0.15
271	177.72	11.18	0.15	0.15
272	178.72	11.18	0.15	0.15
273	179.72	11.19	0.16	0.15
274	180.72	11.19	0.16	0.15
275	181.72	11.19	0.16	0.15
276	182.72	11.19	0.16	0.15
277	183.72	11.19	0.16	0.16
278	184.72	11.19	0.16	0.16
279	185.72	11.19	0.16	0.16
280	186.72	11.19	0.16	0.16
281	187.72	11.19	0.16	0.16
282	188.72	11.19	0.16	0.16
283	189.72	11.19	0.16	0.16
284	190.72	11.19	0.16	0.16
285	191.72	11.19	0.16	0.16
286	192.72	11.19	0.16	0.16
287	193.72	11.20	0.17	0.16
288	194.72	11.20	0.17	0.16
289	195.72	11.20	0.17	0.16
290	196.72	11.20	0.17	0.16
291	197.72	11.20	0.17	0.17
292	198.72	11.20	0.17	0.17
293	199.72	11.20	0.17	[illegible]
294	200.72	11.20	0.17	[illegible]
295	201.72	11.20	0.17	0.17
296	202.72	11.20	0.17	0.17
297	203.72	11.20	0.17	0.17
298	204.72	11.20	0.17	0.17
299	205.72	11.20	0.17	0.17
300	206.72	11.20	0.17	0.17

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Theis analysis method Unconfined aquifer	1002OA2.HYT, Page 8 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/19/98

Pumping Test No. 1034 Aquifer Test	Test conducted on: 09/28/98
Observation Well 1002	Observation well 1002
Discharge 4.00 U.S.gal/min	Distance from the pumping well 20.00 ft

Static water level: 11.03 ft below datum

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
301	207.72	11.20	0.17	0.17
302	208.72	11.20	0.17	0.17
303	209.72	11.20	0.17	0.17
304	210.72	11.20	0.17	0.17
305	211.72	11.21	0.18	0.17
306	212.72	11.21	0.18	0.17
307	213.72	11.21	0.18	0.17
308	214.72	11.21	0.18	0.17
309	215.72	11.21	0.18	0.17
310	216.72	11.21	0.18	0.17
311	217.72	11.21	0.18	0.17
312	218.72	11.21	0.18	0.18
313	219.72	11.21	0.18	0.18
314	220.72	11.21	0.18	0.18
315	221.72	11.21	0.18	0.17
316	222.72	11.21	0.18	0.17
317	223.72	11.21	0.18	0.18
318	224.72	11.21	0.18	0.18
319	225.72	11.21	0.18	0.18
320	226.72	11.21	0.18	0.18
321	227.72	11.21	0.18	0.18
322	228.72	11.21	0.18	0.18
323	229.72	11.21	0.18	0.18
324	230.72	11.21	0.18	0.18
325	231.72	11.21	0.18	0.18
326	232.72	11.21	0.18	0.18
327	233.72	11.21	0.18	0.18
328	234.72	11.21	0.18	0.18
329	235.72	11.21	0.18	0.18
330	236.72	11.21	0.18	0.18
331	237.72	11.22	0.19	0.18
332	238.72	11.21	0.18	0.18
333	239.72	11.21	0.18	0.18
334	240.72	11.22	0.19	0.18
335	241.72	11.22	0.19	0.18
336	242.72	11.22	0.19	0.18
337	243.72	11.22	0.19	0.18
338	244.72	11.22	0.19	0.18
339	245.72	11.22	0.19	0.19
340	246.72	11.22	0.19	0.19
341	247.72	11.22	0.19	0.19
342	248.72	11.22	0.19	0.19
343	249.72	11.22	0.19	0.19
344	250.72	11.22	0.19	0.19
345	251.72	11.22	0.19	0.19
346	252.72	11.22	0.19	0.19
347	253.72	11.22	0.19	0.19
348	254.72	11.22	0.19	0.19
349	255.72	11.22	0.19	0.19
350	256.72	11.22	0.19	0.19

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Theis analysis method Unconfined aquifer	1002OA2.HYT, Page 9 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/19/98

Pumping Test No. 1034 Aquifer Test	Test conducted on: 09/28/98
Observation Well 1002	Observation well 1002
Discharge 4.00 U.S.gal/min	Distance from the pumping well 20.00 ft
Static water level: 11.03 ft below datum	

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
351	257.72	11.23	0.20	0.19
352	258.72	11.23	0.20	0.19
353	259.72	11.22	0.19	0.19
354	260.72	11.23	0.20	0.19
355	261.72	11.23	0.20	0.19
356	262.72	11.23	0.20	0.19
357	263.72	11.23	0.20	0.19
358	264.72	11.23	0.20	0.19
359	265.72	11.23	0.20	0.20
360	266.72	11.23	0.20	0.20
361	267.72	11.23	0.20	0.20
362	268.72	11.23	0.20	0.20
363	269.72	11.23	0.20	0.20
364	270.72	11.23	0.20	0.20
365	271.72	11.23	0.20	0.20
366	272.72	11.23	0.20	0.20
367	273.72	11.24	0.21	0.20
368	274.72	11.23	0.20	[illegible]
369	275.72	11.24	0.21	[illegible]
370	276.72	11.24	0.21	0.20
371	277.72	11.24	0.21	0.20
372	278.72	11.24	0.21	0.20
373	279.72	11.24	0.21	0.20
374	280.72	11.24	0.21	0.20
375	281.72	11.24	0.21	0.20
376	282.72	11.24	0.21	0.20
377	283.72	11.24	0.21	0.21
378	284.72	11.24	0.21	0.20
379	285.72	11.24	0.21	0.21
380	286.72	11.24	0.21	0.21
381	287.72	11.24	0.21	0.21
382	288.72	11.24	0.21	0.21
383	289.72	11.24	0.21	0.21
384	290.72	11.24	0.21	0.21
385	291.72	11.24	0.21	0.21
386	292.72	11.24	0.21	0.21
387	293.72	11.24	0.21	0.21
388	294.72	11.24	0.21	0.21
389	295.72	11.24	0.21	0.21
390	296.72	11.24	0.21	0.21
391	297.72	11.24	0.21	0.21
392	298.72	11.24	0.21	0.21
393	299.72	11.24	0.21	[illegible]
394	300.72	11.24	0.21	[illegible]
395	301.72	11.24	0.21	0.21
396	302.72	11.24	0.21	0.21
397	303.72	11.25	0.22	0.21
398	304.72	11.24	0.21	0.21
399	305.72	11.25	0.22	0.21
400	306.72	11.25	0.22	0.21

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Theis analysis method Unconfined aquifer	1002OA2.HYT, Page 10 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/19/98

Pumping Test No. 1034 Aquifer Test	Test conducted on: 09/28/98
Observation Well 1002	Observation well 1002
Discharge 4.00 U.S.gal/min	Distance from the pumping well 20.00 ft

Static water level: 11.03 ft below datum

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
401	307.72	11.25	0.22	0.21
402	308.72	11.25	0.22	0.22
403	309.72	11.25	0.22	0.21
404	310.72	11.25	0.22	0.21
405	311.72	11.25	0.22	0.22
406	312.72	11.25	0.22	0.21
407	313.72	11.25	0.22	0.22
408	314.72	11.25	0.22	0.22
409	315.72	11.25	0.22	0.22
410	316.72	11.25	0.22	0.22
411	317.72	11.25	0.22	0.22
412	318.72	11.25	0.22	0.22
413	319.72	11.25	0.22	0.22
414	320.72	11.25	0.22	0.22
415	321.72	11.25	0.22	0.22
416	322.72	11.25	0.22	0.22
417	323.72	11.25	0.22	0.22
418	324.72	11.25	0.22	0.22
419	325.72	11.25	0.22	0.22
420	326.72	11.26	0.23	0.22
421	327.72	11.25	0.22	0.22
422	328.72	11.25	0.22	0.22
423	329.72	11.26	0.23	0.22
424	330.72	11.26	0.23	0.22
425	331.72	11.26	0.23	0.22
426	332.72	11.26	0.23	0.22
427	333.72	11.26	0.23	0.22
428	334.72	11.26	0.23	0.22
429	335.72	11.26	0.23	0.22
430	336.72	11.26	0.23	0.22
431	337.72	11.26	0.23	0.22
432	338.72	11.26	0.23	0.22
433	339.72	11.26	0.23	0.23
434	340.72	11.26	0.23	0.22
435	341.72	11.26	0.23	0.23
436	342.72	11.26	0.23	0.23
437	343.72	11.26	0.23	0.23
438	344.72	11.26	0.23	0.23
439	345.72	11.26	0.23	0.23
440	346.72	11.26	0.23	0.23
441	347.72	11.26	0.23	0.23
442	348.72	11.26	0.23	0.23
443	349.72	11.26	0.23	0.23
444	350.72	11.26	0.23	0.23
445	351.72	11.26	0.24	0.23
446	352.72	11.26	0.24	0.23
447	353.72	11.26	0.24	0.23
448	354.72	11.26	0.24	0.23
449	355.72	11.26	0.24	0.23
450	356.72	11.26	0.24	0.23

MACTEC-ERS
2597 B 3/4 Road
Grand Junction, CO 81503
970/248-6040

Pumping test analysis
Theis analysis method
Unconfined aquifer

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Project: UGW -- Grand Junction, CO

Evaluated by: RJH | Date: 11/19/98

Pumping Test No. 1034 Aquifer Test | Test conducted on: 09/28/98

Observation Well 1002 | Observation well 1002

Discharge 4.00 U.S.gal/min | Distance from the pumping well 20.00 ft

Static water level: 11.03 ft below datum

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
451	357.72	11.27	0.24	0.23
452	358.72	11.26	0.23	0.23
453	359.72	11.26	0.23	0.23
454	360.72	11.26	0.23	0.23
455	361.72	11.26	0.23	0.23
456	362.72	11.26	0.23	0.23
457	363.72	11.26	0.23	0.23
458	364.72	11.26	0.23	0.23
459	365.72	11.26	0.23	0.23
460	366.72	11.26	0.23	0.23
461	367.72	11.26	0.23	0.23
462	368.72	11.26	0.23	0.23
463	369.72	11.26	0.24	0.23
464	370.72	11.26	0.23	0.23
465	371.72	11.26	0.24	0.23
466	372.72	11.26	0.24	0.23
467	373.72	11.26	0.24	0.23
468	374.72	11.26	0.24	0
469	375.72	11.27	0.24	[illegible]
470	376.72	11.26	0.24	0.
471	377.72	11.27	0.24	0.23
472	378.72	11.27	0.24	0.23
473	379.72	11.27	0.24	0.23
474	380.72	11.27	0.24	0.23
475	381.72	11.27	0.24	0.23
476	382.72	11.27	0.24	0.23
477	383.72	11.27	0.24	0.23
478	384.72	11.27	0.24	0.23
479	385.72	11.27	0.24	0.23
480	386.72	11.27	0.24	0.23
481	387.72	11.27	0.24	0.23
482	388.72	11.27	0.24	0.23
483	389.72	11.27	0.24	0.23
484	390.72	11.27	0.24	0.24
485	391.72	11.27	0.24	0.23
486	392.72	11.27	0.24	0.24
487	393.72	11.27	0.24	0.24
488	394.72	11.27	0.24	0.24
489	395.72	11.27	0.24	0.24
490	396.72	11.27	0.24	0.24
491	397.72	11.27	0.24	0.24
492	398.72	11.27	0.24	0.24
493	399.72	11.27	0.24	0.
494	400.72	11.27	0.24	0
495	401.72	11.28	0.25	0.2
496	402.72	11.28	0.25	0.24
497	403.72	11.28	0.25	0.24
498	404.72	11.28	0.25	0.24
499	405.72	11.27	0.24	0.24
500	406.72	11.28	0.25	0.24

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Theis analysis method Unconfined aquifer	1002OA2.HYT, Page 12 Project: UGW – Grand Junction, CO Evaluated by: RJH Date: 11/19/98

Pumping Test No. 1034 Aquifer Test	Test conducted on: 09/28/98
Observation Well 1002	Observation well 1002
Discharge 4.00 U.S.gal/min	Distance from the pumping well 20.00 ft

Static water level: 11.03 ft below datum

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
501	407.72	11.28	0.25	0.24
502	408.72	11.28	0.25	0.24
503	409.72	11.28	0.25	0.24
504	410.72	11.28	0.25	0.24
505	411.72	11.28	0.25	0.24
506	412.72	11.28	0.25	0.24
507	413.72	11.28	0.25	0.24
508	414.72	11.28	0.25	0.24
509	415.72	11.28	0.25	0.24
510	416.72	11.28	0.25	0.24
511	417.72	11.28	0.25	0.24
512	418.72	11.28	0.25	0.25
513	419.72	11.28	0.25	0.25
514	420.72	11.28	0.25	0.25
515	421.72	11.28	0.25	0.25
516	422.72	11.28	0.25	0.25
517	423.72	11.28	0.25	0.25
518	424.72	11.28	0.25	0.25
519	425.72	11.28	0.25	0.25
520	426.72	11.28	0.25	0.25
521	427.72	11.28	0.25	0.25
522	428.72	11.28	0.25	0.25
523	429.72	11.28	0.25	0.25
524	430.72	11.29	0.26	0.25
525	431.72	11.28	0.25	0.25
526	432.72	11.29	0.26	0.25
527	433.72	11.29	0.26	0.25
528	434.72	11.29	0.26	0.25
529	435.72	11.29	0.26	0.25
530	436.72	11.29	0.26	0.25
531	437.72	11.29	0.26	0.25
532	438.72	11.29	0.26	0.25
533	439.72	11.29	0.26	0.25
534	440.72	11.29	0.26	0.25
535	441.72	11.29	0.26	0.25
536	442.72	11.29	0.26	0.25
537	443.72	11.29	0.26	0.25
538	444.72	11.29	0.26	0.25
539	445.72	11.29	0.26	0.25
540	446.72	11.29	0.26	0.25
541	447.72	11.29	0.26	0.25
542	448.72	11.29	0.26	0.25
543	449.72	11.29	0.26	0.25
544	450.72	11.29	0.26	0.25
545	451.72	11.29	0.26	0.25
546	452.72	11.29	0.26	0.25
547	453.72	11.29	0.26	0.25
548	454.72	11.29	0.26	0.26
549	455.72	11.29	0.26	0.26
550	456.72	11.29	0.26	0.26

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Theis analysis method Unconfined aquifer	1002OA2.HYT, Page 13 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/19/98

Pumping Test No. 1034 Aquifer Test	Test conducted on: 09/28/98
Observation Well 1002	Observation well 1002
Discharge 4.00 U.S.gal/min	Distance from the pumping well 20.00 ft

Static water level: 11.03 ft below datum

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
551	457.72	11.29	0.26	0.26
552	458.72	11.29	0.26	0.26
553	459.72	11.29	0.26	0.26
554	460.72	11.29	0.26	0.26
555	461.72	11.29	0.26	0.26
556	462.72	11.29	0.26	0.26
557	463.72	11.29	0.26	0.26
558	464.72	11.29	0.26	0.26
559	465.72	11.29	0.26	0.26
560	466.72	11.29	0.26	0.26
561	467.72	11.29	0.26	0.26
562	468.72	11.30	0.27	0.26
563	469.72	11.30	0.27	0.26
564	470.72	11.29	0.26	0.26
565	471.72	11.30	0.27	0.26
566	472.72	11.30	0.27	0.26
567	473.72	11.30	0.27	0.26
568	474.72	11.30	0.27	[illegible]
569	475.72	11.30	0.27	[illegible]
570	476.72	11.30	0.27	[illegible]
571	477.72	11.30	0.27	0.26
572	478.72	11.30	0.27	0.26
573	479.72	11.30	0.27	0.26
574	480.72	11.30	0.27	0.26
575	481.72	11.30	0.27	0.26
576	482.72	11.30	0.27	0.26
577	483.72	11.30	0.27	0.26
578	484.72	11.30	0.27	0.26
579	485.72	11.30	0.27	0.26
580	486.72	11.30	0.27	0.26
581	487.72	11.30	0.27	0.26
582	488.72	11.30	0.27	0.26
583	489.72	11.30	0.27	0.26
584	490.72	11.30	0.27	0.26
585	491.72	11.30	0.27	0.26
586	492.72	11.30	0.27	0.26
587	493.72	11.30	0.27	0.27
588	494.72	11.30	0.27	0.27
589	495.72	11.30	0.27	0.27
590	496.72	11.30	0.27	0.27
591	497.72	11.30	0.27	0.27
592	498.72	11.30	0.27	0.27
593	499.72	11.30	0.27	[illegible]
594	500.72	11.30	0.27	[illegible]
595	501.72	11.30	0.27	0.27
596	502.72	11.30	0.27	0.27
597	503.72	11.30	0.27	0.27
598	504.72	11.30	0.27	0.27
599	505.72	11.30	0.27	0.27
600	506.72	11.31	0.28	0.27

MACTEC-ERS
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Grand Junction, CO 81503
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Pumping test analysis
Theis analysis method
Unconfined aquifer

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Project: UGW -- Grand Junction, CO
Evaluated by: RJH
Date: 11/19/98

Pumping Test No. 1034 Aquifer Test

Test conducted on: 09/28/98

Observation Well 1002

Observation well 1002

Discharge 4.00 U.S.gal/min

Distance from the pumping well 20.00 ft

Static water level: 11.03 ft below datum

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
601	507.72	11.31	0.28	0.27
602	508.72	11.31	0.28	0.27
603	509.72	11.31	0.28	0.27
604	510.72	11.31	0.28	0.27
605	511.72	11.31	0.28	0.27
606	512.72	11.31	0.28	0.27
607	513.72	11.31	0.28	0.27
608	514.72	11.31	0.28	0.27
609	515.72	11.31	0.28	0.27
610	516.72	11.31	0.28	0.27
611	517.72	11.31	0.28	0.27
612	518.72	11.30	0.27	0.27
613	519.72	11.31	0.28	0.27
614	520.72	11.31	0.28	0.27
615	521.72	11.31	0.28	0.27
616	522.72	11.31	0.28	0.27
617	523.72	11.31	0.28	0.27
618	524.72	11.31	0.28	0.27
619	525.72	11.31	0.28	0.27
620	526.72	11.31	0.28	0.27
621	527.72	11.31	0.28	0.27
622	528.72	11.31	0.28	0.27
623	529.72	11.31	0.28	0.27
624	530.72	11.31	0.28	0.28
625	531.72	11.31	0.28	0.28
626	532.72	11.31	0.28	0.27
627	533.72	11.31	0.28	0.28
628	534.72	11.31	0.28	0.28
629	535.72	11.32	0.29	0.28
630	536.72	11.32	0.29	0.28
631	537.72	11.32	0.29	0.28
632	538.72	11.32	0.29	0.28
633	539.72	11.32	0.29	0.28
634	540.72	11.32	0.29	0.28
635	541.72	11.32	0.29	0.28
636	542.72	11.32	0.29	0.28
637	543.72	11.32	0.29	0.28
638	544.72	11.32	0.29	0.28
639	545.72	11.32	0.29	0.28
640	546.72	11.32	0.29	0.28
641	547.72	11.32	0.29	0.28
642	548.72	11.32	0.29	0.28
643	549.72	11.32	0.29	0.28
644	550.72	11.32	0.29	0.28
645	551.72	11.32	0.29	0.28
646	552.72	11.32	0.29	0.28
647	553.72	11.32	0.29	0.28
648	554.72	11.32	0.29	0.28
649	555.72	11.32	0.29	0.28
650	556.72	11.32	0.29	0.28

MACTEC-ERS
2597 B 3/4 Road
Grand Junction, CO 81503
970/248-6040

Pumping test analysis
Theis analysis method
Unconfined aquifer

Project: UGW -- Grand Junction, CO

Evaluated by: RJH | Date: 11/19/98

Pumping Test No. 1034 Aquifer Test | Test conducted on: 09/28/98

Observation Well 1002 | Observation well 1002

Discharge 4.00 U.S.gal/min | Distance from the pumping well 20.00 ft

Static water level: 11.03 ft below datum

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
651	557.72	11.32	0.29	0.28
652	558.72	11.32	0.29	0.28
653	559.72	11.32	0.29	0.28
654	560.72	11.32	0.29	0.28
655	561.72	11.32	0.29	0.28
656	562.72	11.32	0.29	0.28
657	563.72	11.32	0.29	0.28
658	564.72	11.32	0.29	0.28
659	565.72	11.32	0.29	0.28
660	566.72	11.32	0.29	0.28
661	567.72	11.32	0.29	0.28
662	568.72	11.32	0.29	0.28
663	569.72	11.32	0.29	0.28
664	570.72	11.32	0.29	0.28
665	571.72	11.32	0.29	0.28
666	572.72	11.32	0.29	0.28
667	573.72	11.32	0.29	0.28
668	574.72	11.32	0.29	[illegible]
669	575.72	11.32	0.29	[illegible]
670	576.72	11.32	0.29	[illegible]
671	577.72	11.32	0.29	0.29
672	578.72	11.31	0.28	0.28
673	579.72	11.32	0.29	0.29
674	580.72	11.32	0.29	0.29
675	581.72	11.33	0.30	0.29
676	582.72	11.33	0.30	0.29
677	583.72	11.33	0.30	0.29
678	584.72	11.33	0.30	0.29
679	585.72	11.32	0.29	0.29
680	586.72	11.33	0.30	0.29
681	587.72	11.33	0.30	0.29
682	588.72	11.33	0.30	0.29
683	589.72	11.33	0.30	0.29
684	590.72	11.33	0.30	0.29
685	591.72	11.33	0.30	0.29
686	592.72	11.33	0.30	0.29
687	593.72	11.33	0.30	0.29
688	594.72	11.33	0.30	0.29
689	595.72	11.33	0.30	0.29
690	596.72	11.33	0.30	0.29
691	597.72	11.33	0.30	0.29
692	598.72	11.33	0.30	0.29
693	599.72	11.33	0.30	[illegible]
694	600.72	11.33	0.30	[illegible]
695	601.72	11.33	0.30	0.29
696	602.72	11.33	0.30	0.29
697	603.72	11.33	0.30	0.29
698	604.72	11.33	0.30	0.29
699	605.72	11.33	0.30	0.29
700	606.72	11.33	0.30	0.29

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Theis analysis method Unconfined aquifer	1002OA2.HYT, Page 16 Project: UGW – Grand Junction, CO Evaluated by: RJH Date: 11/19/98

Pumping Test No. 1034 Aquifer Test	Test conducted on: 09/28/98
Observation Well 1002	Observation well 1002
Discharge 4.00 U.S.gal/min	Distance from the pumping well 20.00 ft
Static water level: 11.03 ft below datum	

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
701	607.72	11.33	0.30	0.29
702	608.72	11.33	0.30	0.29
703	609.72	11.33	0.30	0.30
704	610.72	11.33	0.30	0.30
705	611.72	11.33	0.30	0.30
706	612.72	11.33	0.30	0.30
707	613.72	11.33	0.30	0.30
708	614.72	11.33	0.30	0.30
709	615.72	11.33	0.30	0.30
710	616.72	11.34	0.31	0.30
711	617.72	11.34	0.31	0.30
712	618.72	11.33	0.30	0.30
713	619.72	11.33	0.30	0.30
714	620.72	11.34	0.31	0.30
715	621.72	11.34	0.31	0.30
716	622.72	11.34	0.31	0.30
717	623.72	11.34	0.31	0.30
718	624.72	11.34	0.31	0.30
719	625.72	11.34	0.31	0.30
720	626.72	11.34	0.31	0.30
721	627.72	11.34	0.31	0.30
722	628.72	11.34	0.31	0.30
723	629.72	11.34	0.31	0.30
724	630.72	11.34	0.31	0.30
725	631.72	11.34	0.31	0.30
726	632.72	11.34	0.31	0.30
727	633.72	11.34	0.31	0.30
728	634.72	11.34	0.31	0.30
729	635.72	11.34	0.31	0.30
730	636.72	11.34	0.31	0.30
731	637.72	11.34	0.31	0.30
732	638.72	11.34	0.31	0.30
733	639.72	11.34	0.31	0.30
734	640.72	11.34	0.31	0.30
735	641.72	11.34	0.31	0.30
736	642.72	11.34	0.31	0.30
737	643.72	11.34	0.31	0.30
738	644.72	11.34	0.31	0.30
739	645.72	11.34	0.31	0.30
740	646.72	11.34	0.31	0.30
741	647.72	11.34	0.31	0.30
742	648.72	11.34	0.31	0.30
743	649.72	11.34	0.31	0.30
744	650.72	11.34	0.31	0.30
745	651.72	11.34	0.31	0.30
746	652.72	11.34	0.31	0.30
747	653.72	11.34	0.31	0.30
748	654.72	11.34	0.31	0.30
749	655.72	11.34	0.31	0.30
750	656.72	11.34	0.31	0.30

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Theis analysis method Unconfined aquifer	1002OA2.HYT, Page 17 Project: UGW -- Grand Junction, CO Evaluated by: RJH · Date: 11/19/98

Pumping Test No. 1034 Aquifer Test	Test conducted on: 09/28/98
Observation Well 1002	Observation well 1002
Discharge 4.00 U.S.gal/min	Distance from the pumping well 20.00 ft
Static water level: 11.03 ft below datum	

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
751	657.72	11.34	0.31	0.30
752	658.72	11.34	0.31	0.30
753	659.72	11.35	0.32	0.31
754	660.72	11.34	0.31	0.30
755	661.72	11.34	0.31	0.30
756	662.72	11.35	0.32	0.31
757	663.72	11.35	0.32	0.31
758	664.72	11.35	0.32	0.31
759	665.72	11.35	0.32	0.31
760	666.72	11.35	0.32	0.31
761	667.72	11.35	0.32	0.31
762	668.72	11.35	0.32	0.31
763	669.72	11.35	0.32	0.31
764	670.72	11.35	0.32	0.31
765	671.72	11.35	0.32	0.31
766	672.72	11.35	0.32	0.31
767	673.72	11.35	0.32	0.31
768	674.72	11.35	0.32	0
769	675.72	11.35	0.32	[illegible]
770	676.72	11.35	0.32	0.31
771	677.72	11.35	0.32	0.31
772	678.72	11.35	0.32	0.31
773	679.72	11.35	0.32	0.31
774	680.72	11.35	0.32	0.31
775	681.72	11.35	0.32	0.31
776	682.72	11.35	0.32	0.31
777	683.72	11.35	0.32	0.31
778	684.72	11.35	0.32	0.31
779	685.72	11.35	0.32	0.31
780	686.72	11.35	0.32	0.31
781	687.72	11.35	0.32	0.31
782	688.72	11.35	0.32	0.31
783	689.72	11.35	0.32	0.31
784	690.72	11.35	0.32	0.31
785	691.72	11.35	0.32	0.31
786	692.72	11.35	0.32	0.31
787	693.72	11.35	0.32	0.31
788	694.72	11.35	0.32	0.31
789	695.72	11.35	0.32	0.31
790	696.72	11.35	0.32	0.31
791	697.72	11.35	0.32	0.31
792	698.72	11.35	0.32	0.31
793	699.72	11.35	0.32	0.3
794	700.72	11.35	0.32	0.
795	701.72	11.35	0.32	0.31
796	702.72	11.35	0.32	0.31
797	703.72	11.35	0.32	0.31
798	704.72	11.35	0.32	0.31
799	705.72	11.35	0.32	0.31
800	706.72	11.35	0.32	0.32

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Theis analysis method Unconfined aquifer	1002OA2.HYT, Page 18 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/19/98

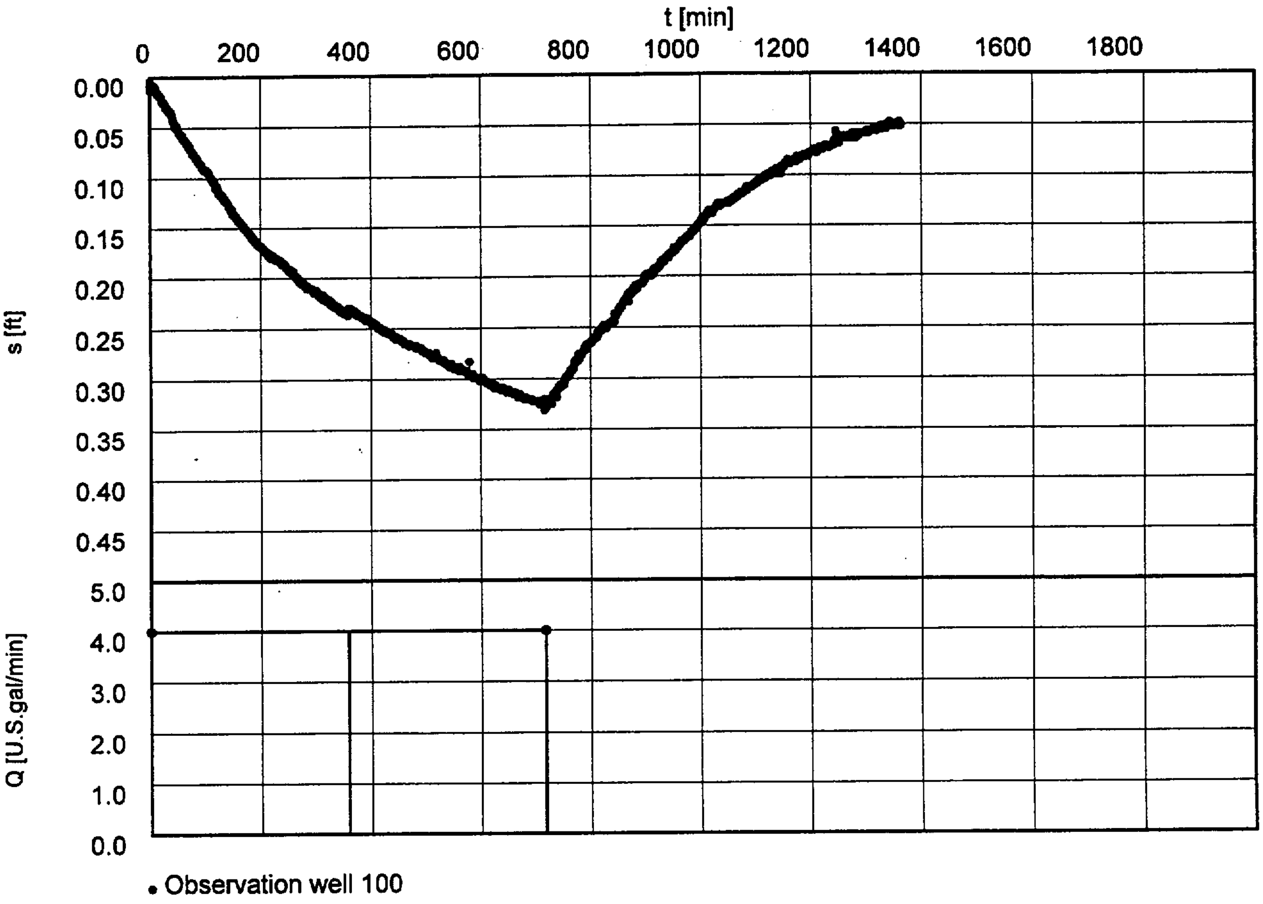
Pumping Test No. 1034 Aquifer Test	Test conducted on: 09/28/98
Observation Well 1002	Observation well 1002
Discharge 4.00 U.S.gal/min	Distance from the pumping well 20.00 ft

Static water level: 11.03 ft below datum

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
801	707.72	11.35	0.32	0.31
802	708.72	11.35	0.32	0.31
803	709.72	11.35	0.32	0.31
804	710.72	11.35	0.32	0.31
805	711.72	11.35	0.32	0.31
806	712.72	11.35	0.32	0.31
807	713.72	11.35	0.32	0.32
808	714.72	11.35	0.32	0.32
809	715.72	11.35	0.32	0.32

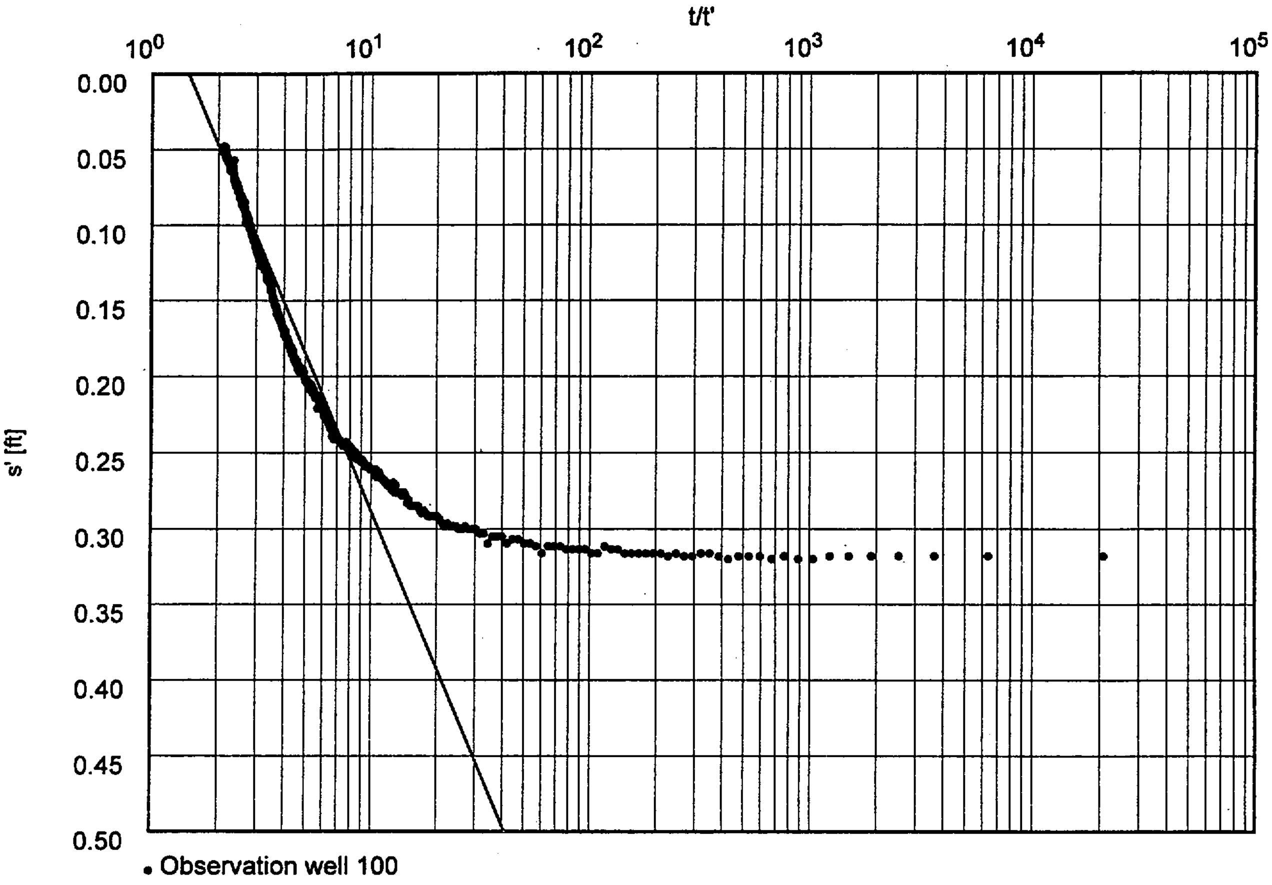
MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Time-Drawdown plot with discharge	1002OR2.HYT, Page 1 Project: UGW – Grand Junction, CO Evaluated by: RJH Date: 11/19/98

Pumping Test No. 1034 Recovery Test	Test conducted on: 09/28/98
Observation Well 1002	
Discharge 4.00 U.S.gal/min	



MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1002OR2.HYT, Page 1 Project: UGW -- Grand Junction, CO	
		Evaluated by: RJH	Date: 11/19/98

Pumping Test No. 1034 Recovery Test	Test conducted on: 09/28/98
Observation Well 1002	
Discharge 4.00 U.S.gal/min	
	Pumping test duration: 717.00 min



Transmissivity [ft²/min]: 2.83×10^{-1} 407.52 ft²/day

Hydraulic conductivity [ft/min]: 4.72×10^{-2} 67.97 ft/day

Aquifer thickness [ft]: 6.00

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1002OR2.HYT, Page 2 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/19/98

Pumping Test No. 1034 Recovery Test	Test conducted on: 09/28/98
Observation Well 1002	Observation well 1002
Discharge 4.00 U.S.gal/min	Distance from the pumping well 20.00 ft
Static water level: 11.03 ft below datum	Pumping test duration: 717.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
1	0.03	11.36	0.33	0.32
2	0.11	11.36	0.33	0.32
3	0.20	11.36	0.33	0.32
4	0.28	11.36	0.33	0.32
5	0.38	11.36	0.33	0.32
6	0.48	11.36	0.33	0.32
7	0.58	11.36	0.33	0.32
8	0.69	11.36	0.33	0.32
9	0.81	11.36	0.33	0.32
10	0.93	11.36	0.33	0.32
11	1.06	11.36	0.33	0.32
12	1.20	11.36	0.33	0.32
13	1.35	11.36	0.33	0.32
14	1.51	11.36	0.33	0.32
15	1.68	11.36	0.33	0.32
16	1.85	11.36	0.33	0.32
17	2.04	11.35	0.32	0.32
18	2.24	11.35	0.32	[illegible]
19	2.45	11.36	0.33	[illegible]
20	2.67	11.36	0.33	[illegible]
21	2.90	11.35	0.32	0.32
22	3.15	11.36	0.33	0.32
23	3.42	11.35	0.32	0.32
24	3.70	11.35	0.32	0.32
25	3.99	11.35	0.32	0.32
26	4.31	11.35	0.32	0.32
27	4.64	11.35	0.32	0.32
28	4.99	11.35	0.32	0.32
29	5.36	11.35	0.32	0.31
30	5.76	11.35	0.32	0.31
31	6.18	11.35	0.32	0.31
32	6.62	11.35	0.32	0.32
33	7.09	11.35	0.32	0.32
34	7.59	11.35	0.32	0.31
35	8.11	11.35	0.32	0.31
36	8.67	11.35	0.32	0.31
37	9.26	11.35	0.32	0.31
38	9.89	11.35	0.32	0.31
39	10.55	11.35	0.32	0.31
40	11.26	11.35	0.32	0.31
41	12.00	11.35	0.32	0.32
42	12.79	11.35	0.32	0.31
43	13.63	11.35	0.32	[illegible]
44	14.51	11.35	0.32	[illegible]
45	15.45	11.35	0.32	0.31
46	16.45	11.35	0.32	0.31
47	17.45	11.35	0.32	0.31
48	18.45	11.34	0.31	0.30
49	19.45	11.34	0.31	0.30
50	20.45	11.34	0.31	0.30

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1002OR2.HYT, Page 3 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/19/98

Pumping Test No. 1034 Recovery Test	Test conducted on: 09/28/98
Observation Well 1002	Observation well 1002
Discharge 4.00 U.S.gal/min	Distance from the pumping well 20.00 ft
Static water level: 11.03 ft below datum	Pumping test duration: 717.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
51	21.45	11.35	0.32	0.31
52	22.45	11.34	0.31	0.30
53	23.45	11.34	0.31	0.30
54	24.45	11.34	0.31	0.30
55	25.45	11.34	0.31	0.30
56	26.45	11.34	0.31	0.30
57	27.45	11.34	0.31	0.30
58	28.45	11.34	0.31	0.30
59	29.45	11.34	0.31	0.30
60	30.45	11.34	0.31	0.30
61	31.45	11.34	0.31	0.30
62	32.45	11.34	0.31	0.30
63	33.45	11.33	0.30	0.30
64	34.45	11.34	0.31	0.30
65	35.45	11.33	0.30	0.30
66	36.45	11.33	0.30	0.29
67	37.45	11.33	0.30	0.29
68	38.45	11.33	0.30	0.29
69	39.45	11.33	0.30	0.29
70	40.45	11.33	0.30	0.29
71	41.45	11.33	0.30	0.29
72	42.45	11.33	0.30	0.29
73	43.45	11.32	0.29	0.29
74	44.45	11.33	0.30	0.29
75	45.45	11.32	0.29	0.29
76	46.45	11.32	0.29	0.28
77	47.45	11.32	0.29	0.28
78	48.45	11.32	0.29	0.28
79	49.45	11.32	0.29	0.28
80	50.45	11.32	0.29	0.28
81	51.45	11.32	0.29	0.28
82	52.45	11.32	0.29	0.28
83	53.45	11.32	0.29	0.28
84	54.45	11.31	0.28	0.28
85	55.45	11.32	0.29	0.28
86	56.45	11.31	0.28	0.28
87	57.45	11.31	0.28	0.28
88	58.45	11.31	0.28	0.28
89	59.45	11.31	0.28	0.27
90	60.45	11.31	0.28	0.28
91	61.45	11.31	0.28	0.27
92	62.45	11.31	0.28	0.27
93	63.45	11.31	0.28	0.27
94	64.45	11.31	0.28	0.27
95	65.45	11.31	0.28	0.27
96	66.45	11.31	0.28	0.27
97	67.45	11.31	0.28	0.27
98	68.45	11.30	0.27	0.27
99	69.45	11.30	0.27	0.27
100	70.45	11.30	0.27	0.27

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1002OR2.HYT, Page 4 Project: UGW – Grand Junction, CO Evaluated by: RJH Date: 11/19/98

Pumping Test No. 1034 Recovery Test	Test conducted on: 09/28/98
Observation Well 1002	Observation well 1002
Discharge 4.00 U.S.gal/min	Distance from the pumping well 20.00 ft
Static water level: 11.03 ft below datum	Pumping test duration: 717.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
101	71.45	11.30	0.27	0.27
102	72.45	11.30	0.27	0.26
103	73.45	11.30	0.27	0.26
104	74.45	11.30	0.27	0.26
105	75.45	11.30	0.27	0.27
106	76.45	11.30	0.27	0.26
107	77.45	11.30	0.27	0.26
108	78.45	11.30	0.27	0.26
109	79.45	11.30	0.27	0.26
110	80.45	11.30	0.27	0.26
111	81.45	11.29	0.26	0.26
112	82.45	11.29	0.26	0.26
113	83.45	11.29	0.26	0.26
114	84.45	11.29	0.26	0.26
115	85.45	11.29	0.26	0.26
116	86.45	11.29	0.26	0.26
117	87.45	11.29	0.26	0.26
118	88.45	11.29	0.26	0.26
119	89.45	11.29	0.26	[illegible]
120	90.45	11.29	0.26	[illegible]
121	91.45	11.29	0.26	[illegible]
122	92.45	11.29	0.26	0.25
123	93.45	11.29	0.26	0.25
124	94.45	11.29	0.26	0.25
125	95.45	11.29	0.26	0.25
126	96.45	11.29	0.26	0.25
127	97.45	11.29	0.26	0.25
128	98.45	11.29	0.26	0.25
129	99.45	11.28	0.25	0.25
130	100.45	11.28	0.25	0.25
131	101.45	11.28	0.25	0.25
132	102.45	11.28	0.25	0.25
133	103.45	11.28	0.25	0.25
134	104.45	11.28	0.25	0.25
135	105.45	11.28	0.25	0.25
136	106.45	11.28	0.25	0.25
137	107.45	11.28	0.25	0.24
138	108.45	11.28	0.25	0.24
139	109.45	11.28	0.25	0.24
140	110.45	11.28	0.25	0.24
141	111.45	11.28	0.25	0.25
142	112.45	11.28	0.25	0.25
143	113.45	11.28	0.25	0.24
144	114.45	11.28	0.25	[illegible]
145	115.45	11.28	0.25	[illegible]
146	116.45	11.28	0.25	0.24
147	117.45	11.28	0.25	0.24
148	118.45	11.28	0.25	0.24
149	119.45	11.28	0.25	0.24
150	120.45	11.28	0.25	0.24

MACTEC-ERS
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Pumping test analysis
Recovery method after
THEIS & JACOB
Unconfined aquifer

1002OR2.HYT, Page 5
Project: UGW -- Grand Junction, CO
Evaluated by: RJH
Date: 11/19/98

Pumping Test No. 1034 Recovery Test	Test conducted on: 09/28/98
Observation Well 1002	Observation well 1002
Discharge 4.00 U.S.gal/min	Distance from the pumping well 20.00 ft
Static water level: 11.03 ft below datum	Pumping test duration: 717.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
151	121.45	11.27	0.24	0.24
152	122.45	11.27	0.24	0.24
153	123.45	11.27	0.24	0.24
154	124.45	11.28	0.25	0.24
155	125.45	11.27	0.24	0.24
156	126.45	11.27	0.24	0.23
157	127.45	11.27	0.24	0.24
158	128.45	11.27	0.24	0.23
159	129.45	11.27	0.24	0.23
160	130.45	11.27	0.24	0.23
161	131.45	11.27	0.24	0.23
162	132.45	11.26	0.24	0.23
163	133.45	11.26	0.24	0.23
164	134.45	11.26	0.23	0.23
165	135.45	11.26	0.23	0.23
166	136.45	11.26	0.23	0.23
167	137.45	11.26	0.23	0.23
168	138.45	11.26	0.23	0.23
169	139.45	11.26	0.23	0.23
170	140.45	11.26	0.23	0.23
171	141.45	11.26	0.23	0.22
172	142.45	11.26	0.23	0.22
173	143.45	11.26	0.23	0.22
174	144.45	11.26	0.23	0.22
175	145.45	11.25	0.22	0.22
176	146.45	11.25	0.22	0.22
177	147.45	11.25	0.22	0.22
178	148.45	11.25	0.22	0.22
179	149.45	11.25	0.22	0.22
180	150.45	11.25	0.22	0.21
181	151.45	11.25	0.22	0.21
182	152.45	11.26	0.23	0.22
183	153.45	11.25	0.22	0.21
184	154.45	11.25	0.22	0.21
185	155.45	11.25	0.22	0.21
186	156.45	11.25	0.22	0.21
187	157.45	11.25	0.22	0.21
188	158.45	11.25	0.22	0.21
189	159.45	11.24	0.21	0.21
190	160.45	11.24	0.21	0.21
191	161.45	11.24	0.21	0.21
192	162.45	11.24	0.21	0.21
193	163.45	11.24	0.21	0.21
194	164.45	11.24	0.21	0.21
195	165.45	11.24	0.21	0.21
196	166.45	11.24	0.21	0.21
197	167.45	11.24	0.21	0.21
198	168.45	11.24	0.21	0.21
199	169.45	11.24	0.21	0.21
200	170.45	11.24	0.21	0.21

Pumping Test No. 1034 Recovery Test	Test conducted on: 09/28/98
Observation Well 1002	Observation well 1002
Discharge 4.00 U.S.gal/min	Distance from the pumping well 20.00 ft
Static water level: 11.03 ft below datum	Pumping test duration: 717.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
201	171.45	11.24	0.21	0.20
202	172.45	11.24	0.21	0.20
203	173.45	11.24	0.21	0.20
204	174.45	11.24	0.21	0.20
205	175.45	11.24	0.21	0.20
206	176.45	11.24	0.21	0.20
207	177.45	11.24	0.21	0.20
208	178.45	11.24	0.21	0.20
209	179.45	11.24	0.21	0.20
210	180.45	11.24	0.21	0.20
211	181.45	11.23	0.20	0.20
212	182.45	11.23	0.20	0.20
213	183.45	11.23	0.20	0.20
214	184.45	11.23	0.20	0.20
215	185.45	11.23	0.20	0.19
216	186.45	11.23	0.20	0.19
217	187.45	11.23	0.20	0.20
218	188.45	11.23	0.20	[illegible]
219	189.45	11.23	0.20	[illegible]
220	190.45	11.23	0.20	[illegible]
221	191.45	11.23	0.20	0.20
222	192.45	11.23	0.20	0.19
223	193.45	11.23	0.20	0.20
224	194.45	11.23	0.20	0.19
225	195.45	11.23	0.20	0.19
226	196.45	11.23	0.20	0.19
227	197.45	11.23	0.20	0.19
228	198.45	11.22	0.19	0.19
229	199.45	11.23	0.20	0.19
230	200.45	11.23	0.20	0.19
231	201.45	11.22	0.19	0.19
232	202.45	11.22	0.19	0.19
233	203.45	11.22	0.19	0.19
234	204.45	11.22	0.19	0.19
235	205.45	11.22	0.19	0.19
236	206.45	11.22	0.19	0.19
237	207.45	11.22	0.19	0.19
238	208.45	11.22	0.19	0.19
239	209.45	11.22	0.19	0.19
240	210.45	11.22	0.19	0.18
241	211.45	11.22	0.19	0.19
242	212.45	11.22	0.19	0.19
243	213.45	11.21	0.18	[illegible]
244	214.45	11.22	0.19	[illegible]
245	215.45	11.22	0.19	0.18
246	216.45	11.21	0.18	0.18
247	217.45	11.22	0.19	0.18
248	218.45	11.21	0.18	0.18
249	219.45	11.21	0.18	0.18
250	220.45	11.21	0.18	0.18

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Pumping test analysis
Recovery method after
THEIS & JACOB
Unconfined aquifer

1002OR2.HYT, Page 7

Project: UGW -- Grand Junction, CO

Evaluated by: RJH
Date: 11/19/98

Pumping Test No. 1034 Recovery Test	Test conducted on: 09/28/98
Observation Well 1002	Observation well 1002
Discharge 4.00 U.S.gal/min	Distance from the pumping well 20.00 ft
Static water level: 11.03 ft below datum	Pumping test duration: 717.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
251	221.45	11.21	0.18	0.18
252	222.45	11.21	0.18	0.18
253	223.45	11.21	0.18	0.18
254	224.45	11.21	0.18	0.18
255	225.45	11.21	0.18	0.18
256	226.45	11.21	0.18	0.18
257	227.45	11.21	0.18	0.18
258	228.45	11.21	0.18	0.17
259	229.45	11.21	0.18	0.17
260	230.45	11.21	0.18	0.17
261	231.45	11.21	0.18	0.17
262	232.45	11.21	0.18	0.17
263	233.45	11.21	0.18	0.17
264	234.45	11.20	0.17	0.17
265	235.45	11.21	0.18	0.17
266	236.45	11.21	0.18	0.17
267	237.45	11.21	0.18	0.17
268	238.45	11.20	0.17	0.17
269	239.45	11.20	0.17	0.17
270	240.45	11.20	0.17	0.17
271	241.45	11.20	0.17	0.17
272	242.45	11.20	0.17	0.17
273	243.45	11.20	0.17	0.17
274	244.45	11.20	0.17	0.17
275	245.45	11.20	0.17	0.17
276	246.45	11.20	0.17	0.17
277	247.45	11.20	0.17	0.17
278	248.45	11.20	0.17	0.16
279	249.45	11.20	0.17	0.16
280	250.45	11.20	0.17	0.16
281	251.45	11.20	0.17	0.16
282	252.45	11.20	0.17	0.16
283	253.45	11.20	0.17	0.16
284	254.45	11.20	0.17	0.16
285	255.45	11.19	0.16	0.16
286	256.45	11.19	0.16	0.16
287	257.45	11.19	0.16	0.16
288	258.45	11.19	0.16	0.16
289	259.45	11.19	0.16	0.16
290	260.45	11.19	0.16	0.16
291	261.45	11.19	0.16	0.16
292	262.45	11.19	0.16	0.16
293	263.45	11.19	0.16	0.16
294	264.45	11.19	0.16	0.16
295	265.45	11.19	0.16	0.16
296	266.45	11.19	0.16	0.15
297	267.45	11.19	0.16	0.15
298	268.45	11.19	0.16	0.15
299	269.45	11.19	0.16	0.15
300	270.45	11.19	0.16	0.15

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1002OR2.HYT, Page 8 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/19/98

Pumping Test No. 1034 Recovery Test	Test conducted on: 09/28/98
Observation Well 1002	Observation well 1002
Discharge 4.00 U.S.gal/min	Distance from the pumping well 20.00 ft
Static water level: 11.03 ft below datum	Pumping test duration: 717.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
301	271.45	11.18	0.15	0.15
302	272.45	11.18	0.15	0.15
303	273.45	11.18	0.15	0.15
304	274.45	11.18	0.15	0.15
305	275.45	11.18	0.15	0.15
306	276.45	11.18	0.15	0.15
307	277.45	11.18	0.15	0.15
308	278.45	11.18	0.15	0.15
309	279.45	11.18	0.15	0.15
310	280.45	11.18	0.15	0.15
311	281.45	11.18	0.15	0.15
312	282.45	11.18	0.15	0.15
313	283.45	11.18	0.15	0.15
314	284.45	11.18	0.15	0.14
315	285.45	11.18	0.15	0.14
316	286.45	11.17	0.14	0.14
317	287.45	11.18	0.15	0.14
318	288.45	11.17	0.14	0[illegible]
319	289.45	11.18	0.15	[illegible]
320	290.45	11.17	0.14	0.[illegible]
321	291.45	11.17	0.14	0.14
322	292.45	11.17	0.14	0.14
323	293.45	11.17	0.14	0.14
324	294.45	11.17	0.14	0.14
325	295.45	11.17	0.14	0.14
326	296.45	11.17	0.14	0.14
327	297.45	11.17	0.14	0.14
328	298.45	11.16	0.13	0.13
329	299.45	11.17	0.14	0.14
330	300.45	11.16	0.13	0.13
331	301.45	11.17	0.14	0.14
332	302.45	11.17	0.14	0.14
333	303.45	11.17	0.14	0.14
334	304.45	11.16	0.13	0.13
335	305.45	11.17	0.14	0.14
336	306.45	11.16	0.13	0.13
337	307.45	11.16	0.13	0.13
338	308.45	11.16	0.13	0.13
339	309.45	11.16	0.13	0.13
340	310.45	11.16	0.13	0.13
341	311.45	11.16	0.13	0.13
342	312.45	11.16	0.13	0.13
343	313.45	11.16	0.13	0.[illegible]
344	314.45	11.16	0.13	0.[illegible]
345	315.45	11.16	0.13	0.1[illegible]
346	316.45	11.16	0.13	0.13
347	317.45	11.16	0.13	0.13
348	318.45	11.16	0.13	0.13
349	319.45	11.16	0.13	0.13
350	320.45	11.16	0.13	0.13

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1002OR2.HYT, Page 9 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/19/98

Pumping Test No. 1034 Recovery Test	Test conducted on: 09/28/98
Observation Well 1002	Observation well 1002
Discharge 4.00 U.S.gal/min	Distance from the pumping well 20.00 ft
Static water level: 11.03 ft below datum	Pumping test duration: 717.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
351	321.45	11.16	0.13	0.13
352	322.45	11.16	0.13	0.13
353	323.45	11.16	0.13	0.13
354	324.45	11.16	0.13	0.13
355	325.45	11.16	0.13	0.13
356	326.45	11.16	0.13	0.13
357	327.45	11.16	0.13	0.13
358	328.45	11.16	0.13	0.13
359	329.45	11.16	0.13	0.13
360	330.45	11.16	0.13	0.13
361	331.45	11.16	0.13	0.13
362	332.45	11.16	0.13	0.12
363	333.45	11.16	0.13	0.13
364	334.45	11.16	0.13	0.13
365	335.45	11.16	0.13	0.12
366	336.45	11.16	0.13	0.12
367	337.45	11.16	0.13	0.12
368	338.45	11.16	0.13	0.12
369	339.45	11.15	0.12	0.12
370	340.45	11.16	0.13	0.12
371	341.45	11.15	0.12	0.12
372	342.45	11.15	0.12	0.12
373	343.45	11.15	0.12	0.12
374	344.45	11.15	0.12	0.12
375	345.45	11.15	0.12	0.12
376	346.45	11.15	0.12	0.12
377	347.45	11.15	0.12	0.12
378	348.45	11.15	0.12	0.12
379	349.45	11.15	0.12	0.12
380	350.45	11.15	0.12	0.12
381	351.45	11.15	0.12	0.12
382	352.45	11.15	0.12	0.12
383	353.45	11.15	0.12	0.12
384	354.45	11.15	0.12	0.12
385	355.45	11.15	0.12	0.12
386	356.45	11.15	0.12	0.12
387	357.45	11.15	0.12	0.12
388	358.45	11.15	0.12	0.12
389	359.45	11.15	0.12	0.12
390	360.45	11.15	0.12	0.12
391	361.45	11.15	0.12	0.12
392	362.45	11.15	0.12	0.12
393	363.45	11.15	0.12	0.11
394	364.45	11.15	0.12	0.11
395	365.45	11.15	0.12	0.11
396	366.45	11.14	0.11	0.11
397	367.45	11.14	0.11	0.11
398	368.45	11.15	0.12	0.11
399	369.45	11.14	0.11	0.11
400	370.45	11.14	0.11	0.11

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Grand Junction, CO 81503
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Pumping test analysis
Recovery method after
THEIS & JACOB
Unconfined aquifer

Project: UGW -- Grand Junction, CO

Evaluated by: RJH
Date: 11/19/98

Pumping Test No. 1034 Recovery Test	Test conducted on: 09/28/98
Observation Well 1002	Observation well 1002
Discharge 4.00 U.S.gal/min	Distance from the pumping well 20.00 ft
Static water level: 11.03 ft below datum	Pumping test duration: 717.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
401	371.45	11.14	0.11	0.11
402	372.45	11.14	0.11	0.11
403	373.45	11.14	0.11	0.11
404	374.45	11.14	0.11	0.11
405	375.45	11.14	0.11	0.11
406	376.45	11.14	0.11	0.11
407	377.45	11.14	0.11	0.11
408	378.45	11.14	0.11	0.11
409	379.45	11.14	0.11	0.11
410	380.45	11.14	0.11	0.11
411	381.45	11.14	0.11	0.11
412	382.45	11.14	0.11	0.11
413	383.45	11.14	0.11	0.11
414	384.45	11.14	0.11	0.11
415	385.45	11.14	0.11	0.11
416	386.45	11.14	0.11	0.11
417	387.45	11.14	0.11	0.11
418	388.45	11.13	0.10	0
419	389.45	11.13	0.10	[illegible]
420	390.45	11.13	0.10	0.
421	391.45	11.13	0.10	0.10
422	392.45	11.13	0.10	0.10
423	393.45	11.13	0.10	0.10
424	394.45	11.13	0.10	0.10
425	395.45	11.13	0.10	0.10
426	396.45	11.13	0.10	0.10
427	397.45	11.13	0.10	0.10
428	398.45	11.13	0.10	0.10
429	399.45	11.13	0.10	0.10
430	400.45	11.13	0.10	0.10
431	401.45	11.13	0.10	0.10
432	402.45	11.13	0.10	0.10
433	403.45	11.13	0.10	0.10
434	404.45	11.13	0.10	0.10
435	405.45	11.13	0.10	0.10
436	406.45	11.13	0.10	0.10
437	407.45	11.13	0.10	0.10
438	408.45	11.13	0.10	0.10
439	409.45	11.13	0.10	0.10
440	410.45	11.13	0.10	0.10
441	411.45	11.13	0.10	0.10
442	412.45	11.13	0.10	0.10
443	413.45	11.13	0.10	0.
444	414.45	11.13	0.10	0
445	415.45	11.13	0.10	0.1
446	416.45	11.13	0.10	0.10
447	417.45	11.13	0.10	0.10
448	418.45	11.13	0.10	0.10
449	419.45	11.13	0.10	0.10
450	420.45	11.12	0.09	0.09

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1002OR2.HYT, Page 11 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/19/98

Pumping Test No. 1034 Recovery Test	Test conducted on: 09/28/98
Observation Well 1002	Observation well 1002
Discharge 4.00 U.S.gal/min	Distance from the pumping well 20.00 ft
Static water level: 11.03 ft below datum	Pumping test duration: 717.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
451	421.45	11.13	0.10	0.10
452	422.45	11.13	0.10	0.10
453	423.45	11.12	0.09	0.09
454	424.45	11.13	0.10	0.10
455	425.45	11.12	0.09	0.09
456	426.45	11.13	0.10	0.10
457	427.45	11.12	0.09	0.09
458	428.45	11.12	0.09	0.09
459	429.45	11.13	0.10	0.10
460	430.45	11.12	0.09	0.09
461	431.45	11.12	0.09	0.09
462	432.45	11.12	0.09	0.09
463	433.45	11.12	0.09	0.09
464	434.45	11.12	0.09	0.09
465	435.45	11.12	0.09	0.09
466	436.45	11.12	0.09	0.09
467	437.45	11.12	0.09	0.09
468	438.45	11.12	0.09	0.09
469	439.45	11.12	0.09	0.09
470	440.45	11.12	0.09	0.09
471	441.45	11.12	0.09	0.08
472	442.45	11.12	0.09	0.09
473	443.45	11.12	0.09	0.09
474	444.45	11.12	0.09	0.09
475	445.45	11.12	0.09	0.09
476	446.45	11.12	0.09	0.09
477	447.45	11.12	0.09	0.09
478	448.45	11.12	0.09	0.09
479	449.45	11.12	0.09	0.09
480	450.45	11.12	0.09	0.09
481	451.45	11.12	0.09	0.09
482	452.45	11.12	0.09	0.08
483	453.45	11.12	0.09	0.09
484	454.45	11.12	0.09	0.08
485	455.45	11.12	0.09	0.08
486	456.45	11.12	0.09	0.09
487	457.45	11.12	0.09	0.09
488	458.45	11.11	0.08	0.08
489	459.45	11.12	0.09	0.08
490	460.45	11.12	0.09	0.08
491	461.45	11.12	0.09	0.08
492	462.45	11.11	0.08	0.08
493	463.45	11.11	0.08	0.08
494	464.45	11.12	0.09	0.08
495	465.45	11.11	0.08	0.08
496	466.45	11.11	0.08	0.08
497	467.45	11.11	0.08	0.08
498	468.45	11.11	0.08	0.08
499	469.45	11.11	0.08	0.08
500	470.45	11.11	0.08	0.08

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1002OR2.HYT, Page 12 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/19/98

Pumping Test No. 1034 Recovery Test	Test conducted on: 09/28/98
Observation Well 1002	Observation well 1002
Discharge 4.00 U.S.gal/min	Distance from the pumping well 20.00 ft
Static water level: 11.03 ft below datum	Pumping test duration: 717.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
501	471.45	11.11	0.08	0.08
502	472.45	11.11	0.08	0.08
503	473.45	11.11	0.08	0.08
504	474.45	11.11	0.08	0.08
505	475.45	11.11	0.08	0.08
506	476.45	11.11	0.08	0.08
507	477.45	11.11	0.08	0.08
508	478.45	11.11	0.08	0.08
509	479.45	11.11	0.08	0.08
510	480.45	11.11	0.08	0.08
511	481.45	11.11	0.08	0.08
512	482.45	11.11	0.08	0.08
513	483.45	11.11	0.08	0.08
514	484.45	11.11	0.08	0.08
515	485.45	11.11	0.08	0.08
516	486.45	11.11	0.08	0.08
517	487.45	11.11	0.08	0.08
518	488.45	11.10	0.07	[illegible]
519	489.45	11.10	0.07	[illegible]
520	490.45	11.11	0.08	0.08
521	491.45	11.11	0.08	0.08
522	492.45	11.10	0.07	0.07
523	493.45	11.10	0.07	0.07
524	494.45	11.10	0.07	0.07
525	495.45	11.11	0.08	0.08
526	496.45	11.10	0.07	0.07
527	497.45	11.10	0.07	0.07
528	498.45	11.10	0.07	0.07
529	499.45	11.10	0.07	0.07
530	500.45	11.10	0.07	0.07
531	501.45	11.10	0.07	0.07
532	502.45	11.10	0.07	0.07
533	503.45	11.10	0.07	0.07
534	504.45	11.10	0.07	0.07
535	505.45	11.10	0.07	0.07
536	506.45	11.10	0.07	0.07
537	507.45	11.10	0.07	0.07
538	508.45	11.10	0.07	0.07
539	509.45	11.10	0.07	0.07
540	510.45	11.10	0.07	0.07
541	511.45	11.10	0.07	0.07
542	512.45	11.10	0.07	0.07
543	513.45	11.10	0.07	[illegible]
544	514.45	11.10	0.07	[illegible]
545	515.45	11.10	0.07	0.07
546	516.45	11.10	0.07	0.07
547	517.45	11.10	0.07	0.07
548	518.45	11.10	0.07	0.07
549	519.45	11.10	0.07	0.07
550	520.45	11.10	0.07	0.07

MACTEC-ERS
2597 B 3/4 Road
Grand Junction, CO 81503
970/248-6040

Pumping test analysis
Recovery method after
THEIS & JACOB
Unconfined aquifer

Project: UGW – Grand Junction, CO

Evaluated by: RJH | Date: 11/19/98

Pumping Test No. 1034 Recovery Test	Test conducted on: 09/28/98
Observation Well 1002	Observation well 1002
Discharge 4.00 U.S.gal/min	Distance from the pumping well 20.00 ft
Static water level: 11.03 ft below datum	Pumping test duration: 717.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
551	521.45	11.10	0.07	0.07
552	522.45	11.10	0.07	0.07
553	523.45	11.10	0.07	0.07
554	524.45	11.10	0.07	0.07
555	525.45	11.10	0.07	0.07
556	526.45	11.10	0.07	0.07
557	527.45	11.10	0.07	0.07
558	528.45	11.09	0.06	0.06
559	529.45	11.10	0.07	0.07
560	530.45	11.09	0.06	0.06
561	531.45	11.10	0.07	0.07
562	532.45	11.09	0.06	0.06
563	533.45	11.09	0.06	0.06
564	534.45	11.10	0.07	0.07
565	535.45	11.09	0.06	0.06
566	536.45	11.09	0.06	0.06
567	537.45	11.09	0.06	0.06
568	538.45	11.09	0.06	0.06
569	539.45	11.09	0.06	0.06
570	540.45	11.09	0.06	0.06
571	541.45	11.09	0.06	0.06
572	542.45	11.09	0.06	0.06
573	543.45	11.09	0.06	0.06
574	544.45	11.09	0.06	0.06
575	545.45	11.09	0.06	0.06
576	546.45	11.09	0.06	0.06
577	547.45	11.09	0.06	0.06
578	548.45	11.09	0.06	0.06
579	549.45	11.09	0.06	0.06
580	550.45	11.09	0.06	0.06
581	551.45	11.09	0.06	0.06
582	552.45	11.09	0.06	0.06
583	553.45	11.09	0.06	0.06
584	554.45	11.09	0.06	0.06
585	555.45	11.09	0.06	0.06
586	556.45	11.09	0.06	0.06
587	557.45	11.09	0.06	0.06
588	558.45	11.09	0.06	0.06
589	559.45	11.09	0.06	0.06
590	560.45	11.09	0.06	0.06
591	561.45	11.09	0.06	0.06
592	562.45	11.09	0.06	0.06
593	563.45	11.09	0.06	0.06
594	564.45	11.09	0.06	0.06
595	565.45	11.09	0.06	0.06
596	566.45	11.09	0.06	0.06
597	567.45	11.09	0.06	0.06
598	568.45	11.09	0.06	0.06
599	569.45	11.09	0.06	0.06
600	570.45	11.09	0.06	0.06

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1002OR2.HYT, Page 14 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/19/98

Pumping Test No. 1034 Recovery Test	Test conducted on: 09/28/98
Observation Well 1002	Observation well 1002
Discharge 4.00 U.S.gal/min	Distance from the pumping well 20.00 ft
Static water level: 11.03 ft below datum	Pumping test duration: 717.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
601	571.45	11.09	0.06	0.06
602	572.45	11.09	0.06	0.06
603	573.45	11.09	0.06	0.06
604	574.45	11.09	0.06	0.06
605	575.45	11.09	0.06	0.06
606	576.45	11.09	0.06	0.06
607	577.45	11.09	0.06	0.06
608	578.45	11.09	0.06	0.06
609	579.45	11.09	0.06	0.06
610	580.45	11.09	0.06	0.06
611	581.45	11.09	0.06	0.06
612	582.45	11.09	0.06	0.06
613	583.45	11.09	0.06	0.06
614	584.45	11.09	0.06	0.06
615	585.45	11.09	0.06	0.06
616	586.45	11.09	0.06	0.06
617	587.45	11.09	0.06	0.06
618	588.45	11.09	0.06	[illegible]
619	589.45	11.09	0.06	[illegible]
620	590.45	11.09	0.06	0.06
621	591.45	11.09	0.06	0.06
622	592.45	11.09	0.06	0.06
623	593.45	11.09	0.06	0.06
624	594.45	11.09	0.06	0.06
625	595.45	11.09	0.06	0.06
626	596.45	11.09	0.06	0.05
627	597.45	11.09	0.06	0.06
628	598.45	11.09	0.06	0.05
629	599.45	11.09	0.06	0.05
630	600.45	11.09	0.06	0.05
631	601.45	11.09	0.06	0.06
632	602.45	11.09	0.06	0.06
633	603.45	11.09	0.06	0.05
634	604.45	11.09	0.06	0.05
635	605.45	11.09	0.06	0.05
636	606.45	11.09	0.06	0.05
637	607.45	11.09	0.06	0.05
638	608.45	11.09	0.06	0.05
639	609.45	11.08	0.05	0.05
640	610.45	11.09	0.06	0.05
641	611.45	11.09	0.06	0.05
642	612.45	11.08	0.05	0.05
643	613.45	11.08	0.05	0
644	614.45	11.09	0.06	0.
645	615.45	11.08	0.05	0.05
646	616.45	11.08	0.05	0.05
647	617.45	11.08	0.05	0.05
648	618.45	11.08	0.05	0.05
649	619.45	11.09	0.06	0.05
650	620.45	11.08	0.05	0.05

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1002OR2.HYT, Page 15 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/19/98

Pumping Test No. 1034 Recovery Test	Test conducted on: 09/28/98
Observation Well 1002	Observation well 1002
Discharge 4.00 U.S.gal/min	Distance from the pumping well 20.00 ft
Static water level: 11.03 ft below datum	Pumping test duration: 717.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
651	621.45	11.08	0.05	0.05
652	622.45	11.08	0.05	0.05
653	623.45	11.08	0.05	0.05
654	624.45	11.08	0.05	0.05
655	625.45	11.08	0.05	0.05
656	626.45	11.08	0.05	0.05
657	627.45	11.08	0.05	0.05
658	628.45	11.08	0.05	0.05
659	629.45	11.08	0.05	0.05
660	630.45	11.08	0.05	0.05
661	631.45	11.08	0.05	0.05
662	632.45	11.08	0.05	0.05
663	633.45	11.08	0.05	0.05
664	634.45	11.08	0.05	0.05
665	635.45	11.08	0.05	0.05
666	636.45	11.08	0.05	0.05
667	637.45	11.08	0.05	0.05
668	638.45	11.08	0.05	0.05
669	639.45	11.08	0.05	0.05
670	640.45	11.08	0.05	0.05
671	641.45	11.08	0.05	0.05
672	642.45	11.08	0.05	0.05
673	643.45	11.08	0.05	0.05
674	644.45	11.08	0.05	0.05
675	645.45	11.08	0.05	0.05
676	646.45	11.08	0.05	0.05

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PUMPING WELL 1034

OBSERVATION WELL 1013

DRAWDOWN AND RECOVERY DATA ANALYSES

MACTEC-ERS
2597 B 3/4 Road
Grand Junction, CO 81503
970/248-6040

Pumping test analysis
Time-Drawdown plot
with discharge

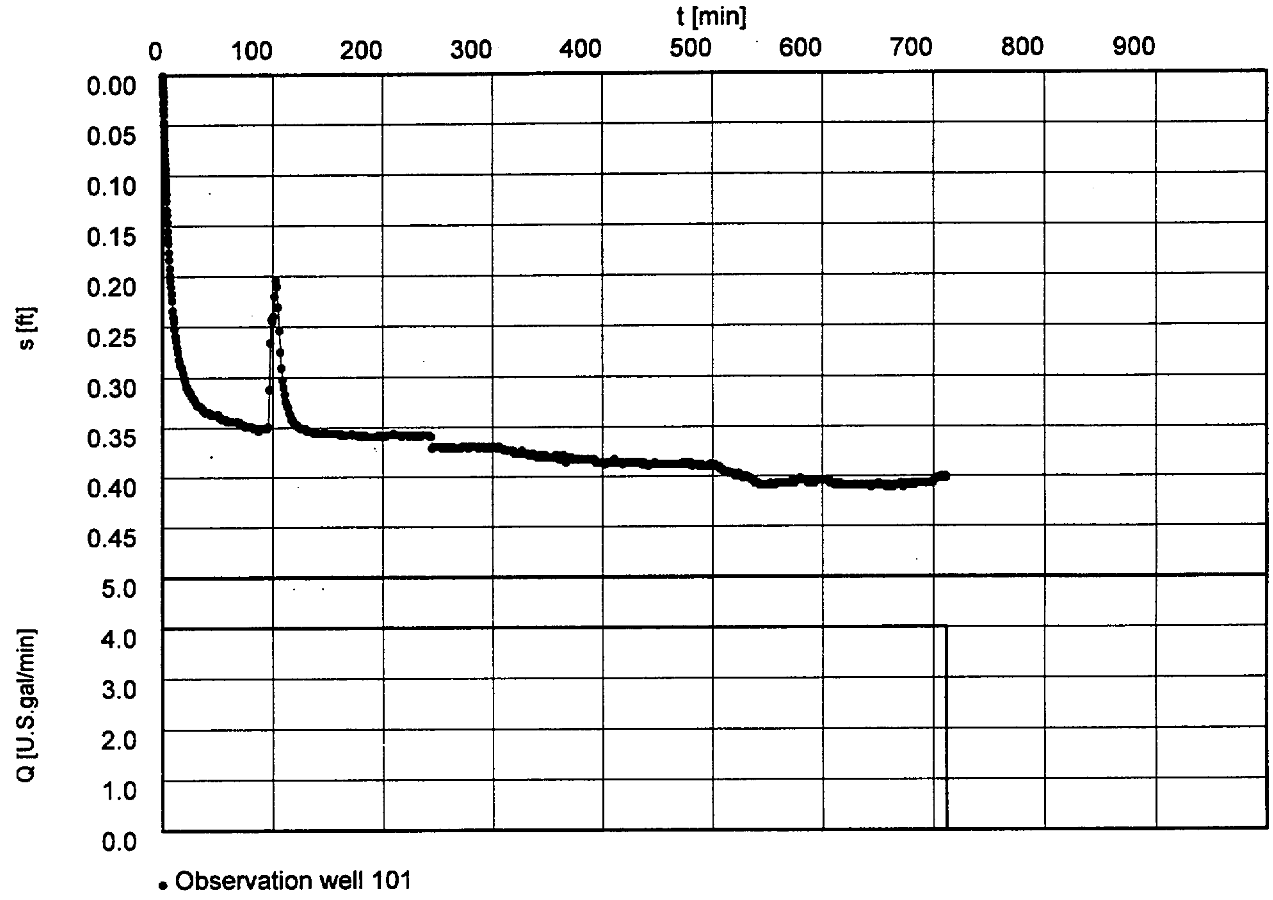
1013OA2.HYT, Page 1

Project: UGW -- Grand Junction, CO

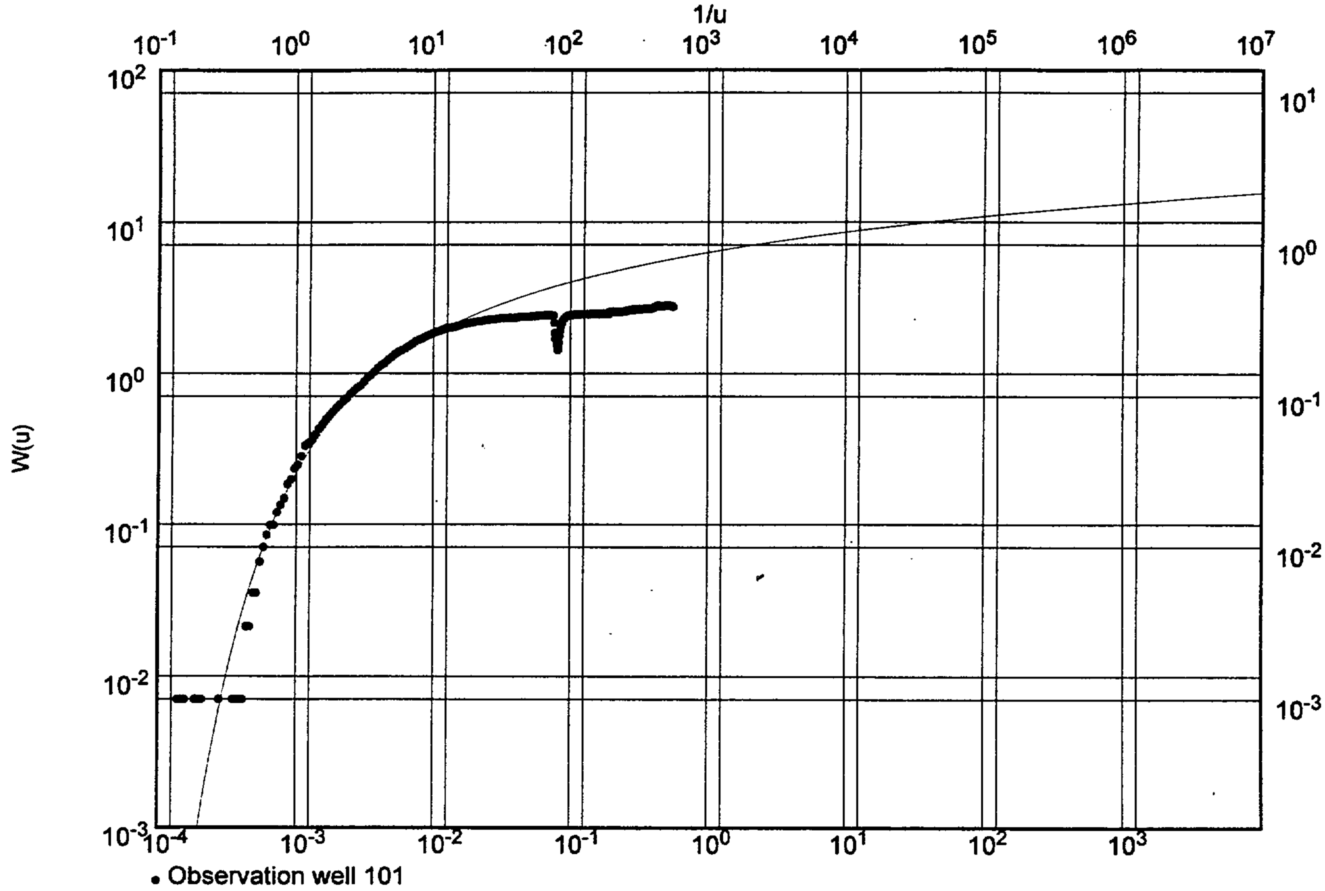
Evaluated by: RJH

Date: 11/18/98

Pumping Test No. 1034 Aquifer Test	Test conducted on: 09/28/98
Observation Well 1013	
Discharge 4.00 U.S.gal/min	



MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Theis analysis method Unconfined aquifer	1013OA2.HYT, Page 1 Project: UGW -- Grand Junction, CO	
		Evaluated by: RJH	Date: 11/18/98
Pumping Test No. 1034 Aquifer Test		Test conducted on: 09/28/98	
Observation Well 1013			
Discharge 4.00 U.S.gal/min			



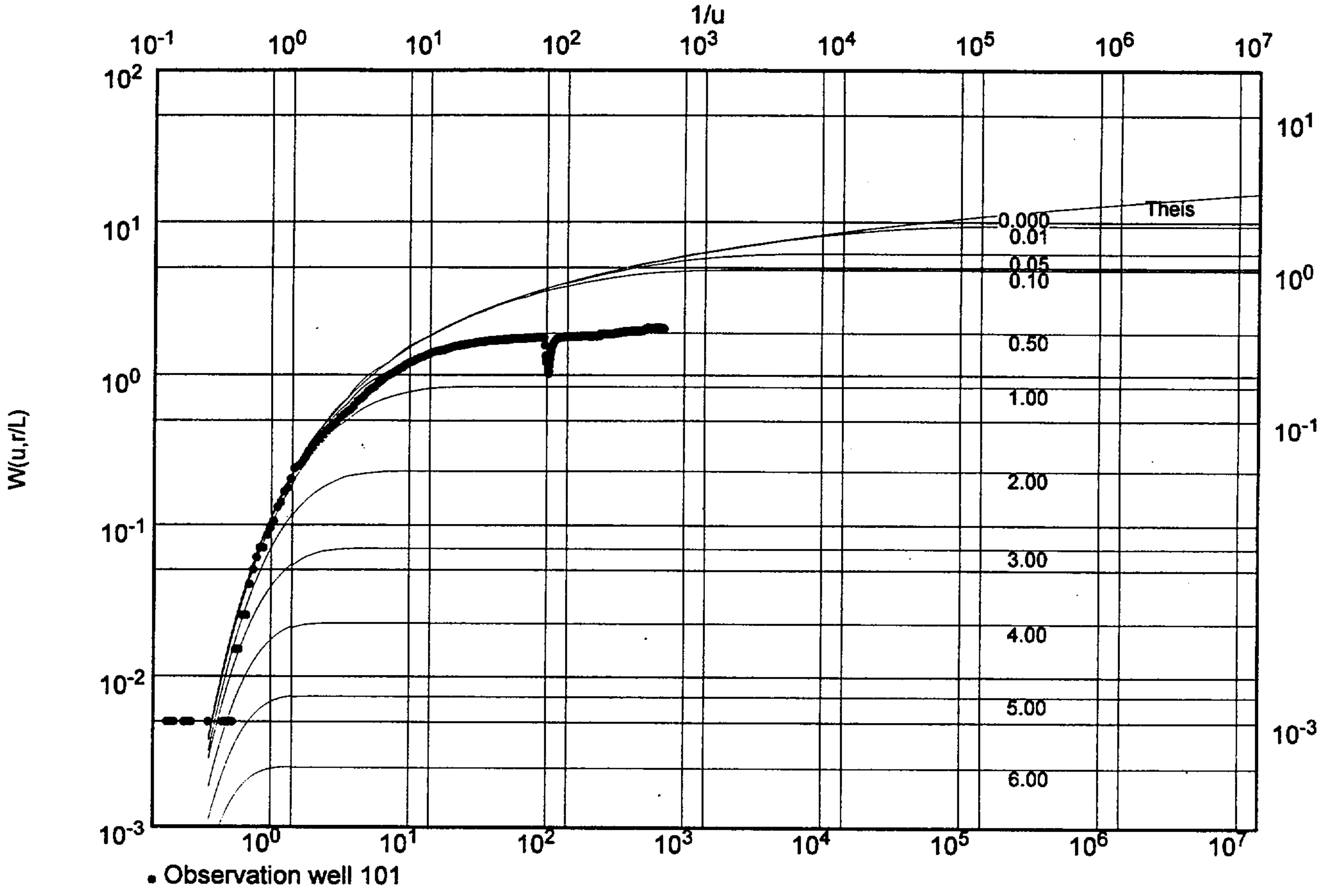
Transmissivity [ft²/min]: 3.01 x 10^{-1} 433.44 ft²/day

Hydraulic conductivity [ft/min]: 3.76 x 10^{-2} 54.14 ft/day

Aquifer thickness [ft]: 8.00

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis HANTUSH's method Leaky aquifer, no aquitard storage	1013OA2.HYT, Page 1 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/18/98

Pumping Test No. 1034 Aquifer Test	Test conducted on: 09/28/98
Observation Well 1013	
Discharge 4.00 U.S.gal/min	



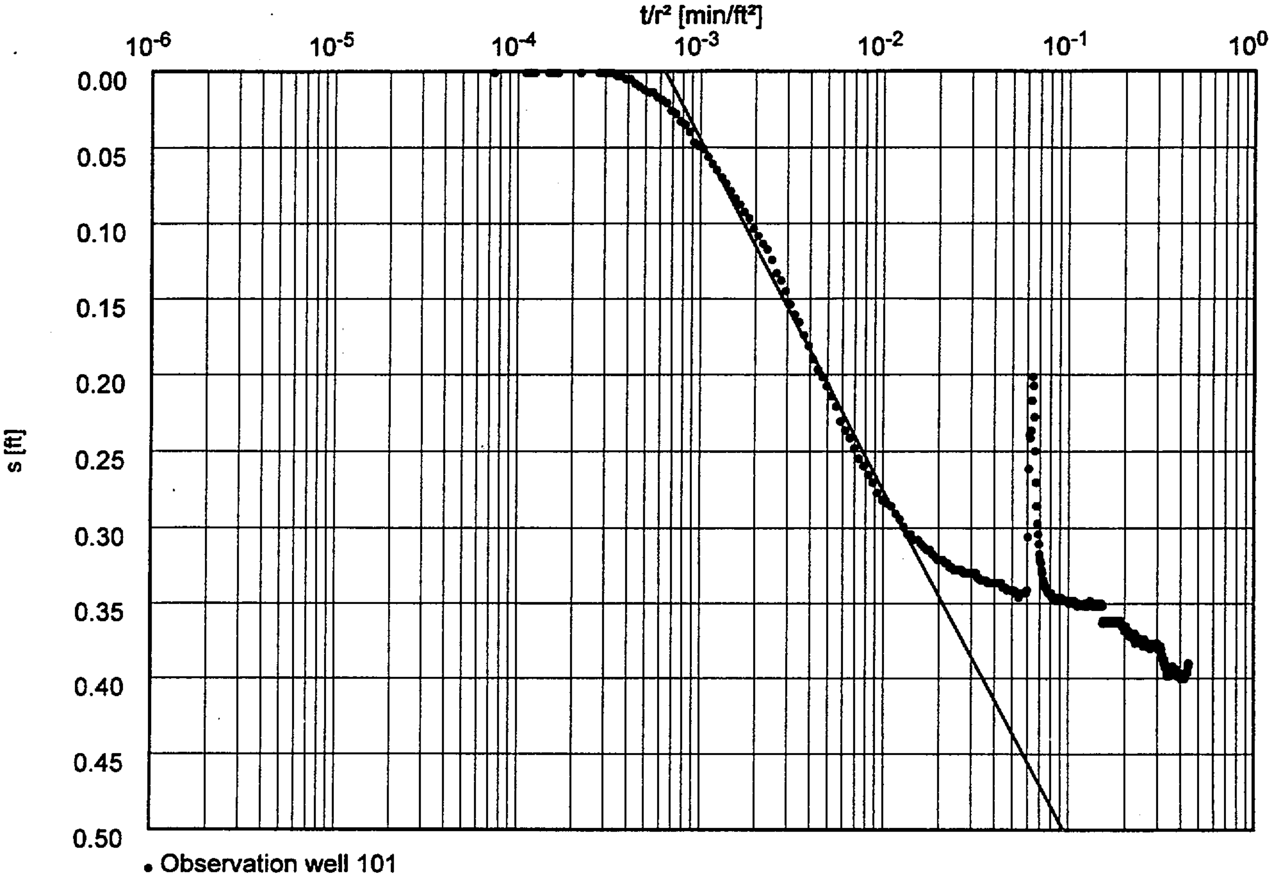
Transmissivity [ft²/min]: 2.13 x 10^{-1} 306.72 ft²/day

Hydraulic conductivity [ft/min]: 2.66 x 10^{-2} 38.30 ft/day

Aquifer thickness [ft]: 8.00

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Distance-Time-Drawdown-method after COOPER & JACOB Unconfined aquifer	1013OA2.HYT, Page 1 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/18/98

Pumping Test No. 1034 Aquifer Test	Test conducted on: 09/28/98
Observation Well 1013	
Discharge 4.00 U.S.gal/min	



Transmissivity [ft²/min]: 4.24 x 10^{-1} 610.56 ft²/day

Hydraulic conductivity [ft/min]: 5.30 x 10^{-2} 76.32 ft/day

Aquifer thickness [ft]: 8.00

MACTEC-ERS
2597 B 3/4 Road
Grand Junction, CO 81503
970/248-6040

Pumping test analysis
Theis analysis method
Unconfined aquifer

1013OA2.HYT, Page 2
Project: UGW -- Grand Junction, CO
Evaluated by: RJH
Date: 11/18/98

Pumping Test No. 1034 Aquifer Test	Test conducted on: 09/28/98
Observation Well 1013	Observation well 1013
Discharge 4.00 U.S.gal/min	Distance from the pumping well 40.00 ft

Static water level: 12.24 ft below datum

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
2	0.01	12.24	-0.00	-0.00
3	0.01	12.24	-0.00	-0.00
4	0.02	12.24	-0.00	-0.00
5	0.02	12.24	-0.00	-0.00
6	0.03	12.24	-0.00	-0.00
7	0.03	12.24	-0.00	-0.00
8	0.04	12.24	-0.00	-0.00
9	0.04	12.24	-0.00	-0.00
10	0.05	12.24	-0.00	-0.00
11	0.05	12.24	-0.00	-0.00
12	0.06	12.24	-0.00	-0.00
13	0.06	12.24	-0.00	-0.00
14	0.07	12.24	-0.00	-0.00
15	0.07	12.24	-0.00	-0.00
16	0.08	12.24	-0.00	-0.00
17	0.08	12.24	-0.00	-0.00
18	0.09	12.24	-0.00	-0
19	0.09	12.24	-0.00	-
20	0.10	12.24	-0.00	-0.00
21	0.10	12.24	-0.00	-0.00
22	0.11	12.24	-0.00	-0.00
23	0.11	12.24	-0.00	-0.00
24	0.12	12.24	0.00	0.00
25	0.13	12.24	-0.00	-0.00
26	0.13	12.24	-0.00	-0.00
27	0.14	12.24	-0.00	-0.00
28	0.15	12.24	-0.00	-0.00
29	0.16	12.24	-0.00	-0.00
30	0.17	12.24	-0.00	-0.00
31	0.18	12.24	0.00	0.00
32	0.19	12.24	0.00	0.00
33	0.20	12.24	0.00	0.00
34	0.21	12.24	-0.00	-0.00
35	0.22	12.24	-0.00	-0.00
36	0.24	12.24	0.00	0.00
37	0.25	12.24	0.00	0.00
38	0.26	12.24	0.00	0.00
39	0.28	12.24	-0.00	-0.00
40	0.30	12.24	-0.00	-0.00
41	0.31	12.24	-0.00	-0.00
42	0.33	12.24	-0.00	-0.00
43	0.35	12.24	0.00	0
44	0.37	12.24	-0.00	-0
45	0.40	12.24	-0.00	-0.00
46	0.42	12.24	-0.00	-0.00
47	0.44	12.24	0.00	0.00
48	0.47	12.24	0.00	0.00
49	0.50	12.24	0.00	0.00
50	0.52	12.24	0.00	0.00

Pumping test analysis
Theis analysis method
Unconfined aquifer

Project: UGW -- Grand Junction, CO

Evaluated by: RJH | Date: 11/18/98

Pumping Test No. 1034 Aquifer Test | Test conducted on: 09/28/98

Observation Well 1013 | Observation well 1013

Discharge 4.00 U.S.gal/min | Distance from the pumping well 40.00 ft

Static water level: 12.24 ft below datum

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
51	0.55	12.24	0.00	0.00
52	0.59	12.24	0.00	0.00
53	0.62	12.24	0.00	0.00
54	0.66	12.24	0.00	0.00
55	0.70	12.25	0.01	0.01
56	0.74	12.25	0.01	0.01
57	0.78	12.25	0.01	0.01
58	0.83	12.25	0.01	0.01
59	0.88	12.25	0.01	0.01
60	0.93	12.26	0.02	0.02
61	0.98	12.26	0.02	0.02
62	1.04	12.26	0.02	0.02
63	1.10	12.27	0.03	0.03
64	1.17	12.27	0.03	0.03
65	1.24	12.27	0.03	0.03
66	1.31	12.27	0.03	0.03
67	1.39	12.28	0.04	0.04
68	1.47	12.29	0.05	0.05
69	1.56	12.29	0.05	0.05
70	1.65	12.29	0.05	0.05
71	1.75	12.30	0.06	0.06
72	1.86	12.30	0.06	0.06
73	1.97	12.30	0.06	0.06
74	2.08	12.31	0.07	0.07
75	2.21	12.31	0.07	0.07
76	2.34	12.32	0.08	0.08
77	2.48	12.32	0.08	0.08
78	2.63	12.33	0.09	0.09
79	2.79	12.33	0.09	0.09
80	2.95	12.34	0.10	0.10
81	3.13	12.34	0.10	0.10
82	3.32	12.35	0.11	0.11
83	3.51	12.35	0.11	0.11
84	3.72	12.36	0.12	0.12
85	3.95	12.37	0.13	0.12
86	4.18	12.37	0.13	0.13
87	4.43	12.38	0.14	0.14
88	4.69	12.39	0.15	0.14
89	4.97	12.40	0.15	0.15
90	5.27	12.40	0.16	0.16
91	5.58	12.41	0.17	0.17
92	5.91	12.42	0.18	0.17
93	6.27	12.42	0.18	0.18
94	6.64	12.43	0.19	0.19
95	7.03	12.44	0.20	0.20
96	7.45	12.44	0.20	0.20
97	7.90	12.45	0.21	0.21
98	8.37	12.46	0.22	0.21
99	8.86	12.46	0.22	0.22
100	9.39	12.47	0.23	0.23

Pumping Test No. 1034 Aquifer Test	Test conducted on: 09/28/98
Observation Well 1013	Observation well 1013
Discharge 4.00 U.S.gal/min	Distance from the pumping well 40.00 ft

Static water level: 12.24 ft below datum

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
101	9.95	12.48	0.24	0.24
102	10.54	12.49	0.24	0.24
103	11.17	12.49	0.25	0.25
104	11.83	12.50	0.26	0.25
105	12.53	12.50	0.26	0.26
106	13.28	12.51	0.27	0.27
107	14.07	12.51	0.27	0.27
108	14.91	12.52	0.28	0.28
109	15.79	12.53	0.29	0.28
110	16.73	12.53	0.29	0.28
111	17.72	12.53	0.29	0.29
112	18.72	12.54	0.30	0.29
113	19.72	12.54	0.30	0.29
114	20.72	12.54	0.30	0.30
115	21.72	12.55	0.31	0.30
116	22.72	12.55	0.31	0.30
117	23.72	12.55	0.31	0.31
118	24.72	12.55	0.31	[illegible]
119	25.72	12.56	0.32	[illegible]
120	26.72	12.56	0.32	0.31
121	27.72	12.56	0.32	0.31
122	28.72	12.56	0.32	0.31
123	29.72	12.56	0.32	0.32
124	30.72	12.57	0.33	0.32
125	31.72	12.57	0.33	0.32
126	32.72	12.57	0.33	0.32
127	33.72	12.57	0.33	0.32
128	34.72	12.57	0.33	0.32
129	35.72	12.57	0.33	0.32
130	36.72	12.57	0.33	0.33
131	37.72	12.57	0.33	0.33
132	38.72	12.57	0.33	0.33
133	39.72	12.57	0.33	0.33
134	40.72	12.57	0.33	0.33
135	41.72	12.57	0.33	0.33
136	42.72	12.57	0.33	0.33
137	43.72	12.58	0.34	0.33
138	44.72	12.58	0.34	0.33
139	45.72	12.58	0.34	0.33
140	46.72	12.58	0.34	0.33
141	47.72	12.58	0.34	0.33
142	48.72	12.58	0.34	0.33
143	49.72	12.58	0.34	[illegible]
144	50.72	12.58	0.34	[illegible]
145	51.72	12.58	0.34	0.33
146	52.72	12.58	0.34	0.33
147	53.72	12.58	0.34	0.33
148	54.72	12.58	0.34	0.33
149	55.72	12.58	0.34	0.33
150	56.72	12.58	0.34	0.33

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Pumping test analysis
Theis analysis method
Unconfined aquifer

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Project: UGW -- Grand Junction, CO
Evaluated by: RJH
Date: 11/18/98

Pumping Test No. 1034 Aquifer Test
Test conducted on: 09/28/98
Observation Well 1013
Observation well 1013
Discharge 4.00 U.S.gal/min
Distance from the pumping well 40.00 ft
Static water level: 12.24 ft below datum

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
151	57.72	12.58	0.34	0.33
152	58.72	12.58	0.34	0.34
153	59.72	12.58	0.34	0.34
154	60.72	12.58	0.34	0.34
155	61.72	12.58	0.34	0.34
156	62.72	12.58	0.34	0.34
157	63.72	12.58	0.34	0.34
158	64.72	12.58	0.34	0.34
159	65.72	12.58	0.34	0.34
160	66.72	12.58	0.34	0.34
161	67.72	12.58	0.34	0.34
162	68.72	12.58	0.34	0.34
163	69.72	12.58	0.34	0.34
164	70.72	12.59	0.35	0.34
165	71.72	12.59	0.35	0.34
166	72.72	12.59	0.35	0.34
167	73.72	12.59	0.35	0.34
168	74.72	12.59	0.35	0.34
169	75.72	12.59	0.35	0.34
170	76.72	12.59	0.35	0.34
171	77.72	12.59	0.35	0.34
172	78.72	12.59	0.35	0.34
173	79.72	12.59	0.35	0.34
174	80.72	12.59	0.35	0.34
175	81.72	12.59	0.35	0.34
176	82.72	12.59	0.35	0.34
177	83.72	12.59	0.35	0.34
178	84.72	12.59	0.35	0.34
179	85.72	12.59	0.35	0.34
180	86.72	12.59	0.35	0.35
181	87.72	12.59	0.35	0.34
182	88.72	12.59	0.35	0.34
183	89.72	12.59	0.35	0.34
184	90.72	12.59	0.35	0.34
185	91.72	12.59	0.35	0.34
186	92.72	12.59	0.35	0.34
187	93.72	12.59	0.35	0.34
188	94.72	12.59	0.35	0.34
189	95.72	12.59	0.35	0.34
190	96.72	12.55	0.31	0.31
191	97.72	12.51	0.27	0.26
192	98.72	12.48	0.24	0.24
193	99.72	12.49	0.24	0.24
194	100.72	12.48	0.24	0.24
195	101.72	12.46	0.22	0.22
196	102.72	12.44	0.20	0.20
197	103.72	12.45	0.21	0.21
198	104.72	12.47	0.23	0.23
199	105.72	12.49	0.25	0.25
200	106.72	12.51	0.27	0.27

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Theis analysis method Unconfined aquifer	1013OA2.HYT, Page 6 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/18/98

Pumping Test No. 1034 Aquifer Test	Test conducted on: 09/28/98
Observation Well 1013	Observation well 1013
Discharge 4.00 U.S.gal/min	Distance from the pumping well 40.00 ft

Static water level: 12.24 ft below datum

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
201	107.72	12.53	0.29	0.29
202	108.72	12.54	0.30	0.30
203	109.72	12.55	0.31	0.30
204	110.72	12.56	0.32	0.31
205	111.72	12.56	0.32	0.32
206	112.72	12.57	0.33	0.32
207	113.72	12.57	0.33	0.32
208	114.72	12.57	0.33	0.33
209	115.72	12.58	0.34	0.33
210	116.72	12.58	0.34	0.33
211	117.72	12.58	0.34	0.33
212	118.72	12.58	0.34	0.34
213	119.72	12.59	0.35	0.34
214	120.72	12.59	0.35	0.34
215	121.72	12.59	0.35	0.34
216	122.72	12.59	0.35	0.34
217	123.72	12.59	0.35	0.34
218	124.72	12.59	0.35	[illegible]
219	125.72	12.59	0.35	[illegible]
220	126.72	12.59	0.35	0.34
221	127.72	12.59	0.35	0.34
222	128.72	12.59	0.35	0.34
223	129.72	12.59	0.35	0.34
224	130.72	12.59	0.35	0.35
225	131.72	12.59	0.35	0.35
226	132.72	12.59	0.35	0.35
227	133.72	12.59	0.35	0.35
228	134.72	12.59	0.35	0.35
229	135.72	12.59	0.35	0.35
230	136.72	12.60	0.36	0.35
231	137.72	12.60	0.36	0.35
232	138.72	12.59	0.35	0.35
233	139.72	12.60	0.36	0.35
234	140.72	12.60	0.36	0.35
235	141.72	12.60	0.36	0.35
236	142.72	12.60	0.36	0.35
237	143.72	12.60	0.36	0.35
238	144.72	12.60	0.36	0.35
239	145.72	12.60	0.36	0.35
240	146.72	12.59	0.35	0.35
241	147.72	12.60	0.36	0.35
242	148.72	12.60	0.36	0.35
243	149.72	12.60	0.36	[illegible]
244	150.72	12.60	0.36	[illegible]
245	151.72	12.60	0.36	0.35
246	152.72	12.60	0.36	0.35
247	153.72	12.60	0.36	0.35
248	154.72	12.60	0.36	0.35
249	155.72	12.60	0.36	0.35
250	156.72	12.60	0.36	0.35

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Pumping test analysis
Theis analysis method
Unconfined aquifer

Project: UGW -- Grand Junction, CO

Evaluated by: RJH | Date: 11/18/98

Pumping Test No. 1034 Aquifer Test

Test conducted on: 09/28/98

Observation Well 1013

Observation well 1013

Discharge 4.00 U.S.gal/min

Distance from the pumping well 40.00 ft

Static water level: 12.24 ft below datum

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
251	157.72	12.60	0.36	0.35
252	158.72	12.60	0.36	0.35
253	159.72	12.60	0.36	0.35
254	160.72	12.60	0.36	0.35
255	161.72	12.60	0.36	0.35
256	162.72	12.60	0.36	0.35
257	163.72	12.60	0.36	0.35
258	164.72	12.60	0.36	0.35
259	165.72	12.60	0.36	0.35
260	166.72	12.60	0.36	0.35
261	167.72	12.60	0.36	0.35
262	168.72	12.60	0.36	0.35
263	169.72	12.60	0.36	0.35
264	170.72	12.60	0.36	0.35
265	171.72	12.60	0.36	0.35
266	172.72	12.60	0.36	0.35
267	173.72	12.60	0.36	0.35
268	174.72	12.60	0.36	0.35
269	175.72	12.60	0.36	0.35
270	176.72	12.60	0.36	0.35
271	177.72	12.60	0.36	0.35
272	178.72	12.60	0.36	0.35
273	179.72	12.60	0.36	0.35
274	180.72	12.60	0.36	0.35
275	181.72	12.60	0.36	0.35
276	182.72	12.60	0.36	0.35
277	183.72	12.60	0.36	0.35
278	184.72	12.60	0.36	0.35
279	185.72	12.60	0.36	0.35
280	186.72	12.60	0.36	0.35
281	187.72	12.60	0.36	0.35
282	188.72	12.60	0.36	0.35
283	189.72	12.60	0.36	0.35
284	190.72	12.60	0.36	0.35
285	191.72	12.60	0.36	0.35
286	192.72	12.60	0.36	0.35
287	193.72	12.60	0.36	0.35
288	194.72	12.60	0.36	0.35
289	195.72	12.60	0.36	0.35
290	196.72	12.60	0.36	0.35
291	197.72	12.60	0.36	0.35
292	198.72	12.60	0.36	0.35
293	199.72	12.60	0.36	0.35
294	200.72	12.60	0.36	0.35
295	201.72	12.60	0.36	0.35
296	202.72	12.60	0.36	0.35
297	203.72	12.60	0.36	0.35
298	204.72	12.60	0.36	0.35
299	205.72	12.60	0.36	0.35
300	206.72	12.60	0.36	0.35

Pumping Test No. 1034 Aquifer Test	Test conducted on: 09/28/98
Observation Well 1013	Observation well 1013
Discharge 4.00 U.S.gal/min	Distance from the pumping well 40.00 ft

Static water level: 12.24 ft below datum

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
301	207.72	12.60	0.36	0.35
302	208.72	12.60	0.36	0.35
303	209.72	12.60	0.36	0.35
304	210.72	12.60	0.36	0.35
305	211.72	12.60	0.36	0.35
306	212.72	12.60	0.36	0.35
307	213.72	12.60	0.36	0.35
308	214.72	12.60	0.36	0.35
309	215.72	12.60	0.36	0.35
310	216.72	12.60	0.36	0.35
311	217.72	12.60	0.36	0.35
312	218.72	12.60	0.36	0.35
313	219.72	12.60	0.36	0.35
314	220.72	12.60	0.36	0.35
315	221.72	12.60	0.36	0.35
316	222.72	12.60	0.36	0.35
317	223.72	12.60	0.36	0.35
318	224.72	12.60	0.36	[illegible]
319	225.72	12.60	0.36	[illegible]
320	226.72	12.60	0.36	0.35
321	227.72	12.60	0.36	0.35
322	228.72	12.60	0.36	0.35
323	229.72	12.60	0.36	0.35
324	230.72	12.60	0.36	0.35
325	231.72	12.60	0.36	0.35
326	232.72	12.60	0.36	0.35
327	233.72	12.60	0.36	0.35
328	234.72	12.60	0.36	0.35
329	235.72	12.60	0.36	0.35
330	236.72	12.60	0.36	0.35
331	237.72	12.60	0.36	0.35
332	238.72	12.60	0.36	0.35
333	239.72	12.60	0.36	0.35
334	240.72	12.60	0.36	0.35
335	241.72	12.60	0.36	0.35
336	242.72	12.60	0.36	0.35
337	243.72	12.60	0.36	0.35
338	244.72	12.61	0.37	0.36
339	245.72	12.61	0.37	0.36
340	246.72	12.61	0.37	0.36
341	247.72	12.61	0.37	0.36
342	248.72	12.61	0.37	0.36
343	249.72	12.61	0.37	[illegible]
344	250.72	12.61	0.37	[illegible]
345	251.72	12.61	0.37	0.36
346	252.72	12.61	0.37	0.36
347	253.72	12.61	0.37	0.36
348	254.72	12.61	0.37	0.36
349	255.72	12.61	0.37	0.36
350	256.72	12.61	0.37	0.36

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Pumping test analysis
Theis analysis method
Unconfined aquifer

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Project: UGW -- Grand Junction, CO

Evaluated by: RJH

Date: 11/18/98

Pumping Test No. 1034 Aquifer Test	Test conducted on: 09/28/98
Observation Well 1013	Observation well 1013
Discharge 4.00 U.S.gal/min	Distance from the pumping well 40.00 ft

Static water level: 12.24 ft below datum

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
351	257.72	12.61	0.37	0.36
352	258.72	12.61	0.37	0.36
353	259.72	12.61	0.37	0.36
354	260.72	12.61	0.37	0.36
355	261.72	12.61	0.37	0.36
356	262.72	12.61	0.37	0.36
357	263.72	12.61	0.37	0.36
358	264.72	12.61	0.37	0.36
359	265.72	12.61	0.37	0.36
360	266.72	12.61	0.37	0.36
361	267.72	12.61	0.37	0.36
362	268.72	12.61	0.37	0.36
363	269.72	12.61	0.37	0.36
364	270.72	12.61	0.37	0.36
365	271.72	12.61	0.37	0.36
366	272.72	12.61	0.37	0.36
367	273.72	12.61	0.37	0.36
368	274.72	12.61	0.37	0.36
369	275.72	12.61	0.37	0.36
370	276.72	12.61	0.37	0.36
371	277.72	12.61	0.37	0.36
372	278.72	12.61	0.37	0.36
373	279.72	12.61	0.37	0.36
374	280.72	12.61	0.37	0.36
375	281.72	12.61	0.37	0.36
376	282.72	12.61	0.37	0.36
377	283.72	12.61	0.37	0.36
378	284.72	12.61	0.37	0.36
379	285.72	12.61	0.37	0.36
380	286.72	12.61	0.37	0.36
381	287.72	12.61	0.37	0.36
382	288.72	12.61	0.37	0.36
383	289.72	12.61	0.37	0.36
384	290.72	12.61	0.37	0.36
385	291.72	12.61	0.37	0.36
386	292.72	12.61	0.37	0.36
387	293.72	12.61	0.37	0.36
388	294.72	12.61	0.37	0.36
389	295.72	12.61	0.37	0.36
390	296.72	12.61	0.37	0.36
391	297.72	12.61	0.37	0.36
392	298.72	12.61	0.37	0.36
393	299.72	12.61	0.37	0.36
394	300.72	12.61	0.37	0.36
395	301.72	12.61	0.37	0.36
396	302.72	12.61	0.37	0.36
397	303.72	12.61	0.37	0.36
398	304.72	12.61	0.37	0.36
399	305.72	12.61	0.37	0.36
400	306.72	12.61	0.37	0.36

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Pumping test analysis
Theis analysis method
Unconfined aquifer

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Project: UGW -- Grand Junction, CO
Evaluated by: RJH | Date: 11/18/98

Pumping Test No. 1034 Aquifer Test	Test conducted on: 09/28/98
Observation Well 1013	Observation well 1013
Discharge 4.00 U.S.gal/min	Distance from the pumping well 40.00 ft

Static water level: 12.24 ft below datum

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
401	307.72	12.61	0.37	0.36
402	308.72	12.61	0.37	0.36
403	309.72	12.61	0.37	0.36
404	310.72	12.61	0.37	0.37
405	311.72	12.61	0.37	0.37
406	312.72	12.61	0.37	0.37
407	313.72	12.61	0.37	0.37
408	314.72	12.61	0.37	0.37
409	315.72	12.61	0.37	0.37
410	316.72	12.61	0.37	0.37
411	317.72	12.61	0.37	0.37
412	318.72	12.61	0.37	0.37
413	319.72	12.62	0.38	0.37
414	320.72	12.62	0.38	0.37
415	321.72	12.62	0.38	0.37
416	322.72	12.62	0.38	0.37
417	323.72	12.62	0.38	0.37
418	324.72	12.62	0.38	[illegible]
419	325.72	12.62	0.38	[illegible]
420	326.72	12.61	0.37	0.37
421	327.72	12.62	0.38	0.37
422	328.72	12.62	0.38	0.37
423	329.72	12.62	0.38	0.37
424	330.72	12.62	0.38	0.37
425	331.72	12.62	0.38	0.37
426	332.72	12.62	0.38	0.37
427	333.72	12.62	0.38	0.37
428	334.72	12.62	0.38	0.37
429	335.72	12.62	0.38	0.37
430	336.72	12.62	0.38	0.37
431	337.72	12.62	0.38	0.37
432	338.72	12.62	0.38	0.37
433	339.72	12.62	0.38	0.37
434	340.72	12.62	0.38	0.37
435	341.72	12.62	0.38	0.37
436	342.72	12.62	0.38	0.37
437	343.72	12.62	0.38	0.37
438	344.72	12.62	0.38	0.37
439	345.72	12.62	0.38	0.37
440	346.72	12.62	0.38	0.37
441	347.72	12.62	0.38	0.37
442	348.72	12.62	0.38	0.37
443	349.72	12.62	0.38	[illegible]
444	350.72	12.62	0.38	[illegible]
445	351.72	12.62	0.38	0.37
446	352.72	12.62	0.38	0.37
447	353.72	12.62	0.38	0.37
448	354.72	12.62	0.38	0.37
449	355.72	12.62	0.38	0.37
450	356.72	12.62	0.38	0.37

Pumping Test No. 1034 Aquifer Test	Test conducted on: 09/28/98
Observation Well 1013	Observation well 1013
Discharge 4.00 U.S.gal/min	Distance from the pumping well 40.00 ft
Static water level: 12.24 ft below datum	

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
451	357.72	12.62	0.38	0.37
452	358.72	12.62	0.38	0.37
453	359.72	12.62	0.38	0.37
454	360.72	12.62	0.38	0.37
455	361.72	12.62	0.38	0.37
456	362.72	12.62	0.38	0.37
457	363.72	12.62	0.38	0.37
458	364.72	12.62	0.38	0.37
459	365.72	12.62	0.38	0.37
460	366.72	12.63	0.39	0.38
461	367.72	12.62	0.38	0.37
462	368.72	12.62	0.38	0.37
463	369.72	12.62	0.38	0.37
464	370.72	12.62	0.38	0.37
465	371.72	12.62	0.38	0.37
466	372.72	12.62	0.38	0.37
467	373.72	12.62	0.38	0.37
468	374.72	12.62	0.38	0.37
469	375.72	12.62	0.38	0.37
470	376.72	12.62	0.38	0.37
471	377.72	12.62	0.38	0.37
472	378.72	12.62	0.38	0.37
473	379.72	12.62	0.38	0.37
474	380.72	12.62	0.38	0.37
475	381.72	12.62	0.38	0.37
476	382.72	12.62	0.38	0.37
477	383.72	12.62	0.38	0.37
478	384.72	12.62	0.38	0.37
479	385.72	12.62	0.38	0.37
480	386.72	12.62	0.38	0.37
481	387.72	12.62	0.38	0.37
482	388.72	12.62	0.38	0.37
483	389.72	12.62	0.38	0.37
484	390.72	12.62	0.38	0.37
485	391.72	12.62	0.38	0.37
486	392.72	12.62	0.38	0.37
487	393.72	12.63	0.39	0.38
488	394.72	12.63	0.39	0.38
489	395.72	12.63	0.39	0.38
490	396.72	12.63	0.39	0.38
491	397.72	12.63	0.39	0.38
492	398.72	12.63	0.39	0.38
493	399.72	12.63	0.39	0.38
494	400.72	12.63	0.39	0.38
495	401.72	12.63	0.39	0.38
496	402.72	12.63	0.39	0.38
497	403.72	12.63	0.39	0.38
498	404.72	12.63	0.39	0.38
499	405.72	12.63	0.39	0.38
500	406.72	12.63	0.39	0.38

MACTEC-ERS
2597 B 3/4 Road
Grand Junction, CO 81503
970/248-6040

Pumping test analysis
Theis analysis method
Unconfined aquifer

1013OA2.HYT, Page 12
Project: UGW -- Grand Junction, CO
Evaluated by: RJH
Date: 11/18/98

Pumping Test No. 1034 Aquifer Test
Test conducted on: 09/28/98
Observation Well 1013
Observation well 1013
Discharge 4.00 U.S.gal/min
Distance from the pumping well 40.00 ft
Static water level: 12.24 ft below datum

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
501	407.72	12.63	0.39	0.38
502	408.72	12.63	0.39	0.38
503	409.72	12.63	0.39	0.38
504	410.72	12.62	0.38	0.37
505	411.72	12.63	0.39	0.38
506	412.72	12.63	0.39	0.38
507	413.72	12.63	0.39	0.38
508	414.72	12.63	0.39	0.38
509	415.72	12.63	0.39	0.38
510	416.72	12.63	0.39	0.38
511	417.72	12.63	0.39	0.38
512	418.72	12.63	0.39	0.38
513	419.72	12.63	0.39	0.38
514	420.72	12.63	0.39	0.38
515	421.72	12.63	0.39	0.38
516	422.72	12.63	0.39	0.38
517	423.72	12.63	0.39	0.38
518	424.72	12.63	0.39	[illegible]
519	425.72	12.63	0.39	[illegible]
520	426.72	12.63	0.39	[illegible]
521	427.72	12.63	0.39	0.38
522	428.72	12.63	0.39	0.38
523	429.72	12.63	0.39	0.38
524	430.72	12.63	0.39	0.38
525	431.72	12.63	0.39	0.38
526	432.72	12.63	0.39	0.38
527	433.72	12.63	0.39	0.38
528	434.72	12.63	0.39	0.38
529	435.72	12.63	0.39	0.38
530	436.72	12.63	0.39	0.38
531	437.72	12.63	0.39	0.38
532	438.72	12.63	0.39	0.38
533	439.72	12.63	0.39	0.38
534	440.72	12.63	0.39	0.38
535	441.72	12.63	0.39	0.38
536	442.72	12.63	0.39	0.38
537	443.72	12.63	0.39	0.38
538	444.72	12.63	0.39	0.38
539	445.72	12.63	0.39	0.38
540	446.72	12.63	0.39	0.38
541	447.72	12.63	0.39	0.38
542	448.72	12.63	0.39	0.38
543	449.72	12.63	0.39	[illegible]
544	450.72	12.63	0.39	[illegible]
545	451.72	12.63	0.39	[illegible]
546	452.72	12.63	0.39	0.38
547	453.72	12.63	0.39	0.38
548	454.72	12.63	0.39	0.38
549	455.72	12.63	0.39	0.38
550	456.72	12.63	0.39	0.38

MACTEC-ERS
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Pumping test analysis
Theis analysis method
Unconfined aquifer

1013OA2.HYT, Page 13
Project: UGW -- Grand Junction, CO
Evaluated by: RJH
Date: 11/18/98

Pumping Test No. 1034 Aquifer Test
Test conducted on: 09/28/98
Observation Well 1013
Observation well 1013
Discharge 4.00 U.S.gal/min
Distance from the pumping well 40.00 ft
Static water level: 12.24 ft below datum

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
551	457.72	12.63	0.39	0.38
552	458.72	12.63	0.39	0.38
553	459.72	12.63	0.39	0.38
554	460.72	12.63	0.39	0.38
555	461.72	12.63	0.39	0.38
556	462.72	12.63	0.39	0.38
557	463.72	12.63	0.39	0.38
558	464.72	12.63	0.39	0.38
559	465.72	12.63	0.39	0.38
560	466.72	12.63	0.39	0.38
561	467.72	12.63	0.39	0.38
562	468.72	12.63	0.39	0.38
563	469.72	12.63	0.39	0.38
564	470.72	12.63	0.39	0.38
565	471.72	12.63	0.39	0.38
566	472.72	12.63	0.39	0.38
567	473.72	12.63	0.39	0.38
568	474.72	12.63	0.39	0.38
569	475.72	12.63	0.39	0.38
570	476.72	12.63	0.39	0.38
571	477.72	12.63	0.39	0.38
572	478.72	12.63	0.39	0.38
573	479.72	12.63	0.39	0.38
574	480.72	12.63	0.39	0.38
575	481.72	12.63	0.39	0.38
576	482.72	12.63	0.39	0.38
577	483.72	12.63	0.39	0.38
578	484.72	12.63	0.39	0.38
579	485.72	12.63	0.39	0.38
580	486.72	12.63	0.39	0.38
581	487.72	12.63	0.39	0.38
582	488.72	12.63	0.39	0.38
583	489.72	12.63	0.39	0.38
584	490.72	12.63	0.39	0.38
585	491.72	12.63	0.39	0.38
586	492.72	12.63	0.39	0.38
587	493.72	12.63	0.39	0.38
588	494.72	12.63	0.39	0.38
589	495.72	12.63	0.39	0.38
590	496.72	12.63	0.39	0.38
591	497.72	12.63	0.39	0.38
592	498.72	12.63	0.39	0.38
593	499.72	12.63	0.39	0.38
594	500.72	12.63	0.39	0.38
595	501.72	12.63	0.39	0.38
596	502.72	12.63	0.39	0.38
597	503.72	12.63	0.39	0.38
598	504.72	12.63	0.39	0.38
599	505.72	12.63	0.39	0.38
600	506.72	12.63	0.39	0.38

MACTEC-ERS
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Pumping test analysis
Theis analysis method
Unconfined aquifer

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Project: UGW -- Grand Junction, CO

Evaluated by: RJH | Date: 11/18/98

Pumping Test No. 1034 Aquifer Test | Test conducted on: 09/28/98

Observation Well 1013 | Observation well 1013

Discharge 4.00 U.S.gal/min | Distance from the pumping well 40.00 ft

Static water level: 12.24 ft below datum

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
601	507.72	12.63	0.39	0.38
602	508.72	12.63	0.39	0.38
603	509.72	12.63	0.39	0.39
604	510.72	12.63	0.39	0.39
605	511.72	12.63	0.39	0.39
606	512.72	12.63	0.39	0.39
607	513.72	12.63	0.39	0.39
608	514.72	12.64	0.40	0.39
609	515.72	12.64	0.40	0.39
610	516.72	12.64	0.40	0.39
611	517.72	12.64	0.40	0.39
612	518.72	12.64	0.40	0.39
613	519.72	12.64	0.40	0.39
614	520.72	12.64	0.40	0.39
615	521.72	12.64	0.40	0.39
616	522.72	12.64	0.40	0.39
617	523.72	12.64	0.40	0.39
618	524.72	12.64	0.40	[illegible]
619	525.72	12.64	0.40	[illegible]
620	526.72	12.64	0.40	[illegible]
621	527.72	12.64	0.40	0.39
622	528.72	12.64	0.40	0.39
623	529.72	12.64	0.40	0.39
624	530.72	12.64	0.40	0.39
625	531.72	12.64	0.40	0.39
626	532.72	12.64	0.40	0.39
627	533.72	12.64	0.40	0.39
628	534.72	12.64	0.40	0.39
629	535.72	12.64	0.40	0.39
630	536.72	12.64	0.40	0.39
631	537.72	12.64	0.40	0.39
632	538.72	12.65	0.41	0.40
633	539.72	12.65	0.41	0.40
634	540.72	12.65	0.41	0.40
635	541.72	12.65	0.41	0.40
636	542.72	12.65	0.41	0.40
637	543.72	12.65	0.41	0.40
638	544.72	12.65	0.41	0.40
639	545.72	12.65	0.41	0.40
640	546.72	12.65	0.41	0.40
641	547.72	12.65	0.41	0.40
642	548.72	12.65	0.41	0.40
643	549.72	12.65	0.41	[illegible]
644	550.72	12.65	0.41	[illegible]
645	551.72	12.65	0.41	0.40
646	552.72	12.65	0.41	0.40
647	553.72	12.65	0.41	0.40
648	554.72	12.65	0.41	0.40
649	555.72	12.65	0.41	0.40
650	556.72	12.65	0.41	0.40

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Theis analysis method Unconfined aquifer	1013OA2.HYT, Page 17 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/18/98

Pumping Test No. 1034 Aquifer Test	Test conducted on: 09/28/98
Observation Well 1013	Observation well 1013
Discharge 4.00 U.S.gal/min	Distance from the pumping well 40.00 ft

Static water level: 12.24 ft below datum

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
751	657.72	12.65	0.41	0.40
752	658.72	12.65	0.41	0.40
753	659.72	12.65	0.41	0.40
754	660.72	12.65	0.41	0.40
755	661.72	12.65	0.41	0.40
756	662.72	12.65	0.41	0.40
757	663.72	12.65	0.41	0.40
758	664.72	12.65	0.41	0.40
759	665.72	12.65	0.41	0.40
760	666.72	12.65	0.41	0.40
761	667.72	12.65	0.41	0.40
762	668.72	12.65	0.41	0.40
763	669.72	12.65	0.41	0.40
764	670.72	12.65	0.41	0.40
765	671.72	12.65	0.41	0.40
766	672.72	12.65	0.41	0.40
767	673.72	12.65	0.41	0.40
768	674.72	12.65	0.41	0.40
769	675.72	12.65	0.41	0.40
770	676.72	12.65	0.41	0.40
771	677.72	12.65	0.41	0.40
772	678.72	12.65	0.41	0.40
773	679.72	12.65	0.41	0.40
774	680.72	12.65	0.41	0.40
775	681.72	12.65	0.41	0.40
776	682.72	12.65	0.41	0.40
777	683.72	12.65	0.41	0.40
778	684.72	12.65	0.41	0.40
779	685.72	12.65	0.41	0.40
780	686.72	12.65	0.41	0.40
781	687.72	12.65	0.41	0.40
782	688.72	12.65	0.41	0.40
783	689.72	12.65	0.41	0.40
784	690.72	12.65	0.41	0.40
785	691.72	12.65	0.41	0.40
786	692.72	12.65	0.41	0.40
787	693.72	12.65	0.41	0.40
788	694.72	12.65	0.41	0.40
789	695.72	12.65	0.41	0.40
790	696.72	12.65	0.41	0.40
791	697.72	12.65	0.41	0.40
792	698.72	12.65	0.41	0.40
793	699.72	12.65	0.41	0.40
794	700.72	12.64	0.40	0.39
795	701.72	12.64	0.40	0.39
796	702.72	12.64	0.40	0.39
797	703.72	12.64	0.40	0.39
798	704.72	12.64	0.40	0.39
799	705.72	12.64	0.40	0.39
800	706.72	12.64	0.40	0.39

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MACTEC-ERS
2597 B 3/4 Road
Grand Junction, CO 81503
970/248-6040

Pumping test analysis
Theis analysis method
Unconfined aquifer

Project: UGW -- Grand Junction, CO

Evaluated by: RJH | Date: 11/18/98

Pumping Test No. 1034 Aquifer Test	Test conducted on: 09/28/98
Observation Well 1013	Observation well 1013
Discharge 4.00 U.S.gal/min	Distance from the pumping well 40.00 ft

Static water level: 12.24 ft below datum

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
801	707.72	12.64	0.40	0.39
802	708.72	12.64	0.40	0.39
803	709.72	12.64	0.40	0.39
804	710.72	12.64	0.40	0.39
805	711.72	12.64	0.40	0.39

MACTEC-ERS
2597 B 3/4 Road
Grand Junction, CO 81503
970/248-6040

Pumping test analysis
Theis analysis method
Unconfined aquifer

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Project: UGW -- Grand Junction, CO
Evaluated by: RJH
Date: 11/18/98

Pumping Test No. 1034 Aquifer Test	Test conducted on: 09/28/98
Observation Well 1013	Observation well 1013
Discharge 4.00 U.S.gal/min	Distance from the pumping well 40.00 ft

Static water level: 12.24 ft below datum

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
651	557.72	12.65	0.41	0.40
652	558.72	12.65	0.41	0.40
653	559.72	12.65	0.41	0.40
654	560.72	12.65	0.41	0.40
655	561.72	12.65	0.41	0.40
656	562.72	12.65	0.41	0.40
657	563.72	12.65	0.41	0.40
658	564.72	12.65	0.41	0.40
659	565.72	12.65	0.41	0.40
660	566.72	12.65	0.41	0.40
661	567.72	12.65	0.41	0.40
662	568.72	12.65	0.41	0.40
663	569.72	12.65	0.41	0.40
664	570.72	12.65	0.41	0.40
665	571.72	12.65	0.41	0.40
666	572.72	12.64	0.40	0.39
667	573.72	12.64	0.40	0.39
668	574.72	12.65	0.41	0.40
669	575.72	12.64	0.40	0.39
670	576.72	12.64	0.40	0.39
671	577.72	12.64	0.40	0.39
672	578.72	12.64	0.40	0.39
673	579.72	12.64	0.40	0.39
674	580.72	12.64	0.40	0.39
675	581.72	12.64	0.40	0.39
676	582.72	12.64	0.40	0.39
677	583.72	12.64	0.40	0.39
678	584.72	12.64	0.40	0.39
679	585.72	12.64	0.40	0.39
680	586.72	12.65	0.41	0.40
681	587.72	12.65	0.41	0.40
682	588.72	12.64	0.40	0.39
683	589.72	12.64	0.40	0.39
684	590.72	12.65	0.41	0.40
685	591.72	12.64	0.40	0.39
686	592.72	12.65	0.41	0.40
687	593.72	12.64	0.40	0.39
688	594.72	12.64	0.40	0.39
689	595.72	12.64	0.40	0.39
690	596.72	12.64	0.40	0.39
691	597.72	12.64	0.40	0.39
692	598.72	12.64	0.40	0.39
693	599.72	12.64	0.40	0.39
694	600.72	12.64	0.40	0.39
695	601.72	12.64	0.40	0.39
696	602.72	12.64	0.40	0.39
697	603.72	12.64	0.40	0.39
698	604.72	12.64	0.40	0.39
699	605.72	12.64	0.40	0.39
700	606.72	12.65	0.41	0.40

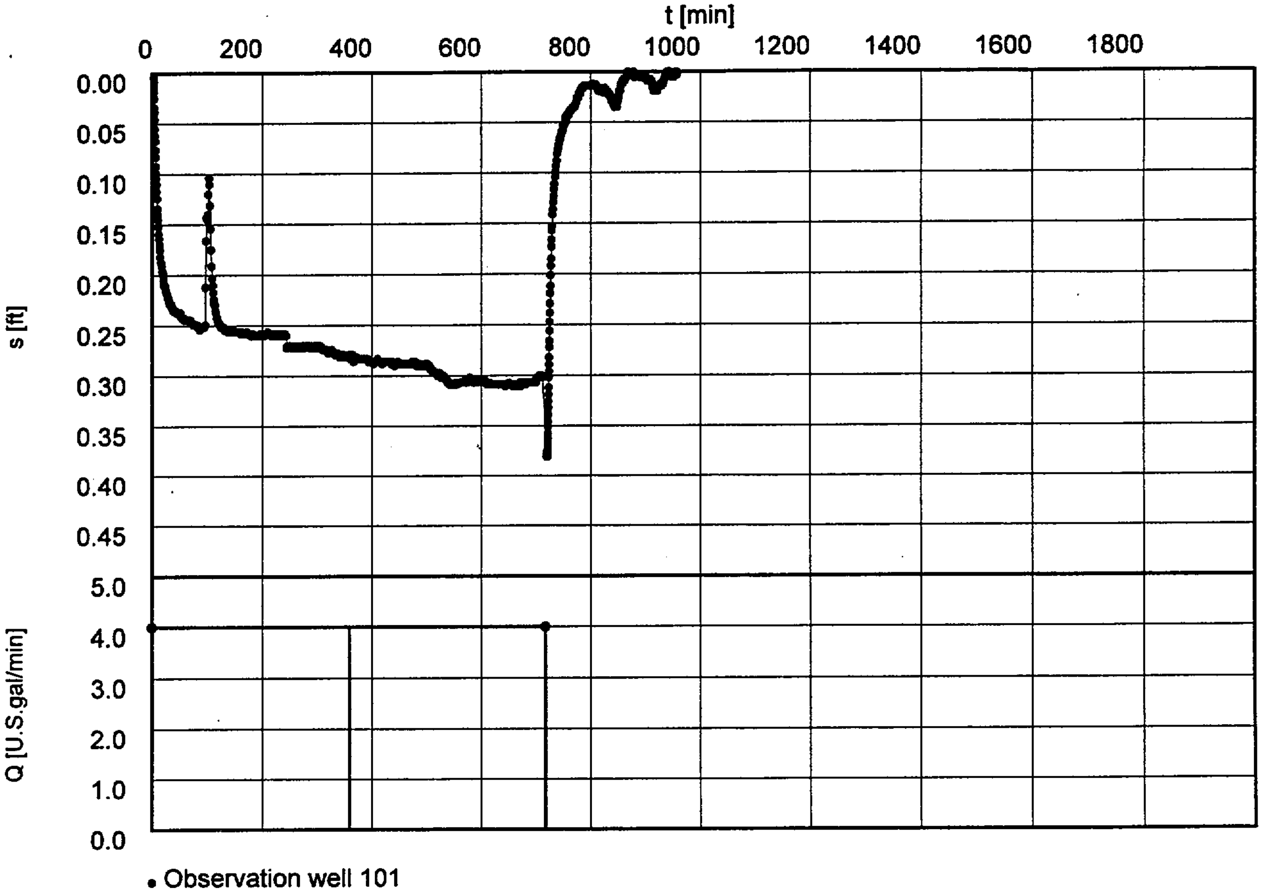
MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Theis analysis method Unconfined aquifer	1013OA2.HYT, Page 16 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/18/98

Pumping Test No. 1034 Aquifer Test	Test conducted on: 09/28/98
Observation Well 1013	Observation well 1013
Discharge 4.00 U.S.gal/min	Distance from the pumping well 40.00 ft
Static water level: 12.24 ft below datum	

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
701	607.72	12.65	0.41	0.40
702	608.72	12.65	0.41	0.40
703	609.72	12.65	0.41	0.40
704	610.72	12.65	0.41	0.40
705	611.72	12.65	0.41	0.40
706	612.72	12.65	0.41	0.40
707	613.72	12.65	0.41	0.40
708	614.72	12.65	0.41	0.40
709	615.72	12.65	0.41	0.40
710	616.72	12.65	0.41	0.40
711	617.72	12.65	0.41	0.40
712	618.72	12.65	0.41	0.40
713	619.72	12.65	0.41	0.40
714	620.72	12.65	0.41	0.40
715	621.72	12.65	0.41	0.40
716	622.72	12.65	0.41	0.40
717	623.72	12.65	0.41	0.40
718	624.72	12.65	0.41	[illegible]
719	625.72	12.65	0.41	[illegible]
720	626.72	12.65	0.41	0.40
721	627.72	12.65	0.41	0.40
722	628.72	12.65	0.41	0.40
723	629.72	12.65	0.41	0.40
724	630.72	12.65	0.41	0.40
725	631.72	12.65	0.41	0.40
726	632.72	12.65	0.41	0.40
727	633.72	12.65	0.41	0.40
728	634.72	12.65	0.41	0.40
729	635.72	12.65	0.41	0.40
730	636.72	12.65	0.41	0.40
731	637.72	12.65	0.41	0.40
732	638.72	12.65	0.41	0.40
733	639.72	12.65	0.41	0.40
734	640.72	12.65	0.41	0.40
735	641.72	12.65	0.41	0.40
736	642.72	12.65	0.41	0.40
737	643.72	12.65	0.41	0.40
738	644.72	12.65	0.41	0.40
739	645.72	12.65	0.41	0.40
740	646.72	12.65	0.41	0.40
741	647.72	12.65	0.41	0.40
742	648.72	12.65	0.41	0.40
743	649.72	12.65	0.41	[illegible]
744	650.72	12.65	0.41	[illegible]
745	651.72	12.65	0.41	0.40
746	652.72	12.65	0.41	0.40
747	653.72	12.65	0.41	0.40
748	654.72	12.65	0.41	0.40
749	655.72	12.65	0.41	0.40
750	656.72	12.65	0.41	0.40

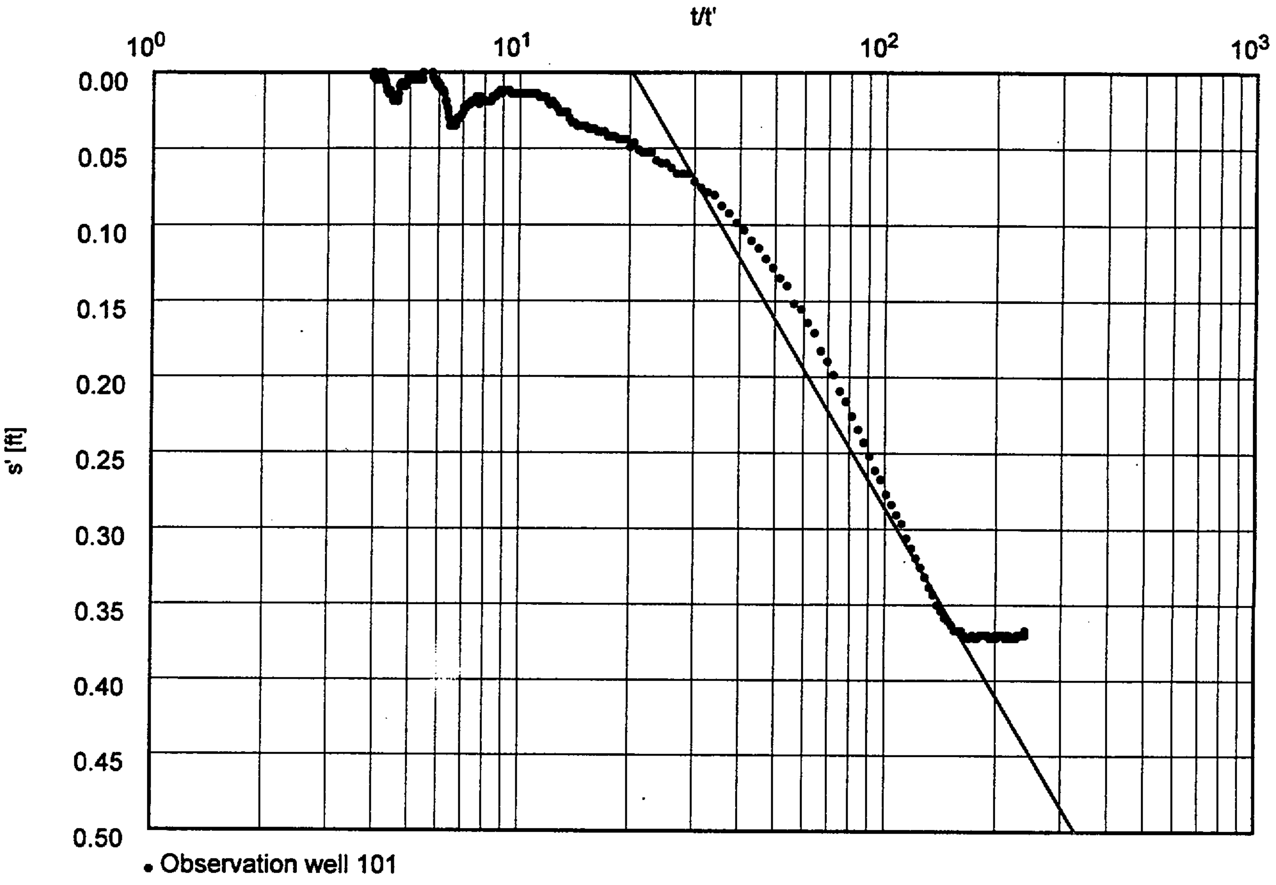
MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Time-Drawdown plot with discharge	1013OR2.HYT, Page 1 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/19/98

Pumping Test No. 1034 Recovery Test	Test conducted on: 09/28/98
Observation Well 1013	
Discharge 4.00 U.S.gal/min	



MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1013OR2.HYT, Page 1 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/19/98

Pumping Test No. 1034 Recovery Test	Test conducted on: 09/28/98
Observation Well 1013	
Discharge 4.00 U.S.gal/min	
	Pumping test duration: 717.00 min



Transmissivity [ft²/min]: 2.36×10^{-1} 339.84 ft²/day

Hydraulic conductivity [ft/min]: 2.96×10^{-2} 42.62 ft/day

Aquifer thickness [ft]: 8.00

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1013OR2.HYT, Page 2 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/19/98

Pumping Test No. 1034 Recovery Test	Test conducted on: 09/28/98
Observation Well 1013	Observation well 1013
Discharge 4.00 U.S.gal/min	Distance from the pumping well 40.00 ft
Static water level: 12.34 ft below datum	Pumping test duration: 717.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
1	3.00	12.72	0.38	0.37
2	3.00	12.72	0.38	0.37
3	3.01	12.72	0.38	0.37
4	3.01	12.72	0.38	0.37
5	3.02	12.72	0.38	0.37
6	3.03	12.72	0.38	0.37
7	3.03	12.72	0.38	0.37
8	3.04	12.72	0.38	0.37
9	3.04	12.72	0.38	0.37
10	3.04	12.72	0.38	0.37
11	3.05	12.72	0.38	0.37
12	3.05	12.72	0.38	0.37
13	3.06	12.72	0.38	0.37
14	3.07	12.72	0.38	0.37
15	3.07	12.72	0.38	0.37
16	3.08	12.72	0.38	0.37
17	3.08	12.72	0.38	0.37
18	3.08	12.72	0.38	0.37
19	3.09	12.72	0.38	0.37
20	3.09	12.72	0.38	0.37
21	3.10	12.72	0.38	0.37
22	3.11	12.72	0.38	0.37
23	3.11	12.72	0.38	0.37
24	3.12	12.72	0.38	0.37
25	3.13	12.72	0.38	0.37
26	3.13	12.72	0.38	0.37
27	3.14	12.72	0.38	0.37
28	3.15	12.72	0.38	0.37
29	3.16	12.72	0.38	0.37
30	3.17	12.72	0.38	0.37
31	3.18	12.72	0.38	0.37
32	3.19	12.72	0.38	0.37
33	3.20	12.72	0.38	0.37
34	3.21	12.72	0.38	0.37
35	3.22	12.72	0.38	0.37
36	3.24	12.72	0.38	0.37
37	3.25	12.72	0.38	0.37
38	3.26	12.72	0.38	0.37
39	3.28	12.72	0.38	0.37
40	3.30	12.72	0.38	0.37
41	3.31	12.72	0.38	0.37
42	3.33	12.72	0.38	0.37
43	3.35	12.72	0.38	0.37
44	3.37	12.72	0.38	0.37
45	3.40	12.72	0.38	0.37
46	3.42	12.72	0.38	0.37
47	3.44	12.72	0.38	0.37
48	3.47	12.72	0.38	0.37
49	3.50	12.72	0.38	0.37
50	3.52	12.72	0.38	0.37

MACTEC-ERS
2597 B 3/4 Road
Grand Junction, CO 81503
970/248-6040

Pumping test analysis
Recovery method after
THEIS & JACOB
Unconfined aquifer

1013OR2.HYT, Page 3
Project: UGW -- Grand Junction, CO
Evaluated by: RJH
Date: 11/19/98

Pumping Test No. 1034 Recovery Test	Test conducted on: 09/28/98
Observation Well 1013	Observation well 1013
Discharge 4.00 U.S.gal/min	Distance from the pumping well 40.00 ft
Static water level: 12.34 ft below datum	Pumping test duration: 717.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
51	3.55	12.72	0.38	0.37
52	3.59	12.72	0.38	0.37
53	3.62	12.72	0.38	0.37
54	3.66	12.72	0.38	0.37
55	3.70	12.72	0.38	0.37
56	3.74	12.72	0.38	0.37
57	3.78	12.72	0.38	0.37
58	3.83	12.72	0.38	0.37
59	3.88	12.72	0.38	0.37
60	3.93	12.72	0.38	0.37
61	3.98	12.72	0.38	0.37
62	4.04	12.72	0.38	0.37
63	4.10	12.72	0.38	0.37
64	4.17	12.72	0.38	0.37
65	4.24	12.72	0.38	0.37
66	4.31	12.72	0.38	0.37
67	4.39	12.72	0.38	0.37
68	4.47	12.72	0.38	[illegible]
69	4.56	12.72	0.38	[illegible]
70	4.65	12.72	0.38	0.37
71	4.75	12.71	0.37	0.36
72	4.86	12.71	0.37	0.36
73	4.97	12.71	0.37	0.36
74	5.08	12.70	0.36	0.35
75	5.21	12.70	0.36	0.35
76	5.34	12.69	0.35	0.34
77	5.48	12.69	0.35	0.34
78	5.63	12.68	0.34	0.33
79	5.79	12.67	0.33	0.33
80	5.95	12.67	0.33	0.32
81	6.13	12.66	0.32	0.31
82	6.32	12.65	0.31	0.31
83	6.51	12.64	0.30	0.30
84	6.72	12.64	0.30	0.29
85	6.95	12.63	0.29	0.28
86	7.18	12.62	0.28	0.28
87	7.43	12.61	0.27	0.27
88	7.69	12.61	0.27	0.26
89	7.97	12.60	0.26	0.25
90	8.27	12.59	0.25	0.24
91	8.58	12.58	0.24	0.23
92	8.91	12.57	0.23	0.23
93	9.27	12.56	0.22	[illegible]
94	9.64	12.55	0.21	[illegible]
95	10.03	12.54	0.20	0.20
96	10.45	12.53	0.19	0.19
97	10.90	12.52	0.18	0.18
98	11.37	12.51	0.17	0.17
99	11.86	12.51	0.17	0.16
100	12.39	12.50	0.16	0.16

MACTEC-ERS
2597 B 3/4 Road
Grand Junction, CO 81503
970/248-6040

Pumping test analysis
Recovery method after
THEIS & JACOB
Unconfined aquifer

Project: UGW -- Grand Junction, CO

Evaluated by: RJH | Date: 11/19/98

Pumping Test No. 1034 Recovery Test | Test conducted on: 09/28/98

Observation Well 1013 | Observation well 1013

Discharge 4.00 U.S.gal/min | Distance from the pumping well 40.00 ft

Static water level: 12.34 ft below datum | Pumping test duration: 717.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
101	12.95	12.49	0.15	0.15
102	13.54	12.48	0.14	0.14
103	14.17	12.48	0.14	0.13
104	14.83	12.47	0.13	0.13
105	15.53	12.46	0.12	0.12
106	16.28	12.46	0.12	0.12
107	17.07	12.45	0.11	0.11
108	17.91	12.44	0.10	0.10
109	18.79	12.44	0.10	0.10
110	19.73	12.43	0.09	0.09
111	20.72	12.43	0.09	0.09
112	21.72	12.42	0.08	0.08
113	22.72	12.42	0.08	0.08
114	23.72	12.42	0.08	0.08
115	24.72	12.41	0.07	0.07
116	25.72	12.41	0.07	0.07
117	26.72	12.41	0.07	0.07
118	27.72	12.41	0.07	0.07
119	28.72	12.40	0.06	0.06
120	29.72	12.40	0.06	0.06
121	30.72	12.40	0.06	0.06
122	31.72	12.40	0.06	0.06
123	32.72	12.39	0.05	0.05
124	33.72	12.39	0.05	0.05
125	34.72	12.39	0.05	0.05
126	35.72	12.39	0.05	0.05
127	36.72	12.39	0.05	0.05
128	37.72	12.39	0.05	0.05
129	38.72	12.38	0.04	0.04
130	39.72	12.38	0.04	0.04
131	40.72	12.38	0.04	0.04
132	41.72	12.38	0.04	0.04
133	42.72	12.38	0.04	0.04
134	43.72	12.38	0.04	0.04
135	44.72	12.38	0.04	0.04
136	45.72	12.38	0.04	0.04
137	46.72	12.38	0.04	0.04
138	47.72	12.38	0.04	0.04
139	48.72	12.38	0.04	0.04
140	49.72	12.38	0.04	0.04
141	50.72	12.38	0.04	0.03
142	51.72	12.38	0.04	0.03
143	52.72	12.38	0.04	0.03
144	53.72	12.38	0.04	0.03
145	54.72	12.37	0.03	0.03
146	55.72	12.37	0.03	0.03
147	56.72	12.37	0.03	0.03
148	57.72	12.37	0.03	0.03
149	58.72	12.37	0.03	0.03
150	59.72	12.37	0.03	0.03

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1013OR2.HYT, Page 5 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/19/98

Pumping Test No. 1034 Recovery Test	Test conducted on: 09/28/98
Observation Well 1013	Observation well 1013
Discharge 4.00 U.S.gal/min	Distance from the pumping well 40.00 ft
Static water level: 12.34 ft below datum	Pumping test duration: 717.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
151	60.72	12.37	0.03	0.03
152	61.72	12.36	0.02	0.02
153	62.72	12.36	0.02	0.02
154	63.72	12.36	0.02	0.02
155	64.72	12.36	0.02	0.02
156	65.72	12.36	0.02	0.02
157	66.72	12.36	0.02	0.02
158	67.72	12.36	0.02	0.02
159	68.72	12.36	0.02	0.02
160	69.72	12.36	0.02	0.02
161	70.72	12.35	0.01	0.01
162	71.72	12.35	0.01	0.01
163	72.72	12.35	0.01	0.01
164	73.72	12.35	0.01	0.01
165	74.72	12.35	0.01	0.01
166	75.72	12.35	0.01	0.01
167	76.72	12.35	0.01	0.01
168	77.72	12.35	0.01	[illegible]
169	78.72	12.35	0.01	[illegible]
170	79.72	12.35	0.01	0.01
171	80.72	12.35	0.01	0.01
172	81.72	12.35	0.01	0.01
173	82.72	12.35	0.01	0.01
174	83.72	12.35	0.01	0.01
175	84.72	12.35	0.01	0.01
176	85.72	12.35	0.01	0.01
177	86.72	12.35	0.01	0.01
178	87.72	12.35	0.01	0.01
179	88.72	12.35	0.01	0.01
180	89.72	12.35	0.01	0.01
181	90.72	12.35	0.01	0.01
182	91.72	12.35	0.01	0.01
183	92.72	12.35	0.01	0.01
184	93.72	12.35	0.01	0.01
185	94.72	12.36	0.02	0.02
186	95.72	12.36	0.02	0.02
187	96.72	12.36	0.02	0.02
188	97.72	12.36	0.02	0.02
189	98.72	12.36	0.02	0.02
190	99.72	12.36	0.02	0.02
191	100.72	12.36	0.02	0.02
192	101.72	12.36	0.02	0.02
193	102.72	12.36	0.02	[illegible]
194	103.72	12.36	0.02	[illegible]
195	104.72	12.36	0.02	0.02
196	105.72	12.36	0.02	0.02
197	106.72	12.36	0.02	0.02
198	107.72	12.36	0.02	0.02
199	108.72	12.36	0.02	0.02
200	109.72	12.36	0.02	0.02

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1013OR2.HYT, Page 6 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/19/98

Pumping Test No. 1034 Recovery Test	Test conducted on: 09/28/98
Observation Well 1013	Observation well 1013
Discharge 4.00 U.S.gal/min	Distance from the pumping well 40.00 ft
Static water level: 12.34 ft below datum	Pumping test duration: 717.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
201	110.72	12.36	0.02	0.02
202	111.72	12.36	0.02	0.02
203	112.72	12.36	0.02	0.02
204	113.72	12.36	0.02	0.02
205	114.72	12.36	0.02	0.02
206	115.72	12.36	0.02	0.02
207	116.72	12.36	0.02	0.02
208	117.72	12.36	0.02	0.02
209	118.72	12.36	0.02	0.02
210	119.72	12.37	0.03	0.03
211	120.72	12.37	0.03	0.03
212	121.72	12.37	0.03	0.03
213	122.72	12.37	0.03	0.03
214	123.72	12.37	0.03	0.03
215	124.72	12.37	0.03	0.03
216	125.72	12.37	0.03	0.03
217	126.72	12.38	0.04	0.03
218	127.72	12.38	0.04	0.03
219	128.72	12.38	0.04	0.03
220	129.72	12.38	0.04	0.03
221	130.72	12.37	0.03	0.03
222	131.72	12.38	0.04	0.03
223	132.72	12.37	0.03	0.03
224	133.72	12.37	0.03	0.03
225	134.72	12.36	0.02	0.02
226	135.72	12.36	0.02	0.02
227	136.72	12.36	0.02	0.02
228	137.72	12.35	0.01	0.01
229	138.72	12.35	0.01	0.01
230	139.72	12.35	0.01	0.01
231	140.72	12.35	0.01	0.01
232	141.72	12.35	0.01	0.01
233	142.72	12.35	0.01	0.01
234	143.72	12.35	0.01	0.01
235	144.72	12.35	0.01	0.01
236	145.72	12.35	0.01	0.01
237	146.72	12.35	0.01	0.01
238	147.72	12.35	0.01	0.00
239	148.72	12.35	0.01	0.00
240	149.72	12.34	0.00	0.00
241	150.72	12.34	0.00	0.00
242	151.72	12.34	-0.00	-0.00
243	152.72	12.34	-0.00	-0.00
244	153.72	12.34	-0.00	-0.00
245	154.72	12.33	-0.01	-0.01
246	155.72	12.33	-0.01	-0.01
247	156.72	12.33	-0.01	-0.01
248	157.72	12.33	-0.01	-0.01
249	158.72	12.33	-0.01	-0.01
250	159.72	12.34	-0.00	-0.00

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1013OR2.HYT, Page 7 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/19/98

Pumping Test No. 1034 Recovery Test	Test conducted on: 09/28/98
Observation Well 1013	Observation well 1013
Discharge 4.00 U.S.gal/min	Distance from the pumping well 40.00 ft
Static water level: 12.34 ft below datum	Pumping test duration: 717.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
251	160.72	12.34	-0.00	-0.00
252	161.72	12.34	0.00	0.00
253	16[illegible]2	12.35	0.01	0.00
254	163.72	12.34	0.00	0.00
255	164.72	12.35	0.01	0.00
256	165.72	12.35	0.01	0.00
257	166.72	12.34	0.00	0.00
258	167.72	12.34	0.00	0.00
259	168.72	12.34	0.00	0.00
260	169.72	12.34	0.00	0.00
261	170.72	12.34	0.00	0.00
262	171.72	12.35	0.01	0.00
263	172.72	12.34	0.00	0.00
264	173.72	12.35	0.01	0.00
265	174.72	12.34	0.00	0.00
266	175.72	12.34	0.00	0.00
267	176.72	12.34	0.00	0.00
268	177.72	12.34	0.00	[illegible]
269	178.72	12.34	0.00	[illegible]
270	179.72	12.35	0.01	0.00
271	180.72	12.35	0.01	0.00
272	181.72	12.34	0.00	0.00
273	182.72	12.35	0.01	0.00
274	183.72	12.35	0.01	0.01
275	184.72	12.35	0.01	0.01
276	185.72	12.35	0.01	0.01
277	186.72	12.35	0.01	0.01
278	187.72	12.35	0.01	0.01
279	188.72	12.35	0.01	0.01
280	189.72	12.35	0.01	0.01
281	190.72	12.35	0.01	0.01
282	191.72	12.35	0.01	0.01
283	192.72	12.35	0.01	0.01
284	193.72	12.35	0.01	0.01
285	194.72	12.35	0.01	0.01
286	195.72	12.35	0.01	0.01
287	196.72	12.36	0.02	0.02
288	197.72	12.36	0.02	0.02
289	198.72	12.36	0.02	0.02
290	199.72	12.36	0.02	0.02
291	200.72	12.36	0.02	0.02
292	201.72	12.36	0.02	0.02
293	202.72	12.36	0.02	[illegible]
294	203.72	12.36	0.02	[illegible]
295	204.72	12.36	0.02	0.02
296	205.72	12.36	0.02	0.02
297	206.72	12.36	0.02	0.02
298	207.72	12.35	0.01	0.01
299	208.72	12.35	0.01	0.01
300	209.72	12.35	0.01	0.01

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1013OR2.HYT, Page 8 Project: UGW – Grand Junction, CO Evaluated by: RJH Date: 11/19/98

Pumping Test No. 1034 Recovery Test	Test conducted on: 09/28/98
Observation Well 1013	Observation well 1013
Discharge 4.00 U.S.gal/min	Distance from the pumping well 40.00 ft
Static water level: 12.34 ft below datum	Pumping test duration: 717.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
301	210.72	12.35	0.01	0.01
302	211.72	12.35	0.01	0.01
303	212.72	12.35	0.01	0.01
304	213.72	12.35	0.01	0.01
305	214.72	12.35	0.01	0.01
306	215.72	12.35	0.01	0.01
307	216.72	12.35	0.01	0.01
308	217.72	12.35	0.01	0.01
309	218.72	12.35	0.01	0.00
310	219.72	12.35	0.01	0.00
311	220.72	12.34	0.00	0.00
312	221.72	12.34	0.00	0.00
313	222.72	12.34	0.00	0.00
314	223.72	12.34	0.00	0.00
315	224.72	12.34	0.00	0.00
316	225.72	12.34	0.00	0.00
317	226.72	12.34	0.00	0.00
318	227.72	12.34	0.00	0.00
319	228.72	12.34	0.00	0.00
320	229.72	12.34	0.00	0.00
321	230.72	12.34	0.00	0.00
322	231.72	12.35	0.01	0.00
323	232.72	12.35	0.01	0.00
324	233.72	12.34	0.00	0.00
325	234.72	12.35	0.01	0.00
326	235.72	12.35	0.01	0.00
327	236.72	12.34	0.00	0.00
328	237.72	12.34	0.00	0.00
329	238.72	12.34	0.00	0.00
330	239.72	12.34	0.00	0.00
331	240.72	12.34	0.00	0.00
332	241.72	12.34	-0.00	-0.00
333	242.72	12.34	-0.00	-0.00
334	243.72	12.34	-0.00	-0.00
335	244.72	12.34	-0.00	-0.00
336	245.72	12.34	-0.00	-0.00
337	246.72	12.33	-0.01	-0.01
338	247.72	12.33	-0.01	-0.01
339	248.72	12.33	-0.01	-0.01
340	249.72	12.33	-0.01	-0.01
341	250.72	12.33	-0.01	-0.01
342	251.72	12.33	-0.01	-0.01
343	252.72	12.33	-0.01	-0.01
344	253.72	12.33	-0.01	-0.01
345	254.72	12.33	-0.01	-0.01
346	255.72	12.33	-0.01	-0.01
347	256.72	12.33	-0.01	-0.01
348	257.72	12.33	-0.01	-0.01
349	258.72	12.34	-0.00	-0.00
350	259.72	12.34	-0.00	-0.00

Pumping Test No. 1034 Recovery Test
Test conducted on: 09/28/98

Observation Well 1013
Observation well 1013

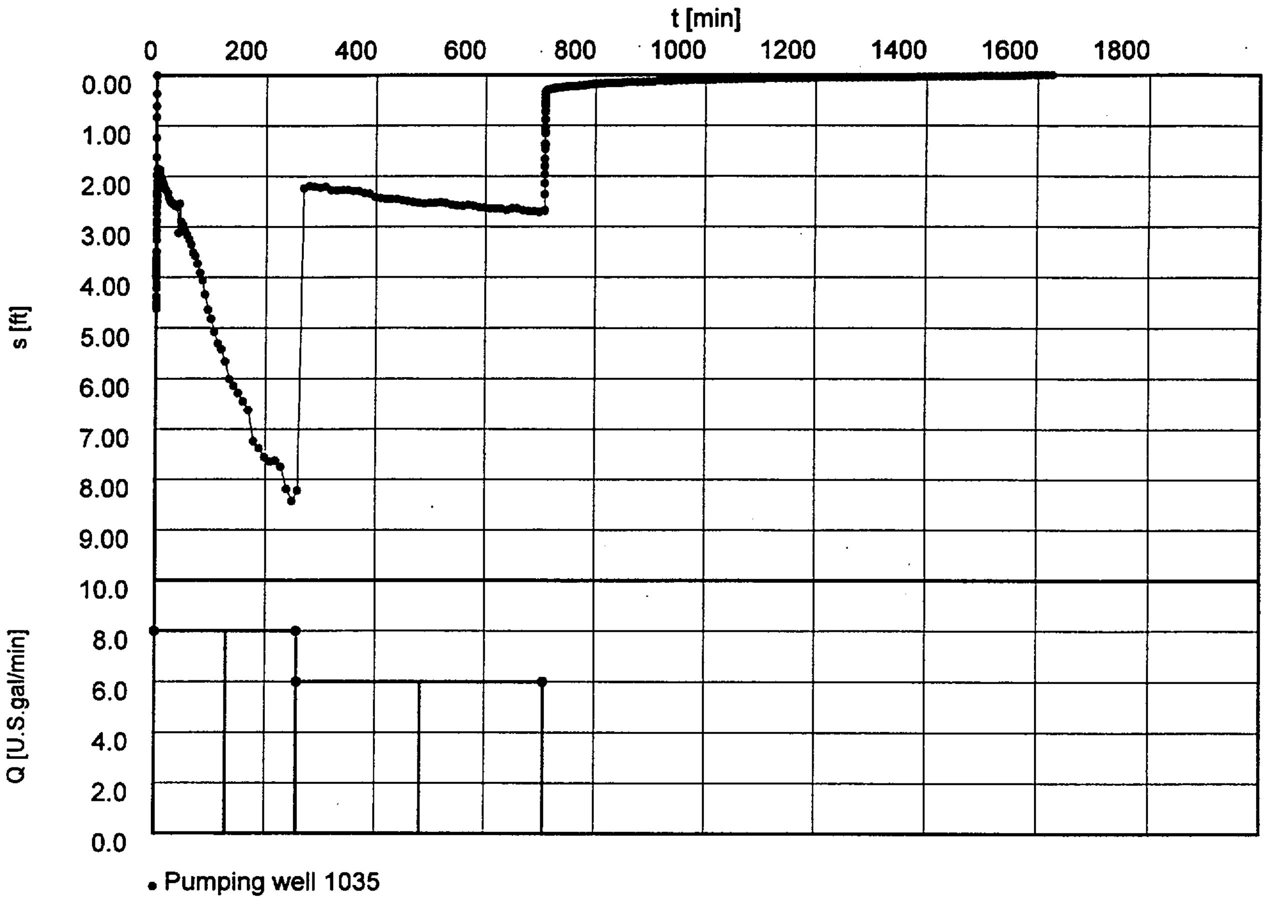
Discharge 4.00 U.S.gal/min
Distance from the pumping well 40.00 ft

Static water level: 12.34 ft below datum
Pumping test duration: 717.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
351	260.72	12.34	-0.00	-0.00
352	261.72	12.34	-0.00	-0.00
353	262.72	12.34	-0.00	-0.00
354	263.72	12.34	-0.00	-0.00
355	264.72	12.34	-0.00	-0.00
356	265.72	12.34	-0.00	-0.00
357	266.72	12.34	-0.00	-0.00
358	267.72	12.33	-0.01	-0.01
359	268.72	12.33	-0.01	-0.01
360	269.72	12.33	-0.01	-0.01
361	270.72	12.33	-0.01	-0.01
362	271.72	12.33	-0.01	-0.01
363	272.72	12.33	-0.01	-0.01
364	273.72	12.33	-0.01	-0.01
365	274.72	12.33	-0.01	-0.01
366	275.72	12.33	-0.01	-0.01
367	276.72	12.33	-0.01	-0.01
368	277.72	12.32	-0.02	[illegible]
369	278.72	12.32	-0.02	[illegible]
370	279.72	12.32	-0.02	-0.02
371	280.72	12.32	-0.02	-0.02
372	281.72	12.32	-0.02	-0.02
373	282.72	12.32	-0.02	-0.02
374	283.72	12.32	-0.02	-0.02
375	284.72	12.32	-0.02	-0.02
376	285.72	12.32	-0.02	-0.02
377	286.72	12.32	-0.02	-0.03
378	287.72	12.32	-0.02	-0.03

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Time-Drawdown plot with discharge	1035R1.HYT, Page 1 Project: UGW -- Grand Junction, CO Evaluated by: RJH	 Date: 11/18/98

Pumping Test No. 1035 Recovery Test	Test conducted on: 09/29/98
Pumping Well 1035	
Discharge 6.73 U.S.gal/min	



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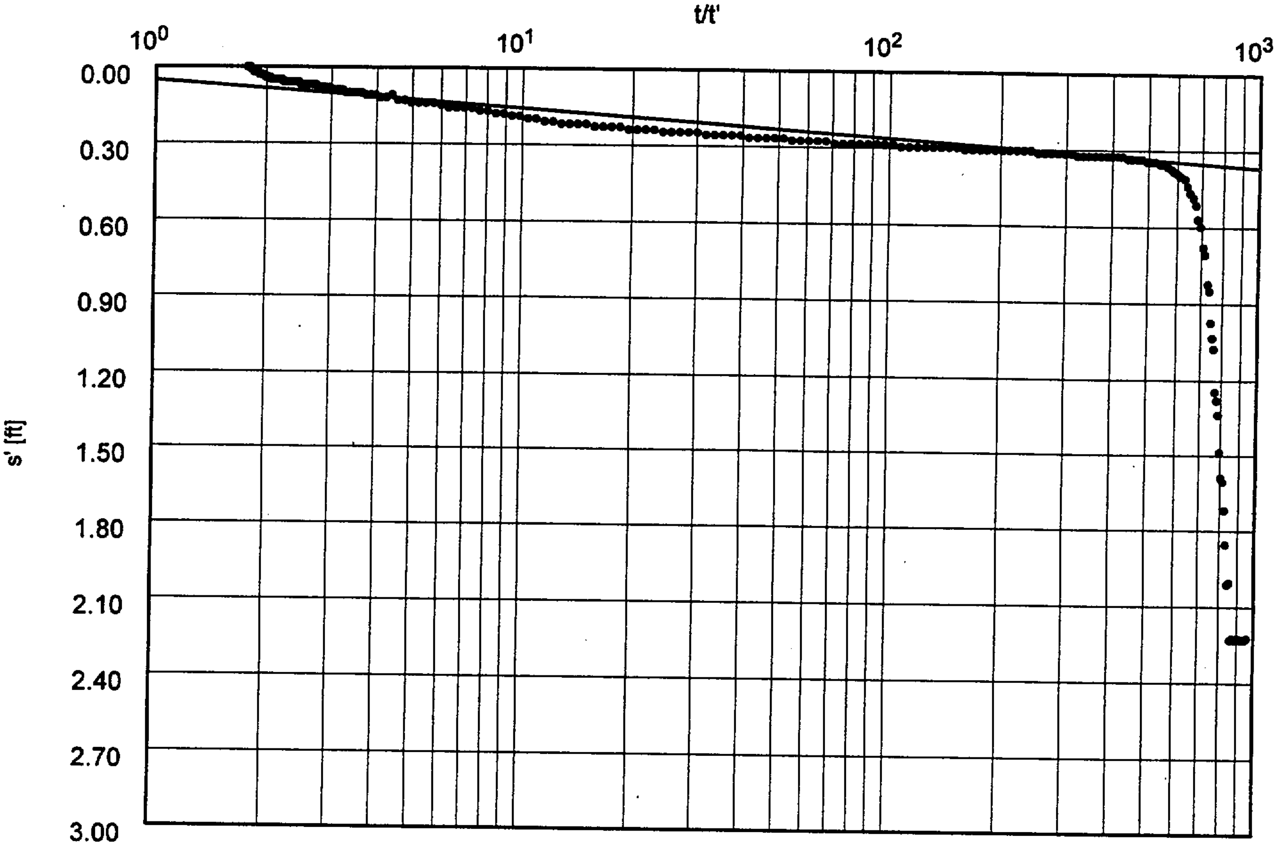
PUMPING WELL 1035

RECOVERY DATA ANALYSES

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1035PR1.HYT, Page 1 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/18/98

Pumping Test No. 1035 Recovery Test	Test conducted on: 09/29/98
Pumping Well 1035	
Discharge 6.73 U.S.gal/min	
	Pumping test duration: 707.00 min



• Pumping well 1035

Transmissivity [ft²/min]: 1.57 x 10^0 2260.80 ft²/day

Hydraulic conductivity [ft/min]: 1.96 x 10^{-1} 282.24 ft/day

Aquifer thickness [ft]: 8.00

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1035PR1.HYT, Page 2 Project: UGW -- Grand Junction, CO Evaluated by: RJH — Date: 11/18/98

Pumping Test No. 1035 Recovery Test	Test conducted on: 09/29/98
Pumping Well 1035	Pumping well 1035
Discharge 6.73 U.S.gal/min	Distance from the pumping well 1.00 ft
Static water level: 10.24 ft below datum	Pumping test duration: 707.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
1	0.74	12.91	2.67	2.22
2	0.75	12.92	2.68	2.23
3	0.76	12.92	2.68	2.23
4	0.77	12.92	2.68	2.23
5	0.78	12.91	2.67	2.22
6	0.79	12.91	2.67	2.22
7	0.80	12.92	2.68	2.23
8	0.81	12.91	2.67	2.22
9	0.82	12.92	2.68	2.23
10	0.83	12.59	2.35	2.00
11	0.84	12.60	2.36	2.01
12	0.85	12.38	2.14	1.85
13	0.86	12.20	1.96	1.72
14	0.87	12.05	1.81	1.61
15	0.88	12.03	1.79	1.59
16	0.89	11.90	1.66	1.49
17	0.90	11.71	1.47	1.33
18	0.91	11.64	1.40	1.28
19	0.92	11.60	1.36	1.24
20	0.93	11.40	1.16	1.08
21	0.94	11.35	1.11	1.03
22	0.95	11.28	1.04	0.97
23	0.96	11.14	0.90	0.85
24	0.97	11.11	0.87	0.82
25	0.99	10.98	0.74	0.71
26	1.00	10.95	0.71	0.68
27	1.02	10.86	0.62	0.60
28	1.04	10.83	0.59	0.57
29	1.05	10.77	0.53	0.51
30	1.07	10.74	0.50	0.48
31	1.09	10.72	0.48	0.47
32	1.11	10.69	0.45	0.44
33	1.13	10.66	0.42	0.41
34	1.16	10.65	0.41	0.40
35	1.18	10.64	0.40	0.39
36	1.21	10.63	0.39	0.38
37	1.23	10.62	0.38	0.37
38	1.26	10.61	0.37	0.36
39	1.29	10.60	0.36	0.35
40	1.32	10.60	0.36	0.35
41	1.36	10.59	0.35	0.34
42	1.40	10.59	0.35	0.34
43	1.43	10.59	0.35	0.34
44	1.48	10.58	0.34	0.33
45	1.52	10.58	0.34	0.33
46	1.57	10.58	0.34	0.33
47	1.61	10.58	0.34	0.33
48	1.67	10.57	0.33	0.32
49	1.72	10.57	0.33	0.32
50	1.78	10.57	0.33	0.32

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1035PR1.HYT, Page 3 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/18/98

Pumping Test No. 1035 Recovery Test	Test conducted on: 09/29/98
Pumping Well 1035	Pumping well 1035
Discharge 6.73 U.S.gal/min	Distance from the pumping well 1.00 ft
Static water level: 10.24 ft below datum	Pumping test duration: 707.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
51	1.84	10.57	0.33	0.32
52	1.91	10.57	0.33	0.32
53	1.98	10.57	0.33	0.32
54	2.05	10.57	0.33	0.32
55	2.13	10.57	0.33	0.32
56	2.21	10.57	0.33	0.32
57	2.30	10.56	0.32	0.31
58	2.39	10.56	0.32	0.31
59	2.49	10.56	0.32	0.31
60	2.60	10.56	0.32	0.31
61	2.71	10.56	0.32	0.31
62	2.82	10.56	0.32	0.31
63	2.95	10.55	0.31	0.30
64	3.08	10.55	0.31	0.30
65	3.22	10.55	0.31	0.30
66	3.37	10.55	0.31	0.30
67	3.52	10.55	0.31	0.30
68	3.69	10.55	0.31	[illegible]
69	3.87	10.55	0.31	[illegible]
70	4.05	10.55	0.31	0.30
71	4.25	10.55	0.31	0.30
72	4.46	10.55	0.31	0.30
73	4.68	10.54	0.30	0.29
74	4.92	10.54	0.30	0.29
75	5.17	10.54	0.30	0.29
76	5.43	10.54	0.30	0.29
77	5.71	10.54	0.30	0.29
78	6.01	10.54	0.30	0.29
79	6.32	10.54	0.30	0.29
80	6.65	10.54	0.30	0.29
81	7.00	10.53	0.29	0.28
82	7.38	10.53	0.29	0.28
83	7.77	10.53	0.29	0.28
84	8.19	10.53	0.29	0.28
85	8.63	10.53	0.29	0.28
86	9.10	10.53	0.29	0.28
87	9.60	10.53	0.29	0.28
88	10.13	10.53	0.29	0.28
89	10.69	10.52	0.28	0.28
90	11.28	10.52	0.28	0.28
91	11.91	10.52	0.28	0.28
92	12.57	10.52	0.28	0.28
93	13.27	10.52	0.28	[illegible]
94	14.02	10.51	0.27	[illegible]
95	14.81	10.51	0.27	0.27
96	15.64	10.51	0.27	0.27
97	16.53	10.51	0.27	0.27
98	17.47	10.51	0.27	0.27
99	18.46	10.50	0.26	0.26
100	19.51	10.50	0.26	0.26

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1035PR1.HYT, Page 4 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/18/98

Pumping Test No. 1035 Recovery Test	Test conducted on: 09/29/98
Pumping Well 1035	Pumping well 1035
Discharge 6.73 U.S.gal/min	Distance from the pumping well 1.00 ft
Static water level: 10.24 ft below datum	Pumping test duration: 707.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
101	20.63	10.50	0.26	0.26
102	21.81	10.50	0.26	0.26
103	23.06	10.50	0.26	0.26
104	24.39	10.49	0.25	0.25
105	25.79	10.49	0.25	0.25
106	27.28	10.49	0.25	0.25
107	28.86	10.49	0.25	0.25
108	30.52	10.49	0.25	0.25
109	32.29	10.48	0.24	0.24
110	34.17	10.48	0.24	0.24
111	36.15	10.48	0.24	0.24
112	38.25	10.48	0.24	0.24
113	40.48	10.47	0.23	0.23
114	42.84	10.47	0.23	0.23
115	45.33	10.47	0.23	0.23
116	47.98	10.47	0.23	0.23
117	50.78	10.46	0.22	0.22
118	53.75	10.46	0.22	0.22
119	56.90	10.46	0.22	0.22
120	60.23	10.46	0.22	0.22
121	63.76	10.45	0.21	0.21
122	67.50	10.45	0.21	0.21
123	71.46	10.44	0.20	0.20
124	75.65	10.44	0.20	0.20
125	80.09	10.43	0.19	0.19
126	84.80	10.43	0.19	0.19
127	89.78	10.42	0.18	0.18
128	95.06	10.42	0.18	0.18
129	100.66	10.41	0.17	0.17
130	106.58	10.41	0.17	0.17
131	112.86	10.40	0.16	0.16
132	119.51	10.40	0.16	0.16
133	126.55	10.40	0.16	0.16
134	134.01	10.40	0.16	0.16
135	141.91	10.39	0.15	0.15
136	150.27	10.38	0.14	0.14
137	159.14	10.38	0.14	0.14
138	168.53	10.38	0.14	0.14
139	178.48	10.38	0.14	0.14
140	188.48	10.37	0.13	0.13
141	198.48	10.37	0.13	0.13
142	208.48	10.35	0.11	0.11
143	218.48	10.36	0.12	0.12
144	228.48	10.36	0.12	0.12
145	238.48	10.35	0.11	0.11
146	248.48	10.35	0.11	0.11
147	258.48	10.35	0.11	0.11
148	268.48	10.34	0.10	0.10
149	278.48	10.34	0.10	0.10
150	288.48	10.34	0.10	0.10

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1035PR1.HYT, Page 5 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/18/98

Pumping Test No. 1035 Recovery Test	Test conducted on: 09/29/98
Pumping Well 1035	Pumping well 1035
Discharge 6.73 U.S.gal/min	Distance from the pumping well 1.00 ft
Static water level: 10.24 ft below datum	Pumping test duration: 707.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
151	298.48	10.34	0.10	0.10
152	308.48	10.34	0.10	0.10
153	318.48	10.33	0.09	0.09
154	328.48	10.33	0.09	0.09
155	338.48	10.33	0.09	0.09
156	348.48	10.33	0.09	0.09
157	358.48	10.32	0.08	0.08
158	368.48	10.32	0.08	0.08
159	378.48	10.32	0.08	0.08
160	388.48	10.32	0.08	0.08
161	398.48	10.32	0.08	0.08
162	408.48	10.31	0.07	0.07
163	418.48	10.31	0.07	0.07
164	428.48	10.31	0.07	0.07
165	438.48	10.31	0.07	0.07
166	448.48	10.31	0.07	0.07
167	458.48	10.31	0.07	0.07
168	468.48	10.31	0.07	[illegible]
169	478.48	10.31	0.07	[illegible]
170	488.48	10.30	0.06	0.06
171	498.48	10.30	0.06	0.06
172	508.48	10.30	0.06	0.06
173	518.48	10.30	0.06	0.06
174	528.48	10.30	0.06	0.06
175	538.48	10.30	0.06	0.06
176	548.48	10.30	0.06	0.06
177	558.48	10.30	0.06	0.06
178	568.48	10.30	0.06	0.06
179	578.48	10.30	0.06	0.06
180	588.48	10.29	0.05	0.05
181	598.48	10.29	0.05	0.05
182	608.48	10.29	0.05	0.05
183	618.48	10.29	0.05	0.05
184	628.48	10.29	0.05	0.05
185	638.48	10.29	0.05	0.05
186	648.48	10.29	0.05	0.05
187	658.48	10.29	0.05	0.05
188	668.48	10.29	0.05	0.05
189	678.48	10.28	0.04	0.04
190	688.48	10.28	0.04	0.04
191	698.48	10.28	0.04	0.04
192	708.48	10.28	0.04	0.04
193	718.48	10.28	0.04	[illegible]
194	728.48	10.27	0.03	[illegible]
195	738.48	10.27	0.03	0.03
196	748.48	10.27	0.03	0.03
197	758.48	10.27	0.03	0.03
198	768.48	10.27	0.03	0.03
199	778.48	10.27	0.03	0.03
200	788.48	10.26	0.02	0.02

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1035PR1.HYT, Page 6 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/18/98

Pumping Test No. 1035 Recovery Test	Test conducted on: 09/29/98
Pumping Well 1035	Pumping well 1035
Discharge 6.73 U.S.gal/min	Distance from the pumping well 1.00 ft
Static water level: 10.24 ft below datum	Pumping test duration: 707.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
201	798.48	10.26	0.02	0.02
202	808.48	10.26	0.02	0.02
203	818.48	10.26	0.02	0.02
204	828.48	10.26	0.02	0.02
205	838.48	10.26	0.02	0.02
206	848.48	10.25	0.01	0.01
207	858.48	10.25	0.01	0.01
208	868.48	10.25	0.01	0.01
209	878.48	10.24	0.00	0.00
210	888.48	10.24	0.00	0.00
211	898.48	10.24	0.00	0.00
212	908.48	10.24	0.00	0.00
213	918.48	10.24	0.00	0.00

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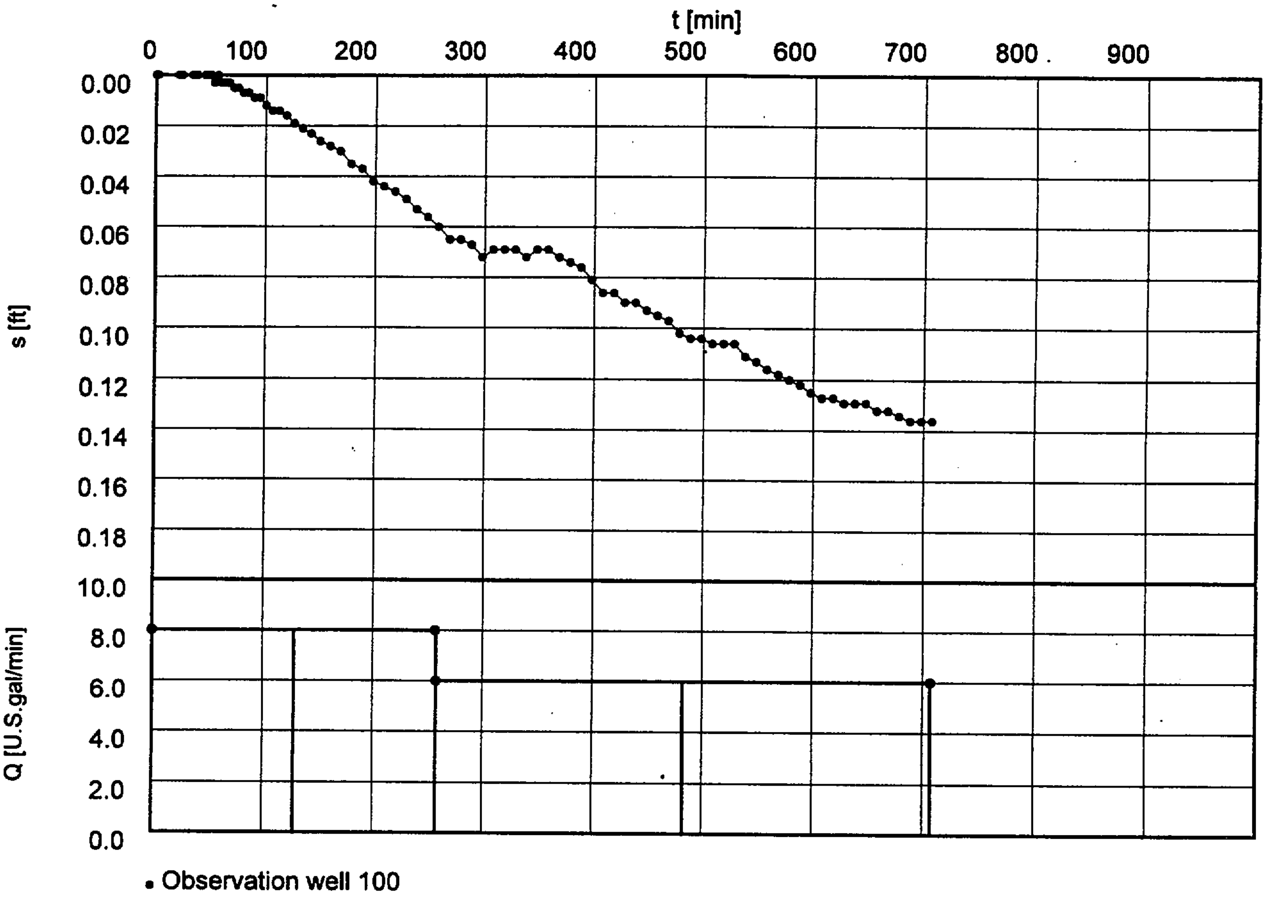
PUMPING WELL 1035

OBSERVATION WELL 1002

DRAWDOWN AND RECOVERY DATA ANALYSES

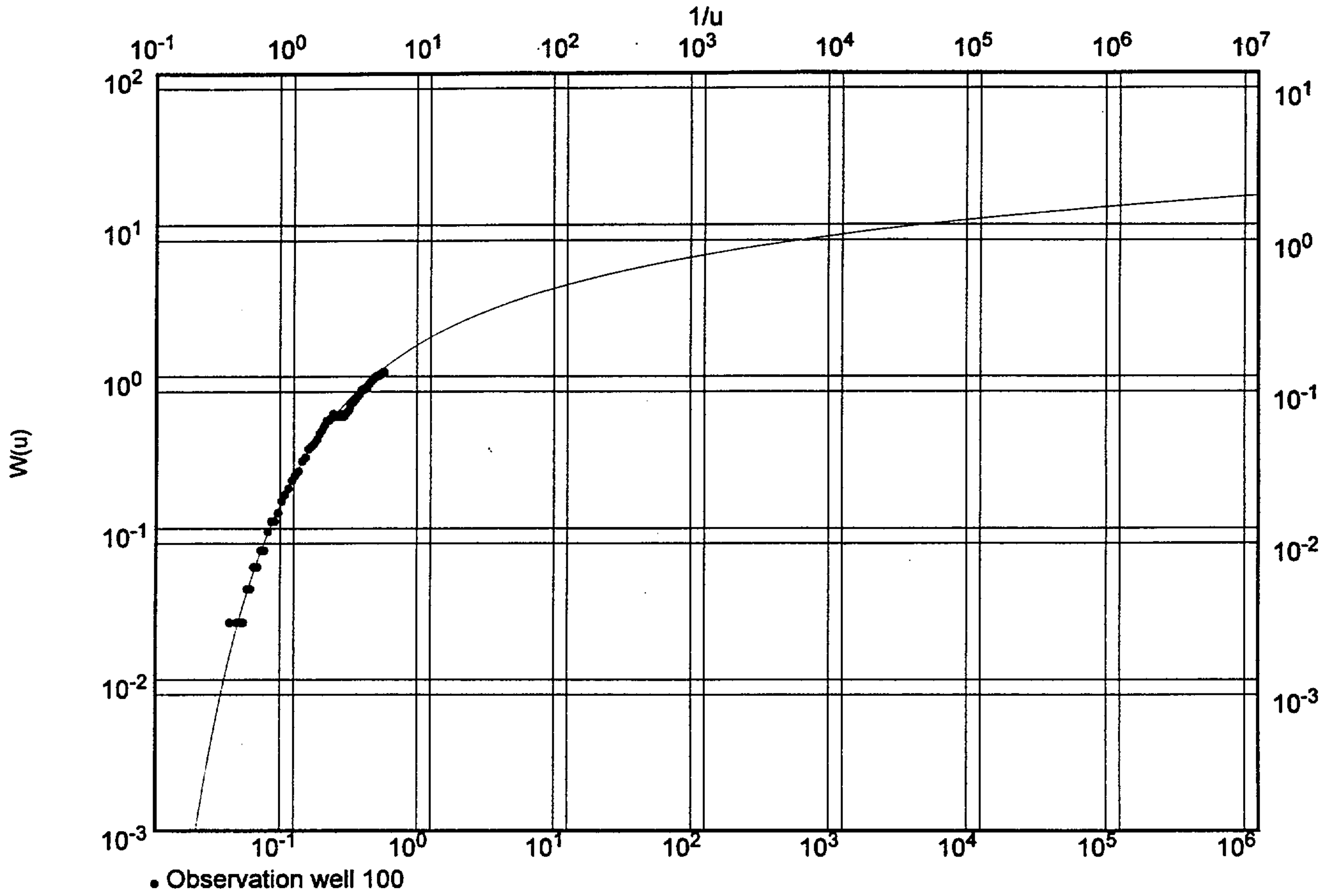
MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Time-Drawdown plot with discharge	1002OA1.HYT, Page 1 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/18/98

Pumping Test No. 1035 Aquifer Test	Test conducted on: 09/29/98
Observation Well 1002	
Discharge 6.73 U.S.gal/min	



MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Theis analysis method Unconfined aquifer	1002OA1.HYT, Page 1 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/18/98

Pumping Test No. 1035 Aquifer Test	Test conducted on: 09/29/98
Observation Well 1002	
Discharge 6.73 U.S.gal/min	



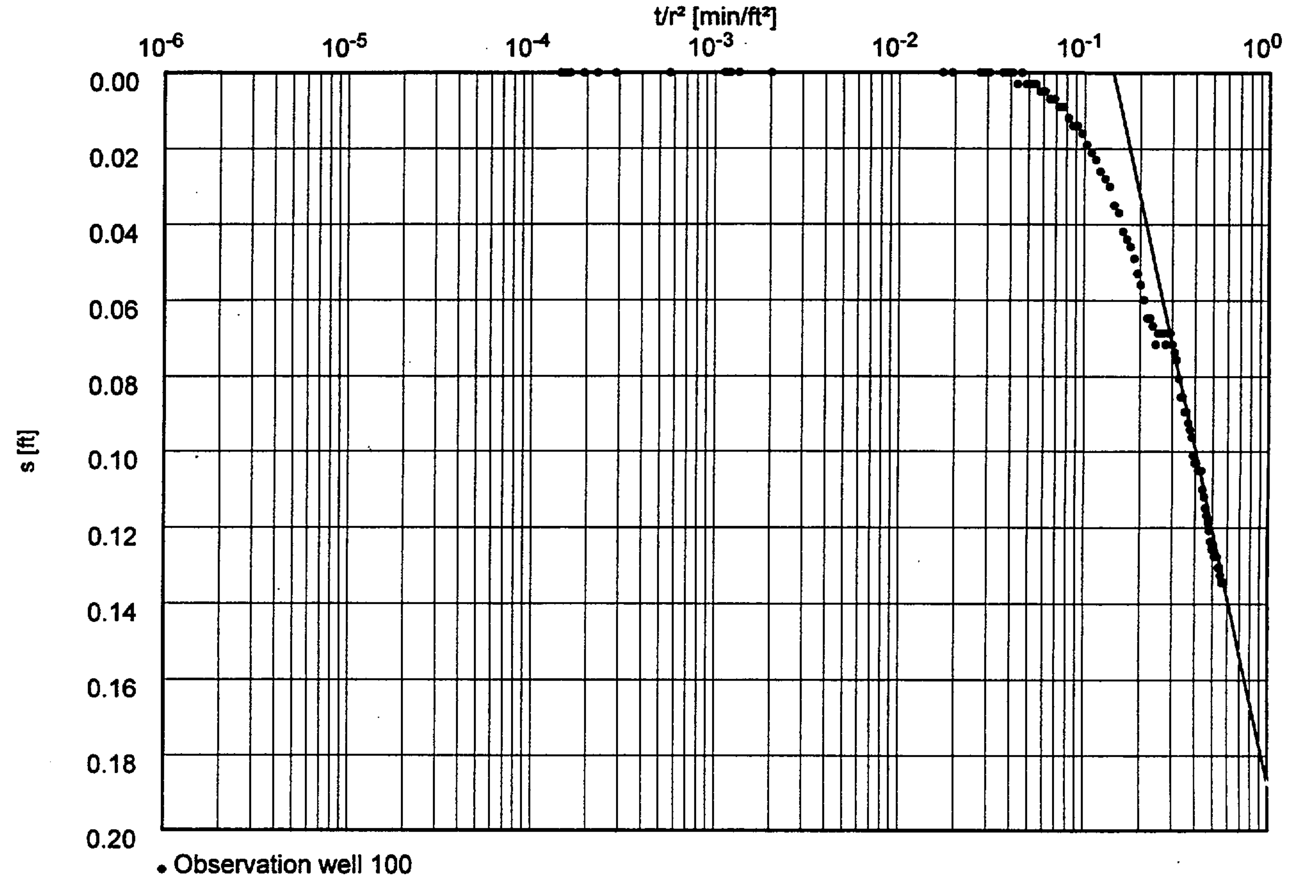
Transmissivity [ft²/min]: 5.68 x 10^{-1} 817.92 ft²/day

Hydraulic conductivity [ft/min]: 9.47 x 10^{-2} 136.37 ft/day

Aquifer thickness [ft]: 6.00

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Distance-Time-Drawdown-method after COOPER & JACOB Unconfined aquifer	1002OA1.HYT, Page 1 Project: UGW -- Grand Junction, CO Evaluated by: RJH	Date: 11/18/98

Pumping Test No. 1035 Aquifer Test	Test conducted on: 09/29/98
Observation Well 1002	
Discharge 6.73 U.S.gal/min	



Transmissivity [ft²/min]: 7.41 x 10^{-1} 1067.04 ft²/day

Hydraulic conductivity [ft/min]: 1.23 x 10^{-1} 177.12 ft/day

Aquifer thickness [ft]: 6.00

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Theis analysis method Unconfined aquifer	1002OA1.HYT, Page 2 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/18/98

Pumping Test No. 1035 Aquifer Test	Test conducted on: 09/29/98
Observation Well 1002	Observation well 1002
Discharge 6.73 U.S.gal/min	Distance from the pumping well 35.00 ft

Static water level: 11.10 ft below datum

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
2	0.01	11.10	-0.00	-0.00
3	0.01	11.10	-0.00	-0.00
4	0.02	11.10	-0.00	-0.00
5	0.02	11.10	-0.00	-0.00
6	0.03	11.10	-0.00	-0.00
7	0.03	11.10	-0.00	-0.00
8	0.04	11.10	-0.00	-0.00
9	0.04	11.10	-0.00	-0.00
10	0.05	11.10	-0.00	-0.00
11	0.05	11.10	-0.00	-0.00
12	0.06	11.10	-0.00	-0.00
13	0.06	11.10	-0.00	-0.00
14	0.07	11.10	-0.00	-0.00
15	0.07	11.10	-0.00	-0.00
16	0.08	11.10	-0.00	-0.00
17	0.08	11.10	-0.00	-0.00
18	0.09	11.10	-0.00	-0.00
19	0.09	11.10	-0.00	-0.00
20	0.10	11.10	-0.00	-0.00
21	0.10	11.10	-0.00	-0.00
22	0.11	11.10	-0.00	-0.00
23	0.11	11.10	-0.00	-0.00
24	0.12	11.10	-0.00	-0.00
25	0.13	11.10	-0.00	-0.00
26	0.13	11.10	-0.00	-0.00
27	0.14	11.10	-0.00	-0.00
28	0.15	11.10	-0.00	-0.00
29	0.16	11.10	-0.00	-0.00
30	0.17	11.10	-0.00	-0.00
31	0.18	11.10	0.00	0.00
32	0.19	11.10	0.00	0.00
33	0.20	11.10	0.00	0.00
34	0.21	11.10	-0.00	-0.00
35	0.22	11.10	-0.00	-0.00
36	0.24	11.10	0.00	0.00
37	0.25	11.10	-0.00	-0.00
38	0.26	11.10	-0.00	-0.00
39	0.28	11.10	0.00	0.00
40	0.30	11.10	-0.00	-0.00
41	0.31	11.10	-0.00	-0.00
42	0.33	11.10	-0.00	-0.00
43	0.35	11.10	0.00	0.00
44	0.37	11.10	-0.00	-0.00
45	0.40	11.10	-0.00	-0.00
46	0.42	11.10	-0.00	-0.00
47	0.44	11.10	-0.00	-0.00
48	0.47	11.10	-0.00	-0.00
49	0.50	11.10	-0.00	-0.00
50	0.52	11.10	-0.00	-0.00

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Theis analysis method Unconfined aquifer	1002OA1.HYT, Page 3 Project: UGW – Grand Junction, CO Evaluated by: RJH Date: 11/18/98

Pumping Test No. 1035 Aquifer Test	Test conducted on: 09/29/98
Observation Well 1002	Observation well 1002
Discharge 6.73 U.S.gal/min	Distance from the pumping well 35.00 ft

Static water level: 11.10 ft below datum

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
51	0.55	11.10	-0.00	-0.00
52	0.59	11.10	-0.00	-0.00
53	0.62	11.10	-0.00	-0.00
54	0.66	11.10	-0.00	-0.00
55	0.70	11.10	0.00	0.00
56	0.74	11.10	-0.00	-0.00
57	0.78	11.10	-0.00	-0.00
58	0.83	11.10	-0.00	-0.00
59	0.88	11.10	-0.00	-0.00
60	0.93	11.10	-0.00	-0.00
61	0.98	11.10	-0.00	-0.00
62	1.04	11.10	-0.00	-0.00
63	1.10	11.10	-0.00	-0.00
64	1.17	11.10	-0.00	-0.00
65	1.24	11.10	-0.00	-0.00
66	1.31	11.10	-0.00	-0.00
67	1.39	11.10	0.00	0.00
68	1.47	11.10	0.00	[illegible]
69	1.56	11.10	-0.00	[illegible]
70	1.65	11.10	0.00	0.00
71	1.75	11.10	-0.00	-0.00
72	1.86	11.10	-0.00	-0.00
73	1.97	11.10	-0.00	-0.00
74	2.08	11.10	-0.00	-0.00
75	2.21	11.10	-0.00	-0.00
76	2.34	11.10	-0.00	-0.00
77	2.48	11.10	0.00	0.00
78	2.63	11.10	-0.00	-0.00
79	2.79	11.10	-0.00	-0.00
80	2.95	11.10	-0.00	-0.00
81	3.13	11.10	-0.00	-0.00
82	3.32	11.10	-0.00	-0.00
83	3.51	11.10	-0.00	-0.00
84	3.72	11.10	-0.00	-0.00
85	3.95	11.10	-0.00	-0.00
86	4.18	11.10	-0.00	-0.00
87	4.43	11.10	-0.00	-0.00
88	4.69	11.10	-0.00	-0.00
89	4.97	11.10	-0.00	-0.00
90	5.27	11.10	-0.00	-0.00
91	5.58	11.10	-0.00	-0.00
92	5.91	11.10	-0.00	-0.00
93	6.27	11.10	-0.00	[illegible]
94	6.64	11.10	-0.00	[illegible]
95	7.03	11.10	-0.00	-0.00
96	7.45	11.10	-0.00	-0.00
97	7.90	11.10	-0.00	-0.00
98	8.37	11.10	-0.00	-0.00
99	8.86	11.10	-0.00	-0.00
100	9.39	11.10	-0.00	-0.00

Pumping Test No. 1035 Aquifer Test	Test conducted on: 09/29/98
Observation Well 1002	Observation well 1002
Discharge 6.73 U.S.gal/min	Distance from the pumping well 35.00 ft

Static water level: 11.10 ft below datum

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
101	9.95	11.10	-0.00	-0.00
102	10.54	11.10	-0.00	-0.00
103	11.17	11.10	-0.00	-0.00
104	11.83	11.10	-0.00	-0.00
105	12.53	11.10	-0.00	-0.00
106	13.28	11.10	-0.00	-0.00
107	14.07	11.10	-0.00	-0.00
108	14.91	11.10	-0.00	-0.00
109	15.79	11.10	-0.00	-0.00
110	16.73	11.10	-0.00	-0.00
111	17.72	11.10	-0.00	-0.00
112	18.78	11.10	-0.00	-0.00
113	19.89	11.10	-0.00	-0.00
114	21.07	11.10	0.00	0.00
115	22.32	11.10	-0.00	-0.00
116	23.65	11.10	0.00	0.00
117	25.05	11.10	-0.00	-0.00
118	26.54	11.10	-0.00	-0.00
119	28.12	11.10	-0.00	-0.00
120	29.79	11.10	-0.00	-0.00
121	31.55	11.10	-0.00	-0.00
122	33.43	11.10	0.00	0.00
123	35.41	11.10	0.00	0.00
124	37.51	11.10	0.00	0.00
125	39.74	11.10	-0.00	-0.00
126	42.10	11.10	-0.00	-0.00
127	44.60	11.10	0.00	0.00
128	47.24	11.10	0.00	0.00
129	50.05	11.10	0.00	0.00
130	53.01	11.10	0.00	0.00
131	56.16	11.10	0.00	0.00
132	59.49	11.10	0.00	0.00
133	63.02	11.10	0.00	0.00
134	66.76	11.10	0.00	0.00
135	70.72	11.10	0.00	0.00
136	74.91	11.10	0.00	0.00
137	79.35	11.11	0.01	0.01
138	84.06	11.11	0.01	0.01
139	89.05	11.11	0.01	0.01
140	94.33	11.11	0.01	0.01
141	99.92	11.11	0.01	0.01
142	105.84	11.11	0.01	0.01
143	112.12	11.11	0.01	0.01
144	118.77	11.12	0.02	0.02
145	125.81	11.12	0.02	0.02
146	133.27	11.12	0.02	0.02
147	141.17	11.12	0.02	0.02
148	149.54	11.13	0.03	0.03
149	158.40	11.13	0.03	0.03
150	167.79	11.13	0.03	0.03

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Theis analysis method Unconfined aquifer	1002OA1.HYT, Page 5 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/18/98

Pumping Test No. 1035 Aquifer Test	Test conducted on: 09/29/98
Observation Well 1002	Observation well 1002
Discharge 6.73 U.S.gal/min	Distance from the pumping well 35.00 ft
Static water level: 11.10 ft below datum	

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
151	177.74	11.13	0.03	0.03
152	187.74	11.14	0.04	0.04
153	197.74	11.14	0.04	0.04
154	207.74	11.14	0.04	0.04
155	217.74	11.15	0.05	0.05
156	227.74	11.15	0.05	0.05
157	237.74	11.15	0.05	0.05
158	247.74	11.16	0.06	0.06
159	257.74	11.16	0.06	0.06
160	267.74	11.16	0.06	0.06
161	277.74	11.16	0.06	0.06
162	287.74	11.17	0.07	0.07
163	297.74	11.17	0.07	0.07
164	307.74	11.17	0.07	0.07
165	317.74	11.17	0.07	0.07
166	327.74	11.17	0.07	0.07
167	337.74	11.17	0.07	0.07
168	347.74	11.17	0.07	[illegible]
169	357.74	11.17	0.07	[illegible]
170	367.74	11.17	0.07	0.07
171	377.74	11.17	0.07	0.07
172	387.74	11.18	0.08	0.08
173	397.74	11.18	0.08	0.08
174	407.74	11.19	0.09	0.09
175	417.74	11.19	0.09	0.09
176	427.74	11.19	0.09	0.09
177	437.74	11.19	0.09	0.09
178	447.74	11.19	0.09	0.09
179	457.74	11.20	0.10	0.09
180	467.74	11.20	0.10	0.10
181	477.74	11.20	0.10	0.10
182	487.74	11.20	0.10	0.10
183	497.74	11.20	0.10	0.10
184	507.74	11.21	0.11	0.11
185	517.74	11.21	0.11	0.11
186	527.74	11.21	0.11	0.11
187	537.74	11.21	0.11	0.11
188	547.74	11.21	0.11	0.11
189	557.74	11.22	0.12	0.11
190	567.74	11.22	0.12	0.12
191	577.74	11.22	0.12	0.12
192	587.74	11.22	0.12	0.12
193	597.74	11.23	0.13	[illegible]
194	607.74	11.23	0.13	[illegible]
195	617.74	11.23	0.13	0.13
196	627.74	11.23	0.13	0.13
197	637.74	11.23	0.13	0.13
198	647.74	11.23	0.13	0.13
199	657.74	11.23	0.13	0.13
200	667.74	11.23	0.13	0.13

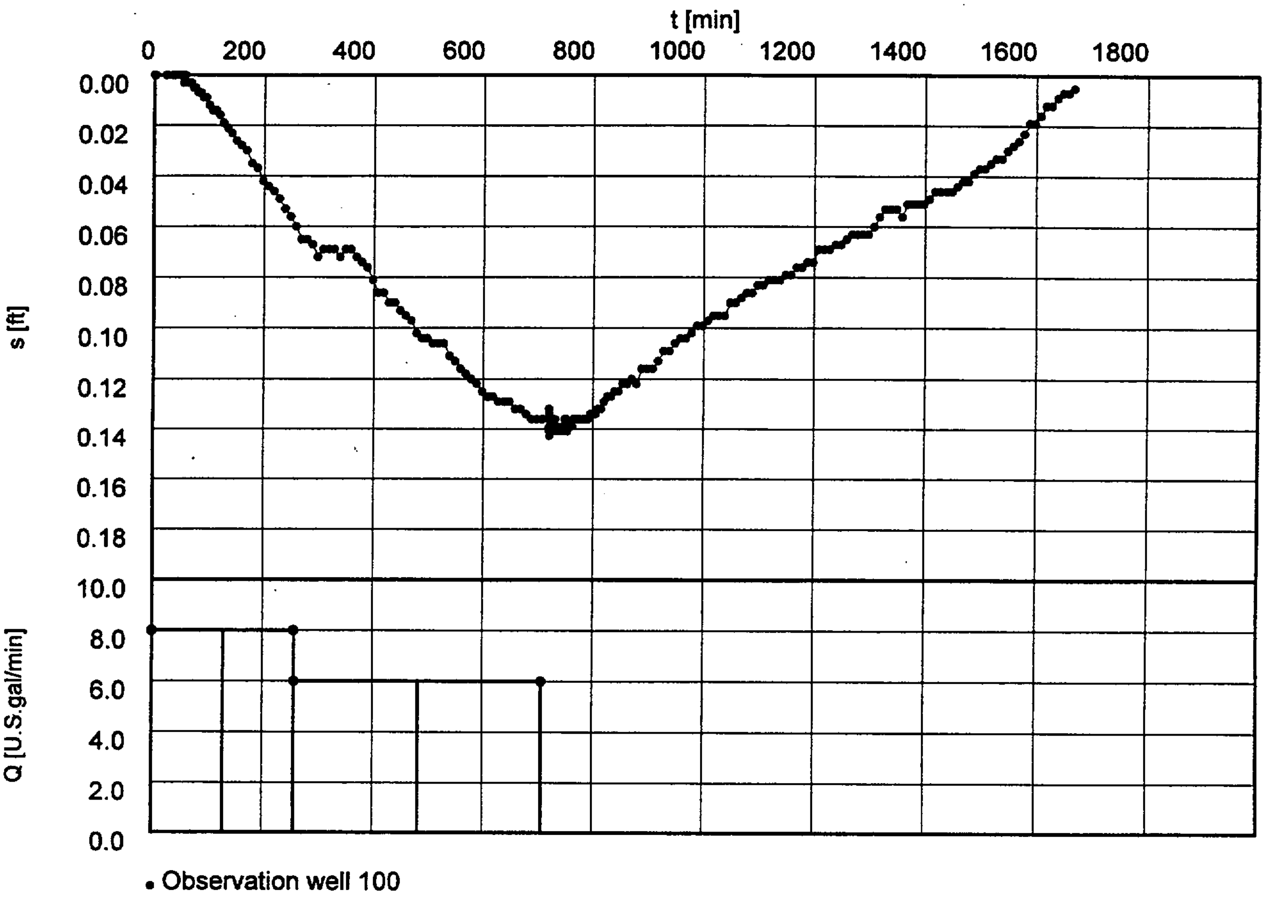
MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Theis analysis method Unconfined aquifer	1002OA1.HYT, Page 6 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/18/98

Pumping Test No. 1035 Aquifer Test	Test conducted on: 09/29/98
Observation Well 1002	Observation well 1002
Discharge 6.73 U.S.gal/min	Distance from the pumping well 35.00 ft
Static water level: 11.10 ft below datum	

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
201	677.74	11.23	0.13	0.13
202	687.74	11.24	0.14	0.13
203	697.74	11.24	0.14	0.13
204	707.74	11.24	0.14	0.13

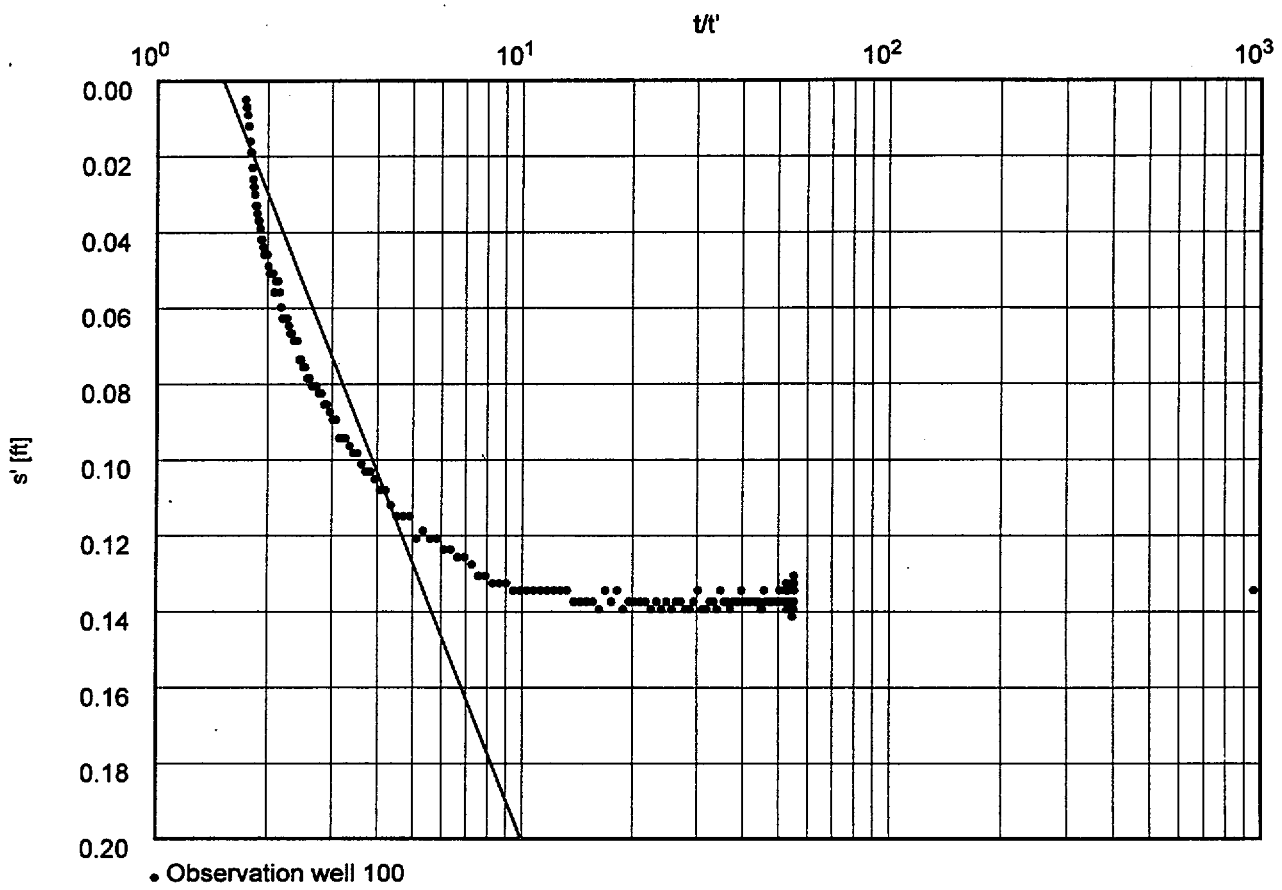
MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Time-Drawdown plot with discharge	1002OR1.HYT, Page 1 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/18/98

Pumping Test No. 1035 Recovery Test	Test conducted on: 09/29/98
Observation Well 1002	
Discharge 6.73 U.S.gal/min	



MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1002OR1.HYT, Page 1 Project: UGW – Grand Junction, CO Evaluated by: RJH Date: 11/18/98

Pumping Test No. 1035 Recovery Test	Test conducted on: 09/29/98
Observation Well 1002	
Discharge 6.73 U.S.gal/min	
	Pumping test duration: 707.00 min



Transmissivity [ft²/min]: 6.73 x 10^{-1} 969.12 ft²/day

Hydraulic conductivity [ft/min]: 1.12 x 10^{-1} 161.28 ft/day

Aquifer thickness [ft]: 6.00

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1002OR1.HYT, Page 2 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/18/98

Pumping Test No. 1035 Recovery Test	Test conducted on: 09/29/98
Observation Well 1002	Observation well 1002
Discharge 6.73 U.S.gal/min	Distance from the pumping well 35.00 ft
Static water level: 11.10 ft below datum	Pumping test duration: 707.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
1	0.74	11.24	0.14	0.13
2	13.00	11.24	0.14	0.13
3	13.00	11.23	0.13	0.13
4	13.01	11.23	0.13	0.13
5	13.01	11.24	0.14	0.13
6	13.02	11.24	0.14	0.13
7	13.03	11.23	0.13	0.13
8	13.03	11.23	0.13	0.13
9	13.04	11.24	0.14	0.13
10	13.04	11.23	0.13	0.13
11	13.04	11.24	0.14	0.14
12	13.05	11.23	0.13	0.13
13	13.05	11.23	0.13	0.13
14	13.06	11.24	0.14	0.13
15	13.07	11.24	0.14	0.14
16	13.07	11.24	0.14	0.14
17	13.08	11.24	0.14	0.14
18	13.08	11.24	0.14	[illegible]
19	13.08	11.24	0.14	[illegible]
20	13.09	11.24	0.14	[illegible]
21	13.09	11.24	0.14	0.13
22	13.10	11.24	0.14	0.13
23	13.11	11.24	0.14	0.14
24	13.11	11.23	0.13	0.13
25	13.12	11.23	0.13	0.13
26	13.13	11.24	0.14	0.14
27	13.13	11.24	0.14	0.14
28	13.14	11.24	0.14	0.14
29	13.15	11.24	0.14	0.13
30	13.16	11.24	0.14	0.14
31	13.17	11.23	0.13	0.13
32	13.18	11.24	0.14	0.14
33	13.19	11.24	0.14	0.14
34	13.20	11.24	0.14	0.14
35	13.21	11.24	0.14	0.14
36	13.22	11.24	0.14	0.14
37	13.24	11.24	0.14	0.14
38	13.25	11.24	0.14	0.14
39	13.26	11.24	0.14	0.14
40	13.28	11.24	0.14	0.13
41	13.30	11.24	0.14	0.13
42	13.31	11.24	0.14	0.14
43	13.33	11.24	0.14	[illegible]
44	13.35	11.24	0.14	[illegible]
45	13.37	11.24	0.14	[illegible]
46	13.40	11.24	0.14	0.13
47	13.42	11.24	0.14	0.13
48	13.44	11.24	0.14	0.14
49	13.47	11.24	0.14	0.14
50	13.50	11.24	0.14	0.14

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1002OR1.HYT, Page 3 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/18/98

Pumping Test No. 1035 Recovery Test
Test conducted on: 09/29/98

Observation Well 1002
Observation well 1002

Discharge 6.73 U.S.gal/min
Distance from the pumping well 35.00 ft

Static water level: 11.10 ft below datum
Pumping test duration: 707.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
51	13.52	11.24	0.14	0.13
52	13.55	11.24	0.14	0.14
53	13.59	11.24	0.14	0.13
54	13.62	11.24	0.14	0.14
55	13.66	11.24	0.14	0.14
56	13.70	11.23	0.13	0.13
57	13.74	11.24	0.14	0.13
58	13.78	11.24	0.14	0.13
59	13.83	11.24	0.14	0.14
60	13.88	11.24	0.14	0.14
61	13.93	11.24	0.14	0.14
62	13.98	11.24	0.14	0.14
63	14.04	11.24	0.14	0.14
64	14.10	11.24	0.14	0.14
65	14.17	11.24	0.14	0.14
66	14.24	11.24	0.14	0.14
67	14.31	11.24	0.14	0.13
68	14.39	11.24	0.14	0.14
69	14.47	11.24	0.14	0.14
70	14.56	11.24	0.14	0.14
71	14.65	11.24	0.14	0.14
72	14.75	11.24	0.14	0.14
73	14.86	11.24	0.14	0.14
74	14.97	11.24	0.14	0.14
75	15.08	11.24	0.14	0.14
76	15.21	11.24	0.14	0.14
77	15.34	11.24	0.14	0.14
78	15.48	11.24	0.14	0.14
79	15.63	11.24	0.14	0.14
80	15.79	11.24	0.14	0.13
81	15.95	11.24	0.14	0.14
82	16.13	11.24	0.14	0.14
83	16.32	11.24	0.14	0.14
84	16.51	11.24	0.14	0.14
85	16.72	11.24	0.14	0.14
86	16.95	11.24	0.14	0.14
87	17.18	11.24	0.14	0.14
88	17.43	11.24	0.14	0.14
89	17.69	11.24	0.14	0.14
90	17.97	11.24	0.14	0.14
91	18.27	11.24	0.14	0.13
92	18.58	11.24	0.14	0.14
93	18.91	11.24	0.14	0.14
94	19.27	11.24	0.14	0.14
95	19.64	11.24	0.14	0.14
96	20.03	11.24	0.14	0.14
97	20.45	11.24	0.14	0.14
98	20.90	11.24	0.14	0.13
99	21.37	11.24	0.14	0.14
100	21.86	11.24	0.14	0.14

Pumping Test No. 1035 Recovery Test	Test conducted on: 09/29/98
Observation Well 1002	Observation well 1002
Discharge 6.73 U.S.gal/min	Distance from the pumping well 35.00 ft
Static water level: 11.10 ft below datum	Pumping test duration: 707.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
101	22.39	11.24	0.14	0.14
102	22.95	11.24	0.14	0.14
103	23.54	11.24	0.14	0.14
104	24.17	11.24	0.14	0.13
105	24.83	11.24	0.14	0.14
106	25.53	11.24	0.14	0.14
107	26.28	11.24	0.14	0.14
108	27.07	11.24	0.14	0.14
109	27.91	11.24	0.14	0.14
110	28.79	11.24	0.14	0.14
111	29.73	11.24	0.14	0.14
112	30.72	11.24	0.14	0.14
113	31.78	11.24	0.14	0.14
114	32.89	11.24	0.14	0.14
115	34.07	11.24	0.14	0.14
116	35.32	11.24	0.14	0.14
117	36.65	11.24	0.14	0.14
118	38.05	11.24	0.14	[illegible]
119	39.54	11.24	0.14	[illegible]
120	41.12	11.24	0.14	0.13
121	42.79	11.24	0.14	0.14
122	44.55	11.24	0.14	0.13
123	46.43	11.24	0.14	0.14
124	48.41	11.24	0.14	0.14
125	50.51	11.24	0.14	0.14
126	52.74	11.24	0.14	0.14
127	55.10	11.24	0.14	0.14
128	57.60	11.24	0.14	0.13
129	60.24	11.24	0.14	0.13
130	63.05	11.24	0.14	0.13
131	66.01	11.24	0.14	0.13
132	69.16	11.24	0.14	0.13
133	72.49	11.24	0.14	0.13
134	76.02	11.24	0.14	0.13
135	79.76	11.24	0.14	0.13
136	83.72	11.24	0.14	0.13
137	87.91	11.23	0.13	0.13
138	92.35	11.23	0.13	0.13
139	97.06	11.23	0.13	0.13
140	102.05	11.23	0.13	0.13
141	107.33	11.23	0.13	0.13
142	112.92	11.23	0.13	0.13
143	118.84	11.23	0.13	[illegible]
144	125.12	11.23	0.13	[illegible]
145	131.77	11.23	0.13	0.12
146	138.81	11.23	0.13	0.12
147	146.27	11.22	0.12	0.12
148	154.17	11.22	0.12	0.12
149	162.54	11.22	0.12	0.12
150	171.40	11.22	0.12	0.12

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1002OR1.HYT, Page 5 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/18/98

Pumping Test No. 1035 Recovery Test	Test conducted on: 09/29/98
Observation Well 1002	Observation well 1002
Discharge 6.73 U.S.gal/min	Distance from the pumping well 35.00 ft
Static water level: 11.10 ft below datum	Pumping test duration: 707.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
151	180.79	11.22	0.12	0.11
152	190.74	11.22	0.12	0.11
153	200.74	11.22	0.12	0.11
154	210.74	11.21	0.11	0.11
155	220.74	11.21	0.11	0.11
156	230.74	11.21	0.11	0.11
157	240.74	11.21	0.11	0.11
158	250.74	11.20	0.10	0.10
159	260.74	11.20	0.10	0.10
160	270.74	11.20	0.10	0.10
161	280.74	11.20	0.10	0.10
162	290.74	11.20	0.10	0.10
163	300.74	11.20	0.10	0.10
164	310.74	11.20	0.10	0.09
165	320.74	11.20	0.10	0.09
166	330.74	11.20	0.10	0.09
167	340.74	11.19	0.09	0.09
168	350.74	11.19	0.09	0.09
169	360.74	11.19	0.09	0.09
170	370.74	11.19	0.09	0.09
171	380.74	11.19	0.09	0.09
172	390.74	11.18	0.08	0.08
173	400.74	11.18	0.08	0.08
174	410.74	11.18	0.08	0.08
175	420.74	11.18	0.08	0.08
176	430.74	11.18	0.08	0.08
177	440.74	11.18	0.08	0.08
178	450.74	11.18	0.08	0.08
179	460.74	11.18	0.08	0.08
180	470.74	11.18	0.08	0.08
181	480.74	11.17	0.07	0.07
182	490.74	11.17	0.07	0.07
183	500.74	11.17	0.07	0.07
184	510.74	11.17	0.07	0.07
185	520.74	11.17	0.07	0.07
186	530.74	11.17	0.07	0.07
187	540.74	11.17	0.07	0.07
188	550.74	11.16	0.06	0.06
189	560.74	11.16	0.06	0.06
190	570.74	11.16	0.06	0.06
191	580.74	11.16	0.06	0.06
192	590.74	11.16	0.06	0.06
193	600.74	11.16	0.06	0.06
194	610.74	11.16	0.06	0.06
195	620.74	11.15	0.05	0.05
196	630.74	11.15	0.05	0.05
197	640.74	11.15	0.05	0.05
198	650.74	11.16	0.06	0.06
199	660.74	11.15	0.05	0.05
200	670.74	11.15	0.05	0.05

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1002OR1.HYT, Page 6 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/18/98

Pumping Test No. 1035 Recovery Test	Test conducted on: 09/29/98
Observation Well 1002	Observation well 1002
Discharge 6.73 U.S.gal/min	Distance from the pumping well 35.00 ft
Static water level: 11.10 ft below datum	Pumping test duration: 707.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
201	680.74	11.15	0.05	0.05
202	690.74	11.15	0.05	0.05
203	700.74	11.15	0.05	0.05
204	710.74	11.15	0.05	0.05
205	720.74	11.15	0.05	0.05
206	730.74	11.15	0.05	0.05
207	740.74	11.15	0.05	0.05
208	750.74	11.14	0.04	0.04
209	760.74	11.14	0.04	0.04
210	770.74	11.14	0.04	0.04
211	780.74	11.14	0.04	0.04
212	790.74	11.14	0.04	0.04
213	800.74	11.14	0.04	0.04
214	810.74	11.13	0.03	0.03
215	820.74	11.13	0.03	0.03
216	830.74	11.13	0.03	0.03
217	840.74	11.13	0.03	0.03
218	850.74	11.13	0.03	
219	860.74	11.13	0.03	
220	870.74	11.12	0.02	0.02
221	880.74	11.12	0.02	0.02
222	890.74	11.12	0.02	0.02
223	900.74	11.12	0.02	0.02
224	910.74	11.11	0.01	0.01
225	920.74	11.11	0.01	0.01
226	930.74	11.11	0.01	0.01
227	940.74	11.11	0.01	0.01
228	950.74	11.11	0.01	0.01
229	960.74	11.10	0.00	0.00

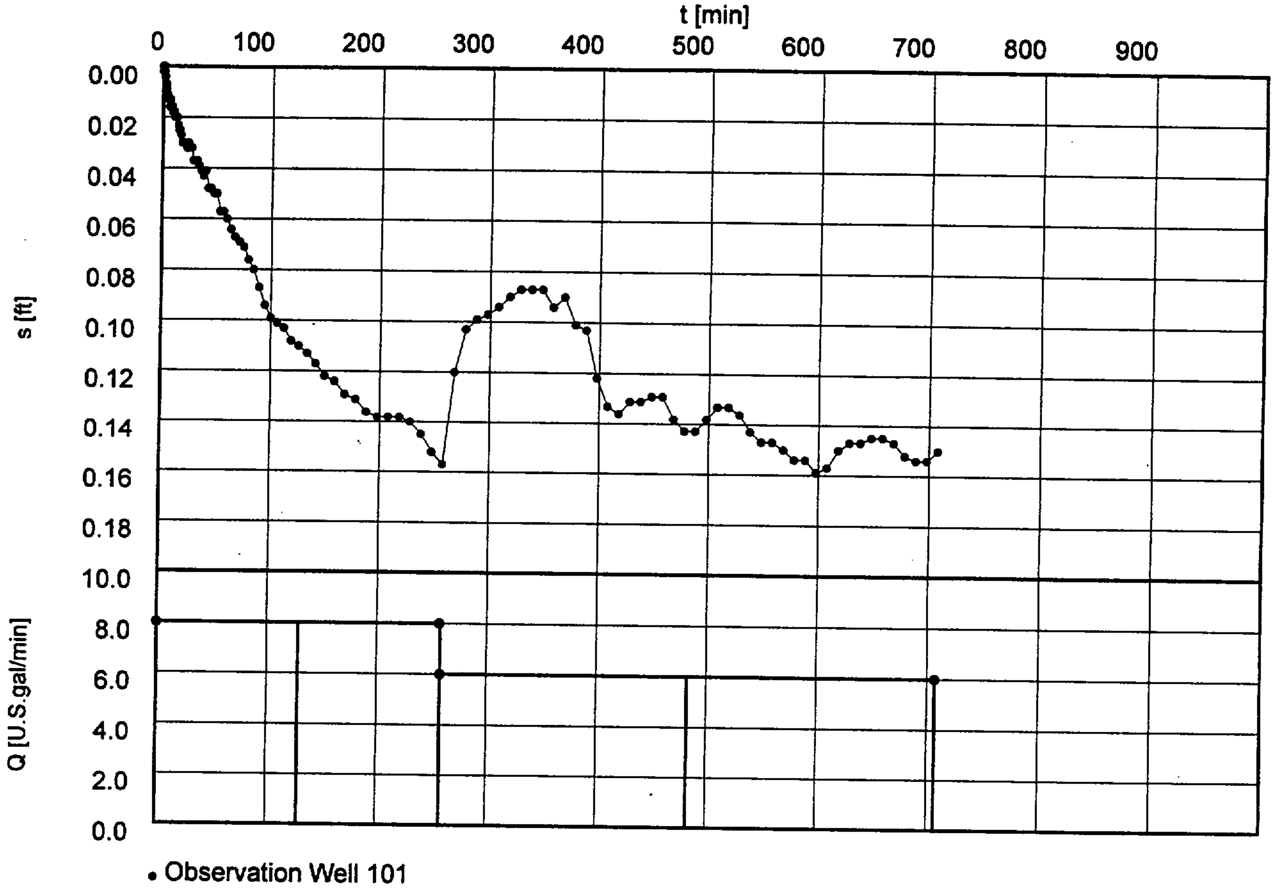
PUMPING WELL 1035

OBSERVATION WELL 1013

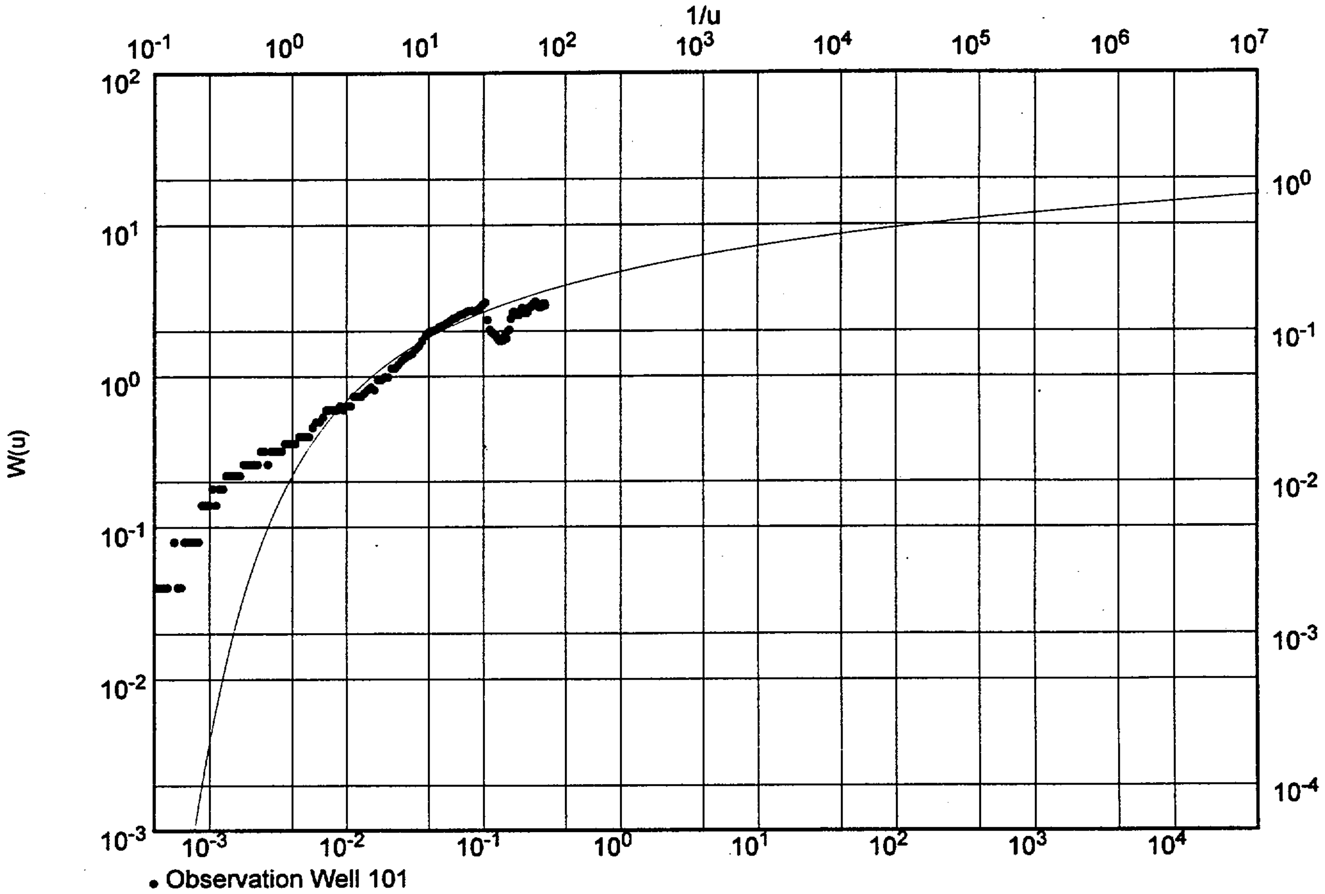
DRAWDOWN AND RECOVERY DATA ANALYSES

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Time-Drawdown plot with discharge	1013OA1.HYT, Page 1 Project: UGW -- Grand Junction, CO	
		Evaluated by: RJH	Date: 11/18/98

Pumping Test No. 1035 Aquifer Test	Test conducted on: 09/29/98
Observation Well 1013	
Discharge 6.73 U.S.gal/min	



MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Theis analysis method Unconfined aquifer	1013OA1.HYT, Page 1 Project: UGW -- Grand Junction, CO	
		Evaluated by: RJH	Date: 11/18/98
Pumping Test No. 1035 Aquifer Test	Test conducted on: 09/29/98		
Observation Well 1013			
Discharge 6.73 U.S.gal/min			



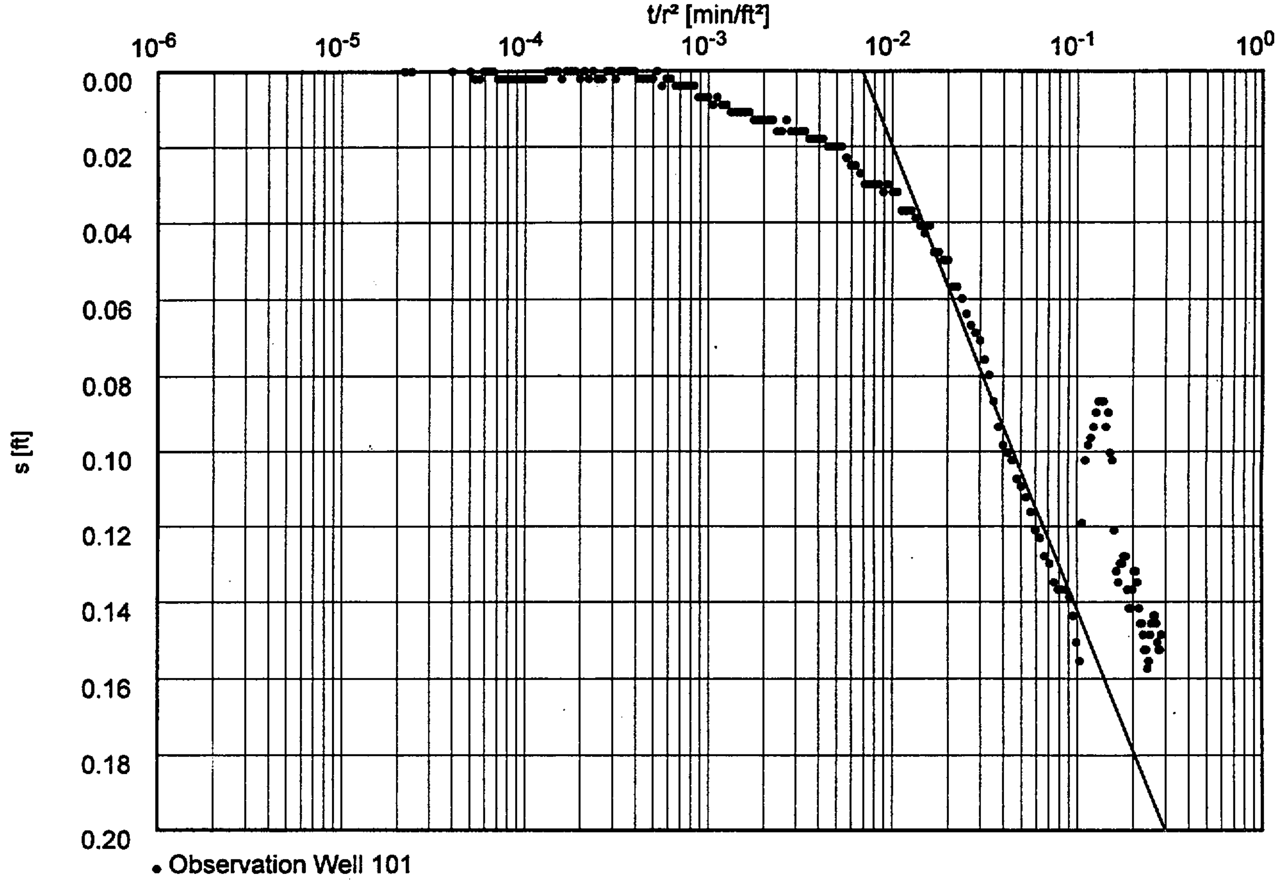
Transmissivity [ft²/min]: 1.42×10^{0} 2044.80 ft²/day

Hydraulic conductivity [ft/min]: 1.78×10^{-1} 256.32 ft/day

Aquifer thickness [ft]: 8.00

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Distance-Time-Drawdown-method after COOPER & JACOB Unconfined aquifer	1013OA1.HYT, Page 1 Project: UGW – Grand Junction, CO	
		Evaluated by: RJH	Date: 11/18/98

Pumping Test No. 1035 Aquifer Test	Test conducted on: 09/29/98
Observation Well 1013	
Discharge 6.73 U.S.gal/min	



Transmissivity [ft²/min]: 1.34 x 10^0 1929.60 ft²/day

Hydraulic conductivity [ft/min]: 1.68 x 10^{-1} 241.92 ft/day

Aquifer thickness [ft]: 8.00

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Theis analysis method Unconfined aquifer	1013OA1.HYT, Page 3 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/18/98

Pumping Test No. 1035 Aquifer Test	Test conducted on: 09/29/98
Observation Well 1013	Observation Well 1013
Discharge 6.73 U.S.gal/min	Distance from the pumping well 50.00 ft

Static water level: 12.28 ft below datum

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
2	0.01	12.28	-0.00	-0.00
3	0.01	12.28	-0.00	-0.00
4	0.02	12.28	-0.00	-0.00
5	0.02	12.28	-0.00	-0.00
6	0.03	12.28	-0.00	-0.00
7	0.03	12.28	-0.00	-0.00
8	0.04	12.28	-0.00	-0.00
9	0.04	12.28	-0.00	-0.00
10	0.05	12.28	-0.00	-0.00
11	0.05	12.28	-0.00	-0.00
12	0.06	12.28	0.00	0.00
13	0.06	12.28	0.00	0.00
14	0.07	12.28	-0.00	-0.00
15	0.07	12.28	-0.00	-0.00
16	0.08	12.28	-0.00	-0.00
17	0.08	12.28	-0.00	-0.00
18	0.09	12.28	-0.00	-0.00
19	0.09	12.28	-0.00	-0.00
20	0.10	12.28	-0.00	-0.00
21	0.10	12.28	0.00	0.00
22	0.11	12.28	-0.00	-0.00
23	0.11	12.28	-0.00	-0.00
24	0.12	12.28	-0.00	-0.00
25	0.13	12.28	0.00	0.00
26	0.13	12.28	0.00	0.00
27	0.14	12.28	0.00	0.00
28	0.15	12.28	0.00	0.00
29	0.16	12.28	0.00	0.00
30	0.17	12.28	0.00	0.00
31	0.18	12.28	0.00	0.00
32	0.19	12.28	0.00	0.00
33	0.20	12.28	0.00	0.00
34	0.21	12.28	0.00	0.00
35	0.22	12.28	0.00	0.00
36	0.24	12.28	0.00	0.00
37	0.25	12.28	0.00	0.00
38	0.26	12.28	0.00	0.00
39	0.28	12.28	0.00	0.00
40	0.30	12.28	0.00	0.00
41	0.31	12.28	0.00	0.00
42	0.33	12.28	0.00	0.00
43	0.35	12.28	0.00	0.00
44	0.37	12.28	0.00	0.00
45	0.40	12.28	0.00	0.00
46	0.42	12.28	0.00	0.00
47	0.44	12.28	0.00	0.00
48	0.47	12.28	0.00	0.00
49	0.50	12.28	0.00	0.00
50	0.52	12.28	0.00	0.00

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Theis analysis method Unconfined aquifer	1013OA1.HYT, Page 4 Project: UGW – Grand Junction, CO Evaluated by: RJH Date: 11/18/98

Pumping Test No. 1035 Aquifer Test	Test conducted on: 09/29/98
Observation Well 1013	Observation Well 1013
Discharge 6.73 U.S.gal/min	Distance from the pumping well 50.00 ft

Static water level: 12.28 ft below datum

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
51	0.55	12.28	0.00	0.00
52	0.59	12.28	0.00	0.00
53	0.62	12.28	0.00	0.00
54	0.66	12.28	0.00	0.00
55	0.70	12.28	0.00	0.00
56	0.74	12.28	0.00	0.00
57	0.78	12.28	0.00	0.00
58	0.83	12.28	0.00	0.00
59	0.88	12.28	0.00	0.00
60	0.93	12.28	0.00	0.00
61	0.98	12.28	0.00	0.00
62	1.04	12.28	0.00	0.00
63	1.10	12.28	0.00	0.00
64	1.17	12.28	0.00	0.00
65	1.24	12.28	0.00	0.00
66	1.31	12.28	0.00	0.00
67	1.39	12.28	0.00	0.00
68	1.47	12.28	0.00	[illegible]
69	1.56	12.28	0.00	[illegible]
70	1.65	12.28	0.00	0.00
71	1.75	12.28	0.00	0.00
72	1.86	12.28	0.00	0.00
73	1.97	12.28	0.00	0.00
74	2.08	12.28	0.00	0.00
75	2.21	12.29	0.01	0.01
76	2.34	12.29	0.01	0.01
77	2.48	12.29	0.01	0.01
78	2.63	12.29	0.01	0.01
79	2.79	12.29	0.01	0.01
80	2.95	12.29	0.01	0.01
81	3.13	12.29	0.01	0.01
82	3.32	12.29	0.01	0.01
83	3.51	12.29	0.01	0.01
84	3.72	12.29	0.01	0.01
85	3.95	12.29	0.01	0.01
86	4.18	12.29	0.01	0.01
87	4.43	12.29	0.01	0.01
88	4.69	12.29	0.01	0.01
89	4.97	12.29	0.01	0.01
90	5.27	12.29	0.01	0.01
91	5.58	12.29	0.01	0.01
92	5.91	12.30	0.02	0.02
93	6.27	12.30	0.02	[illegible]
94	6.64	12.29	0.01	[illegible]
95	7.03	12.30	0.02	0.02
96	7.45	12.30	0.02	0.02
97	7.90	12.30	0.02	0.02
98	8.37	12.30	0.02	0.02
99	8.86	12.30	0.02	0.02
100	9.39	12.30	0.02	0.02

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Theis analysis method Unconfined aquifer	1013OA1.HYT, Page 5 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/18/98

Pumping Test No. 1035 Aquifer Test	Test conducted on: 09/29/98
Observation Well 1013	Observation Well 1013
Discharge 6.73 U.S.gal/min	Distance from the pumping well 50.00 ft
Static water level: 12.28 ft below datum	

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
101	9.95	12.30	0.02	0.02
102	10.54	12.30	0.02	0.02
103	11.17	12.30	0.02	0.02
104	11.83	12.30	0.02	0.02
105	12.53	12.30	0.02	0.02
106	13.28	12.30	0.02	0.02
107	14.07	12.30	0.02	0.02
108	14.91	12.30	0.02	0.02
109	15.79	12.30	0.02	0.02
110	16.73	12.31	0.03	0.03
111	17.72	12.31	0.03	0.03
112	18.78	12.31	0.03	0.03
113	19.89	12.31	0.03	0.03
114	21.07	12.31	0.03	0.03
115	22.32	12.31	0.03	0.03
116	23.65	12.31	0.03	0.03
117	25.05	12.31	0.03	0.03
118	26.54	12.31	0.03	0.03
119	28.12	12.32	0.04	0.04
120	29.79	12.32	0.04	0.04
121	31.55	12.32	0.04	0.04
122	33.43	12.32	0.04	0.04
123	35.41	12.32	0.04	0.04
124	37.51	12.32	0.04	0.04
125	39.74	12.32	0.04	0.04
126	42.10	12.33	0.05	0.05
127	44.60	12.33	0.05	0.05
128	47.24	12.33	0.05	0.05
129	50.05	12.33	0.05	0.05
130	53.01	12.34	0.06	0.06
131	56.16	12.34	0.06	0.06
132	59.49	12.34	0.06	0.06
133	63.02	12.34	0.06	0.06
134	66.76	12.35	0.07	0.07
135	70.72	12.35	0.07	0.07
136	74.91	12.35	0.07	0.07
137	79.35	12.36	0.08	0.08
138	84.06	12.36	0.08	0.08
139	89.05	12.37	0.09	0.09
140	94.33	12.37	0.09	0.09
141	99.92	12.38	0.10	0.10
142	105.84	12.38	0.10	0.10
143	112.12	12.38	0.10	0.10
144	118.77	12.39	0.11	0.11
145	125.81	12.39	0.11	0.11
146	133.27	12.39	0.11	0.11
147	141.17	12.40	0.12	0.12
148	149.54	12.40	0.12	0.12
149	158.40	12.40	0.12	0.12
150	167.79	12.41	0.13	0.13

MACTEC-ERS
2597 B 3/4 Road
Grand Junction, CO 81503
970/248-6040

Pumping test analysis
Theis analysis method
Unconfined aquifer

1013OA1.HYT, Page 6
Project: UGW – Grand Junction, CO
Evaluated by: RJH
Date: 11/18/98

Pumping Test No. 1035 Aquifer Test	Test conducted on: 09/29/98
Observation Well 1013	Observation Well 1013
Discharge 6.73 U.S.gal/min	Distance from the pumping well 50.00 ft

Static water level: 12.28 ft below datum

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
151	177.74	12.41	0.13	0.13
152	187.74	12.42	0.14	0.13
153	197.74	12.42	0.14	0.14
154	207.74	12.42	0.14	0.14
155	217.74	12.42	0.14	0.14
156	227.74	12.42	0.14	0.14
157	237.74	12.43	0.15	0.14
158	247.74	12.43	0.15	0.15
159	257.74	12.44	0.16	0.16
160	267.74	12.40	0.12	0.12
161	277.74	12.38	0.10	0.10
162	287.74	12.38	0.10	0.10
163	297.74	12.38	0.10	0.10
164	307.74	12.37	0.09	0.09
165	317.74	12.37	0.09	0.09
166	327.74	12.37	0.09	0.09
167	337.74	12.37	0.09	0.09
168	347.74	12.37	0.09	[illegible]
169	357.74	12.37	0.09	[illegible]
170	367.74	12.37	0.09	0.09
171	377.74	12.38	0.10	0.10
172	387.74	12.38	0.10	0.10
173	397.74	12.40	0.12	0.12
174	407.74	12.41	0.13	0.13
175	417.74	12.42	0.14	0.13
176	427.74	12.41	0.13	0.13
177	437.74	12.41	0.13	0.13
178	447.74	12.41	0.13	0.13
179	457.74	12.41	0.13	0.13
180	467.74	12.42	0.14	0.14
181	477.74	12.42	0.14	0.14
182	487.74	12.42	0.14	0.14
183	497.74	12.42	0.14	0.14
184	507.74	12.41	0.13	0.13
185	517.74	12.41	0.13	0.13
186	527.74	12.42	0.14	0.13
187	537.74	12.42	0.14	0.14
188	547.74	12.43	0.15	0.15
189	557.74	12.43	0.15	0.15
190	567.74	12.43	0.15	0.15
191	577.74	12.43	0.15	0.15
192	587.74	12.43	0.15	0.15
193	597.74	12.44	0.16	[illegible]
194	607.74	12.44	0.16	[illegible]
195	617.74	12.43	0.15	0.15
196	627.74	12.43	0.15	0.15
197	637.74	12.43	0.15	0.15
198	647.74	12.43	0.15	0.14
199	657.74	12.43	0.15	0.14
200	667.74	12.43	0.15	0.15

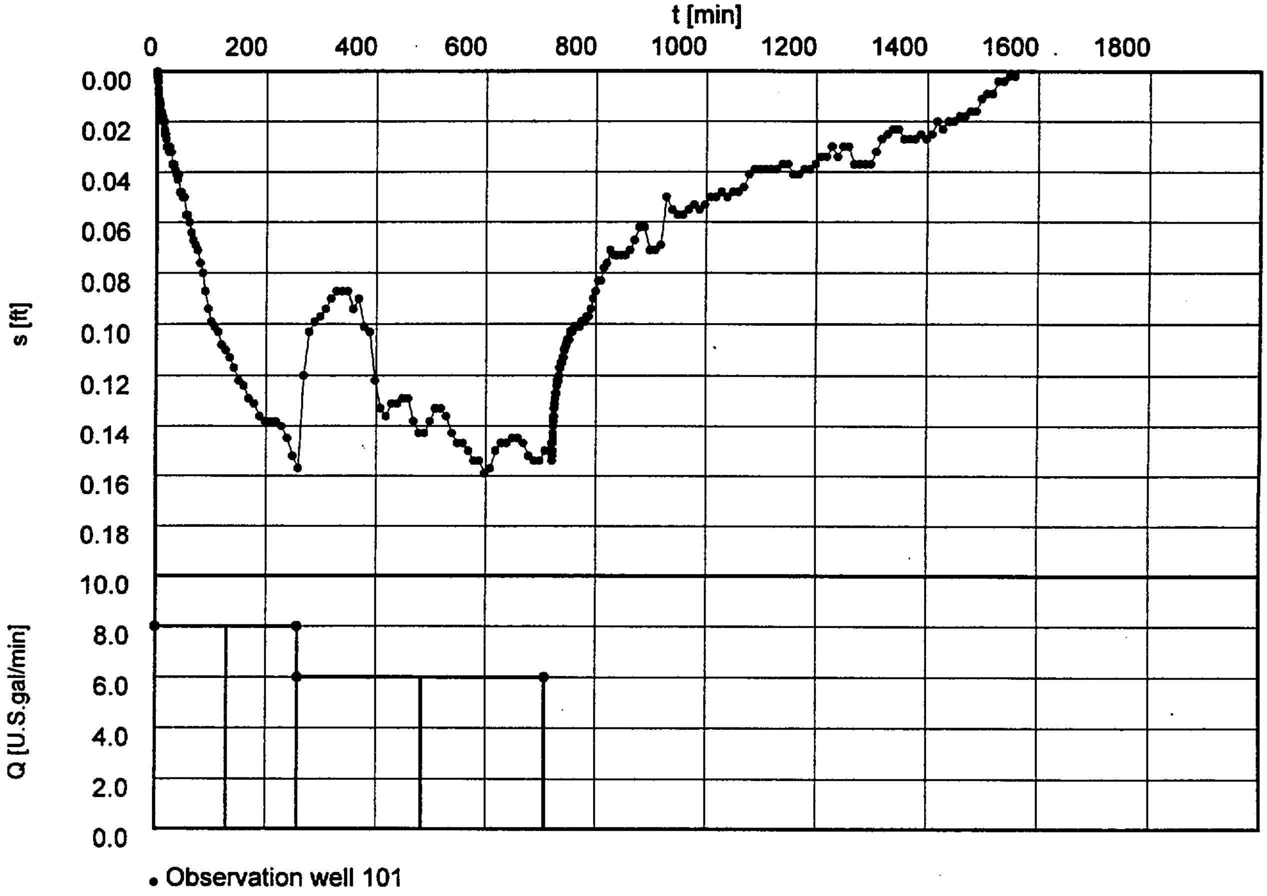
MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Theis analysis method Unconfined aquifer	1013OA1.HYT, Page 7 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/18/98

Pumping Test No. 1035 Aquifer Test	Test conducted on: 09/29/98
Observation Well 1013	Observation Well 1013
Discharge 6.73 U.S.gal/min	Distance from the pumping well 50.00 ft
Static water level: 12.28 ft below datum	

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
201	677.74	12.43	0.15	0.15
202	687.74	12.43	0.15	0.15
203	697.74	12.43	0.15	0.15
204	707.74	12.43	0.15	0.15

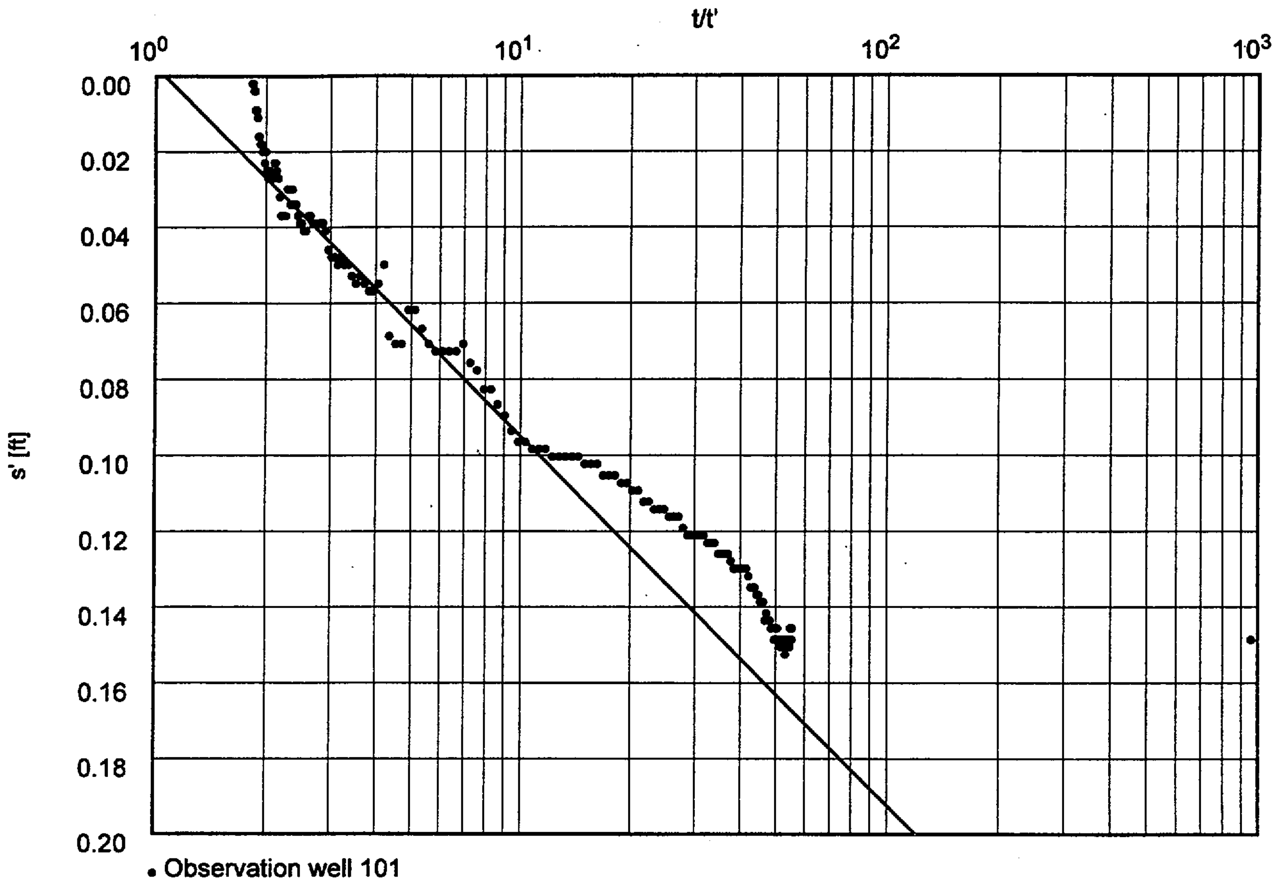
MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Time-Drawdown plot with discharge	1013OR1.HYT, Page 1 Project: UGW -- Grand Junction Evaluated by: RJH Date: 11/18/98

Pumping Test No. 1035 Recovery Test	Test conducted on: 09/29/98
Observation Well 1013	
Discharge 6.73 U.S.gal/min	



MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1013OR1.HYT, Page 1 Project: UGW – Grand Junction Evaluated by: RJH Date: 11/18/98

Pumping Test No. 1035 Recovery Test	Test conducted on: 09/29/98
Observation Well 1013	
Discharge 6.73 U.S.gal/min	
	Pumping test duration: 707.00 min



Transmissivity [ft²/min]: 1.69 x 10^0 2433.60 ft²/day

Hydraulic conductivity [ft/min]: 2.11 x 10^{-1} 303.84 ft/day

Aquifer thickness [ft]: 8.00

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1013OR1.HYT, Page 2 Project: UGW -- Grand Junction Evaluated by: RJH Date: 11/18/98

Pumping Test No. 1035 Recovery Test

Test conducted on: 09/29/98

Observation Well 1013

Observation well 1013

Discharge 6.73 U.S.gal/min

Distance from the pumping well 50.00 ft

Static water level: 12.28 ft below datum

Pumping test duration: 707.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
1	0.74	12.43	0.15	0.15
2	13.00	12.43	0.15	0.15
3	13.00	12.43	0.15	0.15
4	13.01	12.43	0.15	0.15
5	13.01	12.43	0.15	0.15
6	13.02	12.43	0.15	0.15
7	13.03	12.43	0.15	0.15
8	13.03	12.43	0.15	0.15
9	13.04	12.43	0.15	0.15
10	13.04	12.43	0.15	0.15
11	13.04	12.43	0.15	0.15
12	13.05	12.43	0.15	0.15
13	13.05	12.43	0.15	0.15
14	13.06	12.43	0.15	0.15
15	13.07	12.43	0.15	0.15
16	13.07	12.43	0.15	0.15
17	13.08	12.43	0.15	0.15
18	13.08	12.43	0.15	
19	13.08	12.43	0.15	
20	13.09	12.43	0.15	0.15
21	13.09	12.43	0.15	0.15
22	13.10	12.43	0.15	0.15
23	13.11	12.43	0.15	0.15
24	13.11	12.43	0.15	0.15
25	13.12	12.43	0.15	0.15
26	13.13	12.43	0.15	0.15
27	13.13	12.43	0.15	0.15
28	13.14	12.43	0.15	0.15
29	13.15	12.43	0.15	0.15
30	13.16	12.43	0.15	0.15
31	13.17	12.43	0.15	0.15
32	13.18	12.43	0.15	0.15
33	13.19	12.43	0.15	0.15
34	13.20	12.43	0.15	0.15
35	13.21	12.43	0.15	0.15
36	13.22	12.43	0.15	0.15
37	13.24	12.43	0.15	0.15
38	13.25	12.43	0.15	0.15
39	13.26	12.43	0.15	0.15
40	13.28	12.43	0.15	0.15
41	13.30	12.43	0.15	0.15
42	13.31	12.43	0.15	0.15
43	13.33	12.43	0.15	
44	13.35	12.43	0.15	
45	13.37	12.43	0.15	0.15
46	13.40	12.43	0.15	0.15
47	13.42	12.43	0.15	0.15
48	13.44	12.43	0.15	0.15
49	13.47	12.43	0.15	0.15
50	13.50	12.43	0.15	0.15

MACTEC-ERS
2597 B 3/4 Road
Grand Junction, CO 81503
970/248-6040

Pumping test analysis
Recovery method after
THEIS & JACOB
Unconfined aquifer

1013OR1.HYT, Page 3

Project: UGW -- Grand Junction

Evaluated by: RJH
Date: 11/18/98

Pumping Test No. 1035 Recovery Test	Test conducted on: 09/29/98
Observation Well 1013	Observation well 1013
Discharge 6.73 U.S.gal/min	Distance from the pumping well 50.00 ft
Static water level: 12.28 ft below datum	Pumping test duration: 707.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
51	13.52	12.43	0.15	0.15
52	13.55	12.43	0.15	0.15
53	13.59	12.43	0.15	0.15
54	13.62	12.43	0.15	0.15
55	13.66	12.43	0.15	0.15
56	13.70	12.43	0.15	0.15
57	13.74	12.43	0.15	0.15
58	13.78	12.43	0.15	0.15
59	13.83	12.43	0.15	0.15
60	13.88	12.43	0.15	0.15
61	13.93	12.43	0.15	0.15
62	13.98	12.43	0.15	0.15
63	14.04	12.43	0.15	0.15
64	14.10	12.43	0.15	0.15
65	14.17	12.43	0.15	0.15
66	14.24	12.43	0.15	0.15
67	14.31	12.43	0.15	0.15
68	14.39	12.43	0.15	0.15
69	14.47	12.43	0.15	0.15
70	14.56	12.43	0.15	0.15
71	14.65	12.43	0.15	0.15
72	14.75	12.43	0.15	0.15
73	14.86	12.43	0.15	0.15
74	14.97	12.43	0.15	0.14
75	15.08	12.43	0.15	0.14
76	15.21	12.43	0.15	0.14
77	15.34	12.42	0.14	0.14
78	15.48	12.43	0.15	0.14
79	15.63	12.42	0.14	0.14
80	15.79	12.42	0.14	0.14
81	15.95	12.42	0.14	0.14
82	16.13	12.42	0.14	0.14
83	16.32	12.42	0.14	0.14
84	16.51	12.42	0.14	0.13
85	16.72	12.42	0.14	0.13
86	16.95	12.42	0.14	0.13
87	17.18	12.41	0.13	0.13
88	17.43	12.41	0.13	0.13
89	17.69	12.41	0.13	0.13
90	17.97	12.41	0.13	0.13
91	18.27	12.41	0.13	0.13
92	18.58	12.41	0.13	0.13
93	18.91	12.41	0.13	0.13
94	19.27	12.41	0.13	0.13
95	19.64	12.41	0.13	0.13
96	20.03	12.41	0.13	0.13
97	20.45	12.41	0.13	0.13
98	20.90	12.41	0.13	0.13
99	21.37	12.40	0.12	0.12
100	21.86	12.40	0.12	0.12

Pumping Test No. 1035 Recovery Test	Test conducted on: 09/29/98
Observation Well 1013	Observation well 1013
Discharge 6.73 U.S.gal/min	Distance from the pumping well 50.00 ft
Static water level: 12.28 ft below datum	Pumping test duration: 707.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
101	22.39	12.40	0.12	0.12
102	22.95	12.40	0.12	0.12
103	23.54	12.40	0.12	0.12
104	24.17	12.40	0.12	0.12
105	24.83	12.40	0.12	0.12
106	25.53	12.40	0.12	0.12
107	26.28	12.40	0.12	0.12
108	27.07	12.40	0.12	0.12
109	27.91	12.40	0.12	0.12
110	28.79	12.40	0.12	0.12
111	29.73	12.40	0.12	0.11
112	30.72	12.40	0.12	0.11
113	31.78	12.40	0.12	0.11
114	32.89	12.39	0.11	0.11
115	34.07	12.39	0.11	0.11
116	35.32	12.39	0.11	0.11
117	36.65	12.39	0.11	0.11
118	38.05	12.39	0.11	[illegible]
119	39.54	12.39	0.11	[illegible]
120	41.12	12.39	0.11	0.11
121	42.79	12.39	0.11	0.11
122	44.55	12.39	0.11	0.11
123	46.43	12.38	0.10	0.10
124	48.41	12.38	0.10	0.10
125	50.51	12.38	0.10	0.10
126	52.74	12.38	0.10	0.10
127	55.10	12.38	0.10	0.10
128	57.60	12.38	0.10	0.10
129	60.24	12.38	0.10	0.10
130	63.05	12.38	0.10	0.10
131	66.01	12.38	0.10	0.10
132	69.16	12.38	0.10	0.10
133	72.49	12.38	0.10	0.10
134	76.02	12.38	0.10	0.10
135	79.76	12.38	0.10	0.10
136	83.72	12.37	0.09	0.09
137	87.91	12.37	0.09	0.09
138	92.35	12.37	0.09	0.09
139	97.06	12.36	0.08	0.08
140	102.05	12.36	0.08	0.08
141	107.33	12.36	0.08	0.08
142	112.92	12.36	0.08	0.08
143	118.84	12.35	0.07	[illegible]
144	125.12	12.35	0.07	[illegible]
145	131.77	12.35	0.07	0.07
146	138.81	12.35	0.07	0.07
147	146.27	12.35	0.07	0.07
148	154.17	12.35	0.07	0.07
149	162.54	12.35	0.07	0.07
150	171.40	12.34	0.06	0.06

Pumping test analysis
Recovery method after
THEIS & JACOB
Unconfined aquifer

Project: UGW -- Grand Junction

Evaluated by: RJH
Date: 11/18/98

Pumping Test No. 1035 Recovery Test	Test conducted on: 09/29/98
Observation Well 1013	Observation well 1013
Discharge 6.73 U.S.gal/min	Distance from the pumping well 50.00 ft
Static water level: 12.28 ft below datum	Pumping test duration: 707.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
151	180.79	12.34	0.06	0.06
152	190.74	12.35	0.07	0.07
153	200.74	12.35	0.07	0.07
154	210.74	12.35	0.07	0.07
155	220.74	12.33	0.05	0.05
156	230.74	12.34	0.06	0.05
157	240.74	12.34	0.06	0.06
158	250.74	12.34	0.06	0.06
159	260.74	12.34	0.06	0.05
160	270.74	12.33	0.05	0.05
161	280.74	12.34	0.06	0.05
162	290.74	12.33	0.05	0.05
163	300.74	12.33	0.05	0.05
164	310.74	12.33	0.05	0.05
165	320.74	12.33	0.05	0.05
166	330.74	12.33	0.05	0.05
167	340.74	12.33	0.05	0.05
168	350.74	12.33	0.05	0.05
169	360.74	12.33	0.05	0.05
170	370.74	12.32	0.04	0.04
171	380.74	12.32	0.04	0.04
172	390.74	12.32	0.04	0.04
173	400.74	12.32	0.04	0.04
174	410.74	12.32	0.04	0.04
175	420.74	12.32	0.04	0.04
176	430.74	12.32	0.04	0.04
177	440.74	12.32	0.04	0.04
178	450.74	12.32	0.04	0.04
179	460.74	12.32	0.04	0.04
180	470.74	12.32	0.04	0.04
181	480.74	12.32	0.04	0.04
182	490.74	12.32	0.04	0.04
183	500.74	12.31	0.03	0.03
184	510.74	12.31	0.03	0.03
185	520.74	12.31	0.03	0.03
186	530.74	12.31	0.03	0.03
187	540.74	12.31	0.03	0.03
188	550.74	12.31	0.03	0.03
189	560.74	12.32	0.04	0.04
190	570.74	12.32	0.04	0.04
191	580.74	12.32	0.04	0.04
192	590.74	12.32	0.04	0.04
193	600.74	12.31	0.03	0.03
194	610.74	12.31	0.03	0.03
195	620.74	12.30	0.02	0.02
196	630.74	12.30	0.02	0.02
197	640.74	12.30	0.02	0.02
198	650.74	12.31	0.03	0.03
199	660.74	12.31	0.03	0.03
200	670.74	12.31	0.03	0.03

MACTEC-ERS
2597 B 3/4 Road
Grand Junction, CO 81503
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Pumping test analysis
Recovery method after
THEIS & JACOB
Unconfined aquifer

1013OR1.HYT, Page 6

Project: UGW – Grand Junction

Evaluated by: RJH

Date: 11/18/98

Pumping Test No. 1035 Recovery Test	Test conducted on: 09/29/98
Observation Well 1013	Observation well 1013
Discharge 6.73 U.S.gal/min	Distance from the pumping well 50.00 ft
Static water level: 12.28 ft below datum	Pumping test duration: 707.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
201	680.74	12.30	0.02	0.02
202	690.74	12.31	0.03	0.03
203	700.74	12.30	0.02	0.02
204	710.74	12.30	0.02	0.02
205	720.74	12.30	0.02	0.02
206	730.74	12.30	0.02	0.02
207	740.74	12.30	0.02	0.02
208	750.74	12.30	0.02	0.02
209	760.74	12.30	0.02	0.02
210	770.74	12.30	0.02	0.02
211	780.74	12.30	0.02	0.02
212	790.74	12.29	0.01	0.01
213	800.74	12.29	0.01	0.01
214	810.74	12.29	0.01	0.01
215	820.74	12.28	0.00	0.00
216	830.74	12.28	0.00	0.00
217	840.74	12.28	0.00	0.00
218	850.74	12.28	0.00	

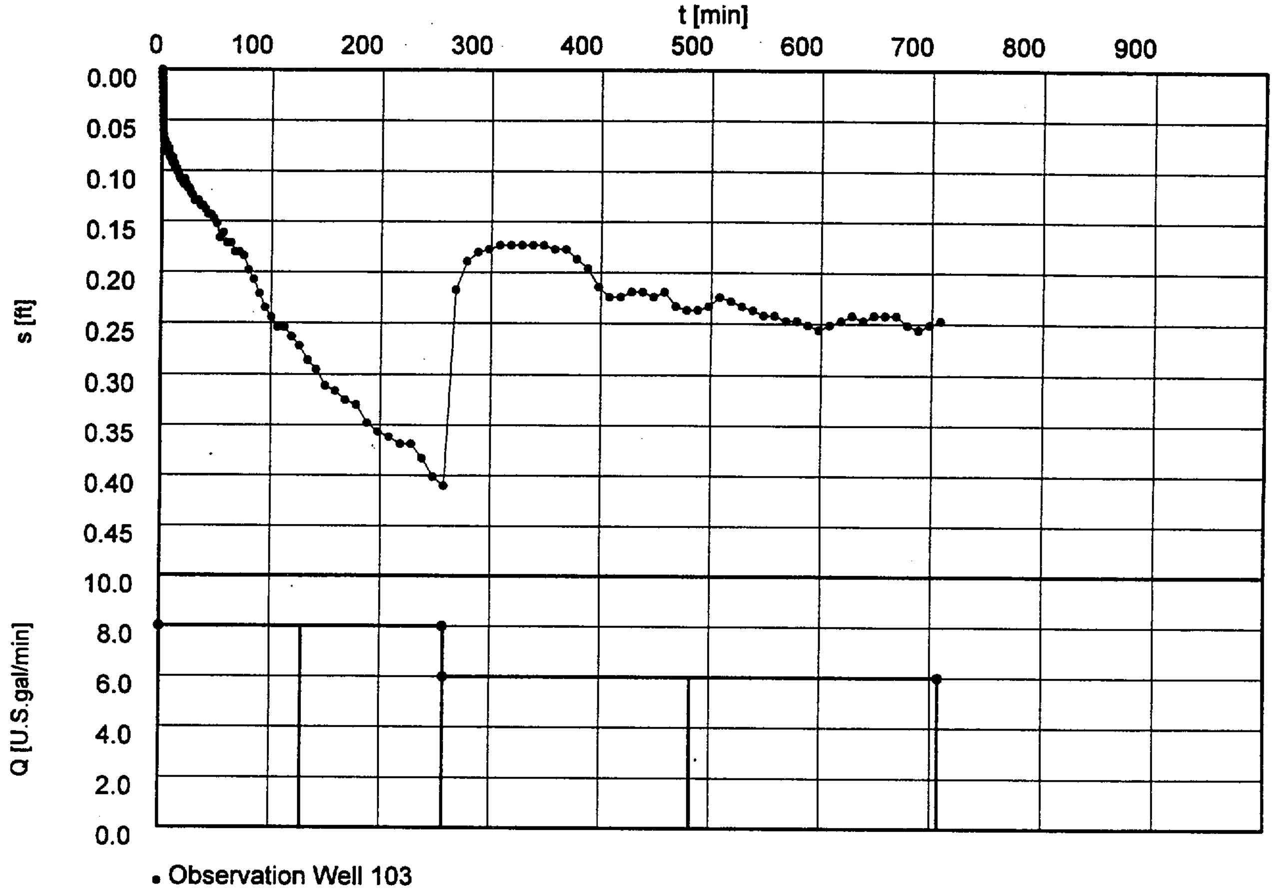
PUMPING WELL 1035

OBSERVATION WELL 1034

DRAWDOWN AND RECOVERY DATA ANALYSES

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Time-Drawdown plot with discharge	1034OA1.HYT, Page 1 Project: UGW – Grand Junction, CO Evaluated by: RJH Date: 11/17/98

Pumping Test No. 1035 Aquifer Test	Test conducted on: 09/29/98
Observation Well 1034	
Discharge 6.73 U.S.gal/min	

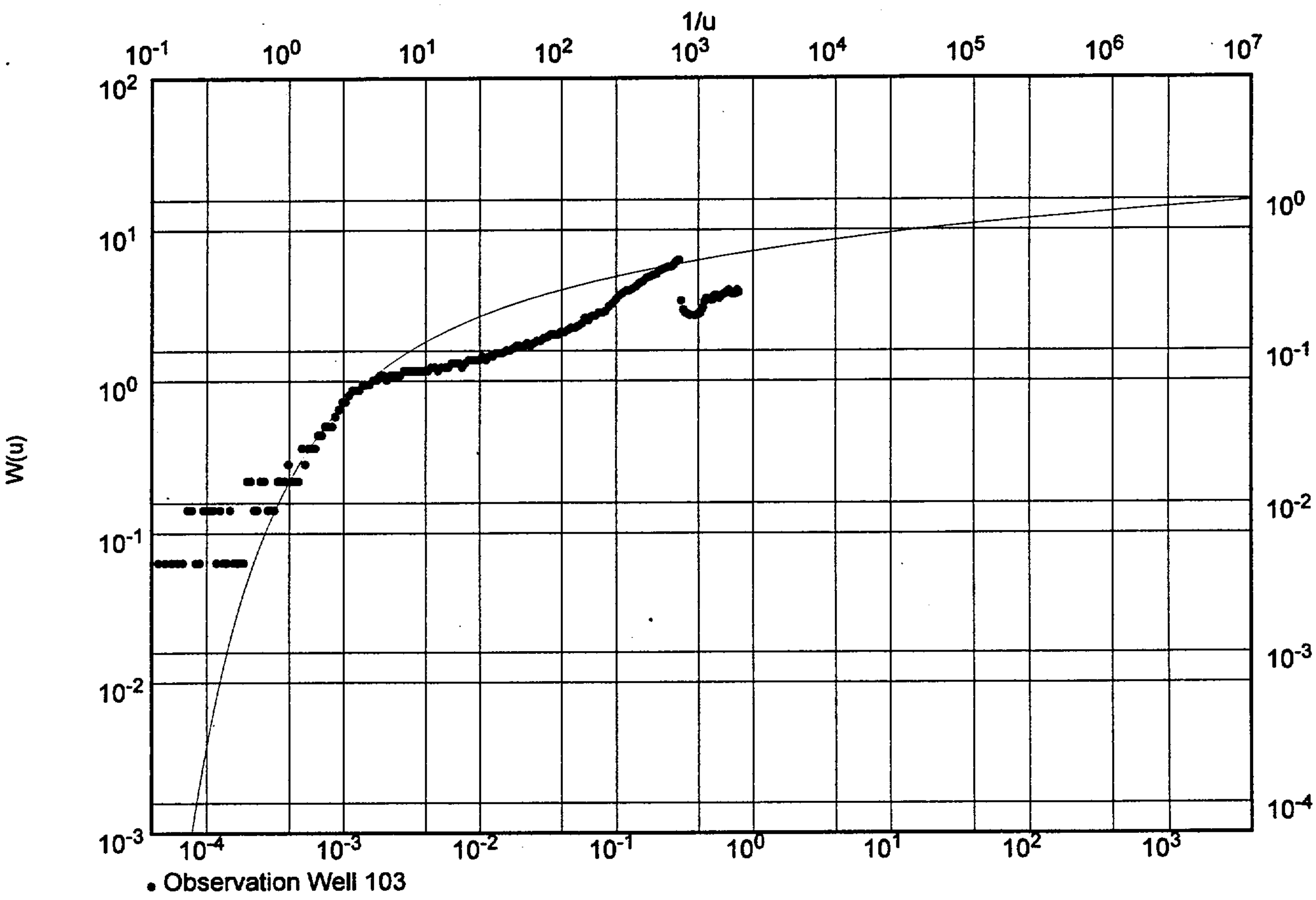


MACTEC-ERS
2597 B 3/4 Road
Grand Junction, CO 81503
970/248-6040

Pumping test analysis
Theis analysis method
Unconfined aquifer

1034OA1.HYT, Page 1
Project: UGW – Grand Junction, CO
Evaluated by: RJH
Date: 11/17/98

Pumping Test No. 1035 Aquifer Test
Test conducted on: 09/29/98
Observation Well 1034
Discharge 6.73 U.S.gal/min



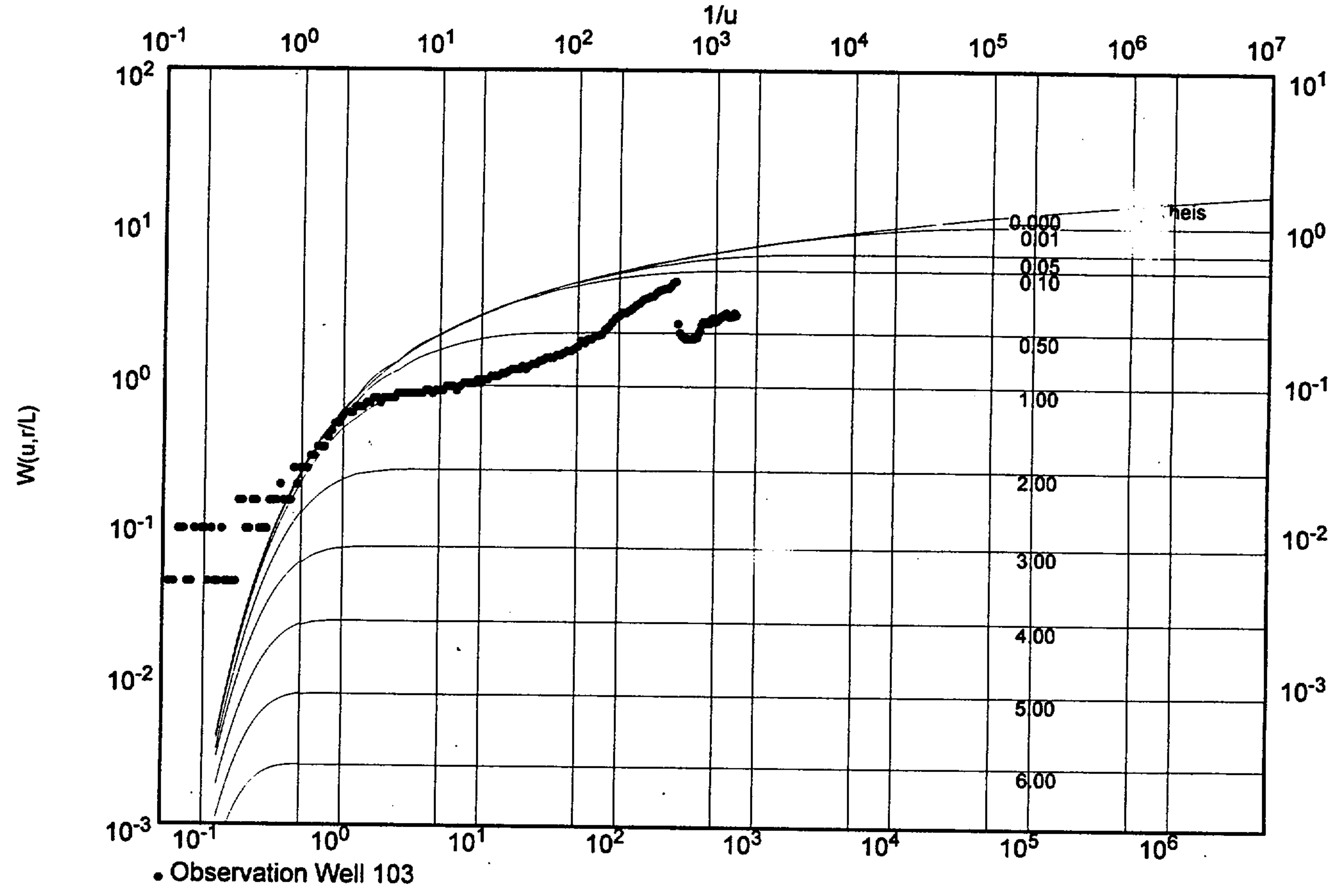
Transmissivity [ft²/min]: 1.13 x 10^{0} 1627.20 ft²/day

Hydraulic conductivity [ft/min]: 1.41 x 10^{-1} 203.04 ft/day

Aquifer thickness [ft]: 8.00

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis HANTUSH's method Leaky aquifer, no aquitard storage	1034OA1.HYT, Page 1 Project: UGW -- Grand Junction, CO Evaluated by: RJH	Date: 11/17/98

Pumping Test No. 1035 Aquifer Test	Test conducted on: 09/29/98
Observation Well 1034	
Discharge 6.73 U.S.gal/min	



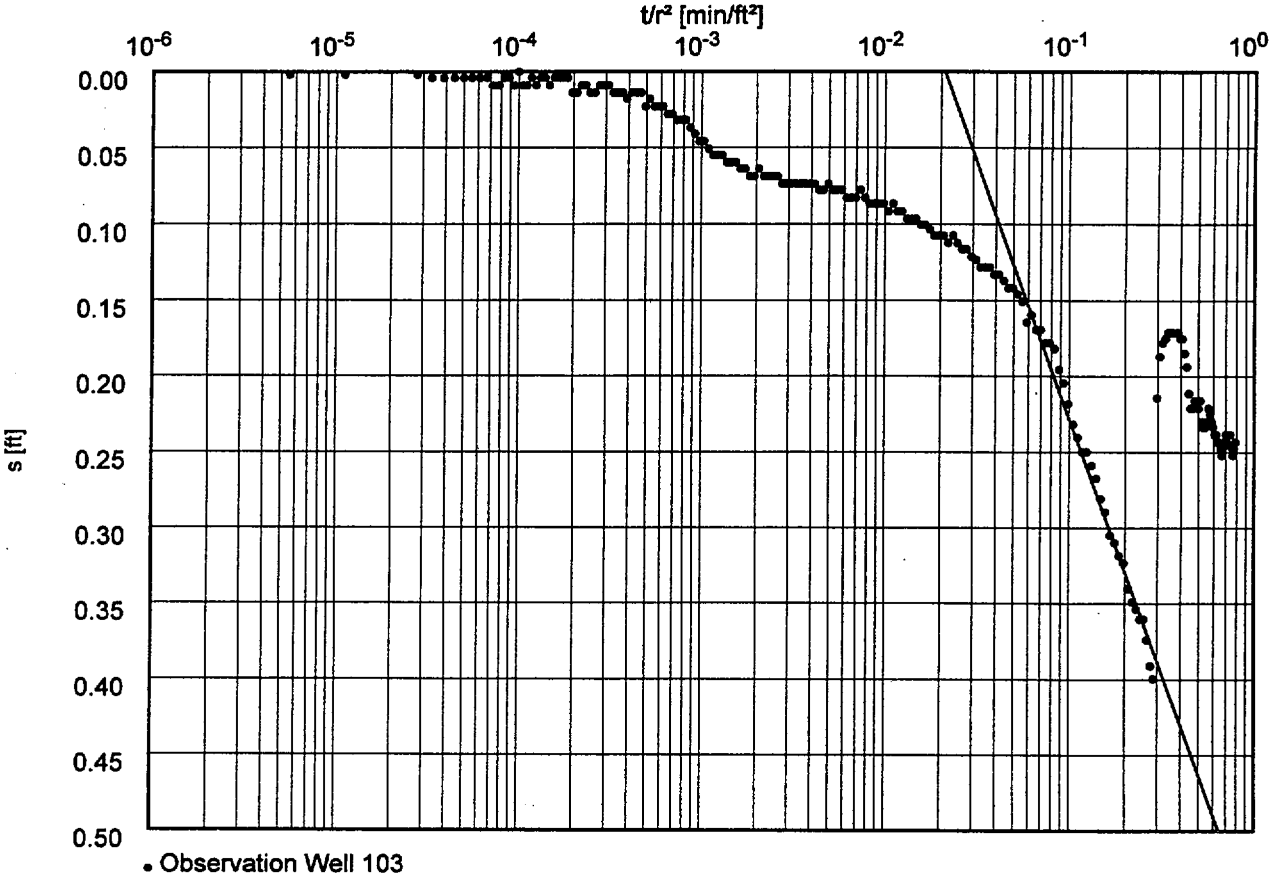
Transmissivity [ft²/min]: 7.15 x 10^{-1} 1029.60 ft²/day

Hydraulic conductivity [ft/min]: 8.94 x 10^{-2} 128.74 ft/day

Aquifer thickness [ft]: 8.00

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Distance-Time-Drawdown-method after COOPER & JACOB Unconfined aquifer	1034OA1.HYT, Page 1 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/17/98

Pumping Test No. 1035 Aquifer Test	Test conducted on: 09/29/98
Observation Well 1034	
Discharge 6.73 U.S.gal/min	



Transmissivity [ft²/min]: 4.89 x 10^{-1} 704.16 ft²/day

Hydraulic conductivity [ft/min]: 6.12 x 10^{-2} 88.12 ft/day

Aquifer thickness [ft]: 8.00

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Theis analysis method Unconfined aquifer	1034OA1.HYT, Page 2 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/17/98

Pumping Test No. 1035 Aquifer Test	Test conducted on: 09/29/98
Observation Well 1034	Observation Well 1034
Discharge 6.73 U.S.gal/min	Distance from the pumping well 30.00 ft
Static water level: 10.38 ft below datum	

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
2	0.01	10.38	0.00	0.00
3	0.01	10.38	0.00	0.00
4	0.02	10.38	-0.00	-0.00
5	0.02	10.38	-0.00	-0.00
6	0.03	10.38	0.00	0.00
7	0.03	10.38	0.00	0.00
8	0.04	10.38	0.00	0.00
9	0.04	10.38	0.00	0.00
10	0.05	10.38	0.00	0.00
11	0.05	10.38	0.00	0.00
12	0.06	10.38	0.00	0.00
13	0.06	10.38	0.00	0.00
14	0.07	10.39	0.01	0.01
15	0.07	10.39	0.01	0.01
16	0.08	10.38	0.00	0.00
17	0.08	10.38	0.00	0.00
18	0.09	10.39	0.01	[illegible]
19	0.09	10.38	0.00	[illegible]
20	0.10	10.39	0.01	0.01
21	0.10	10.39	0.01	0.01
22	0.11	10.38	0.00	0.00
23	0.11	10.39	0.01	0.01
24	0.12	10.38	0.00	0.00
25	0.13	10.38	0.00	0.00
26	0.13	10.39	0.01	0.01
27	0.14	10.38	0.00	0.00
28	0.15	10.38	0.00	0.00
29	0.16	10.38	0.00	0.00
30	0.17	10.38	0.00	0.00
31	0.18	10.39	0.01	0.01
32	0.19	10.39	0.01	0.01
33	0.20	10.39	0.01	0.01
34	0.21	10.39	0.01	0.01
35	0.22	10.39	0.01	0.01
36	0.24	10.39	0.01	0.01
37	0.25	10.39	0.01	0.01
38	0.26	10.39	0.01	0.01
39	0.28	10.39	0.01	0.01
40	0.30	10.39	0.01	0.01
41	0.31	10.39	0.01	0.01
42	0.33	10.39	0.01	0.01
43	0.35	10.40	0.02	[illegible]
44	0.37	10.39	0.01	[illegible]
45	0.40	10.39	0.01	0.01
46	0.42	10.39	0.01	0.01
47	0.44	10.40	0.02	0.02
48	0.47	10.40	0.02	0.02
49	0.50	10.40	0.02	0.02
50	0.52	10.40	0.02	0.02

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Theis analysis method Unconfined aquifer	1034OA1.HYT, Page 3 Project: UGW -- Grand Junction, CO	
		Evaluated by: RJH	Date: 11/17/98

Pumping Test No. 1035 Aquifer Test	Test conducted on: 09/29/98
Observation Well 1034	Observation Well 1034
Discharge 6.73 U.S.gal/min	Distance from the pumping well 30.00 ft
Static water level: 10.38 ft below datum	

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
51	0.55	10.40	0.02	0.02
52	0.59	10.41	0.03	0.03
53	0.62	10.41	0.03	0.03
54	0.66	10.41	0.03	0.03
55	0.70	10.41	0.03	0.03
56	0.74	10.41	0.03	0.03
57	0.78	10.42	0.04	0.04
58	0.83	10.42	0.04	0.04
59	0.88	10.43	0.05	0.05
60	0.93	10.43	0.05	0.05
61	0.98	10.43	0.05	0.05
62	1.04	10.43	0.05	0.05
63	1.10	10.43	0.05	0.05
64	1.17	10.43	0.05	0.05
65	1.24	10.44	0.06	0.06
66	1.31	10.44	0.06	0.06
67	1.39	10.44	0.06	0.06
68	1.47	10.44	0.06	0.06
69	1.56	10.44	0.06	0.06
70	1.65	10.45	0.07	0.07
71	1.75	10.45	0.07	0.07
72	1.86	10.44	0.06	0.06
73	1.97	10.45	0.07	0.07
74	2.08	10.45	0.07	0.07
75	2.21	10.45	0.07	0.07
76	2.34	10.45	0.07	0.07
77	2.48	10.45	0.07	0.07
78	2.63	10.45	0.07	0.07
79	2.79	10.45	0.07	0.07
80	2.95	10.45	0.07	0.07
81	3.13	10.45	0.07	0.07
82	3.32	10.45	0.07	0.07
83	3.51	10.45	0.07	0.07
84	3.72	10.45	0.07	0.07
85	3.95	10.46	0.08	0.08
86	4.18	10.46	0.08	0.08
87	4.43	10.45	0.07	0.07
88	4.69	10.46	0.08	0.08
89	4.97	10.46	0.08	0.08
90	5.27	10.46	0.08	0.08
91	5.58	10.46	0.08	0.08
92	5.91	10.46	0.08	0.08
93	6.27	10.46	0.08	0.08
94	6.64	10.46	0.08	0.08
95	7.03	10.46	0.08	0.08
96	7.45	10.47	0.09	0.09
97	7.90	10.47	0.09	0.09
98	8.37	10.47	0.09	0.09
99	8.86	10.47	0.09	0.09
100	9.39	10.47	0.09	0.09

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Theis analysis method Unconfined aquifer	1034OA1.HYT, Page 4 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/17/98

Pumping Test No. 1035 Aquifer Test	Test conducted on: 09/29/98
Observation Well 1034	Observation Well 1034
Discharge 6.73 U.S.gal/min	Distance from the pumping well 30.00 ft

Static water level: 10.38 ft below datum

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
101	9.95	10.47	0.09	0.09
102	10.54	10.47	0.09	0.09
103	11.17	10.47	0.09	0.09
104	11.83	10.48	0.10	0.10
105	12.53	10.48	0.10	0.10
106	13.28	10.48	0.10	0.10
107	14.07	10.48	0.10	0.10
108	14.91	10.48	0.10	0.10
109	15.79	10.48	0.10	0.10
110	16.73	10.49	0.11	0.11
111	17.72	10.49	0.11	0.11
112	18.78	10.49	0.11	0.11
113	19.89	10.49	0.11	0.11
114	21.07	10.49	0.11	0.11
115	22.32	10.49	0.11	0.11
116	23.65	10.50	0.12	0.12
117	25.05	10.50	0.12	0.12
118	26.54	10.50	0.12	[illegible]
119	28.12	10.50	0.12	[illegible]
120	29.79	10.51	0.13	[illegible]
121	31.55	10.51	0.13	0.13
122	33.43	10.51	0.13	0.13
123	35.41	10.51	0.13	0.13
124	37.51	10.51	0.13	0.13
125	39.74	10.52	0.14	0.14
126	42.10	10.52	0.14	0.14
127	44.60	10.52	0.14	0.14
128	47.24	10.53	0.15	0.15
129	50.05	10.53	0.15	0.15
130	53.01	10.55	0.17	0.16
131	56.16	10.54	0.16	0.16
132	59.49	10.55	0.17	0.17
133	63.02	10.55	0.17	0.17
134	66.76	10.56	0.18	0.18
135	70.72	10.56	0.18	0.18
136	74.91	10.56	0.18	0.18
137	79.35	10.58	0.20	0.20
138	84.06	10.59	0.21	0.20
139	89.05	10.60	0.22	0.22
140	94.33	10.62	0.24	0.23
141	99.92	10.62	0.24	0.24
142	105.84	10.63	0.25	0.25
143	112.12	10.63	0.25	[illegible]
144	118.77	10.64	0.26	[illegible]
145	125.81	10.65	0.27	[illegible]
146	133.27	10.67	0.29	0.28
147	141.17	10.68	0.29	0.29
148	149.54	10.69	0.31	0.30
149	158.40	10.70	0.32	0.31
150	167.79	10.71	0.32	0.32

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Theis analysis method Unconfined aquifer	1034OA1.HYT, Page 5 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/17/98

Pumping Test No. 1035 Aquifer Test	Test conducted on: 09/29/98
Observation Well 1034	Observation Well 1034
Discharge 6.73 U.S.gal/min	Distance from the pumping well 30.00 ft

Static water level: 10.38 ft below datum

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
151	177.74	10.71	0.33	0.32
152	187.74	10.73	0.35	0.34
153	197.74	10.74	0.36	0.35
154	207.74	10.74	0.36	0.35
155	217.74	10.75	0.37	0.36
156	227.74	10.75	0.37	0.36
157	237.74	10.76	0.38	0.37
158	247.74	10.78	0.40	0.39
159	257.74	10.79	0.41	0.40
160	267.74	10.60	0.22	0.21
161	277.74	10.57	0.19	0.19
162	287.74	10.56	0.18	0.18
163	297.74	10.56	0.18	0.18
164	307.74	10.55	0.17	0.17
165	317.74	10.55	0.17	0.17
166	327.74	10.55	0.17	0.17
167	337.74	10.55	0.17	0.17
168	347.74	10.55	0.17	0.17
169	357.74	10.56	0.18	0.18
170	367.74	10.56	0.18	0.18
171	377.74	10.57	0.19	0.18
172	387.74	10.58	0.20	0.19
173	397.74	10.59	0.21	0.21
174	407.74	10.60	0.22	0.22
175	417.74	10.60	0.22	0.22
176	427.74	10.60	0.22	0.22
177	437.74	10.60	0.22	0.22
178	447.74	10.60	0.22	0.22
179	457.74	10.60	0.22	0.22
180	467.74	10.61	0.23	0.23
181	477.74	10.62	0.24	0.23
182	487.74	10.62	0.24	0.23
183	497.74	10.61	0.23	0.23
184	507.74	10.60	0.22	0.22
185	517.74	10.61	0.23	0.22
186	527.74	10.61	0.23	0.23
187	537.74	10.62	0.24	0.23
188	547.74	10.62	0.24	0.24
189	557.74	10.62	0.24	0.24
190	567.74	10.63	0.25	0.24
191	577.74	10.63	0.25	0.24
192	587.74	10.63	0.25	0.25
193	597.74	10.64	0.26	0.25
194	607.74	10.63	0.25	0.25
195	617.74	10.63	0.25	0.24
196	627.74	10.62	0.24	0.24
197	637.74	10.63	0.25	0.24
198	647.74	10.62	0.24	0.24
199	657.74	10.62	0.24	0.24
200	667.74	10.62	0.24	0.24

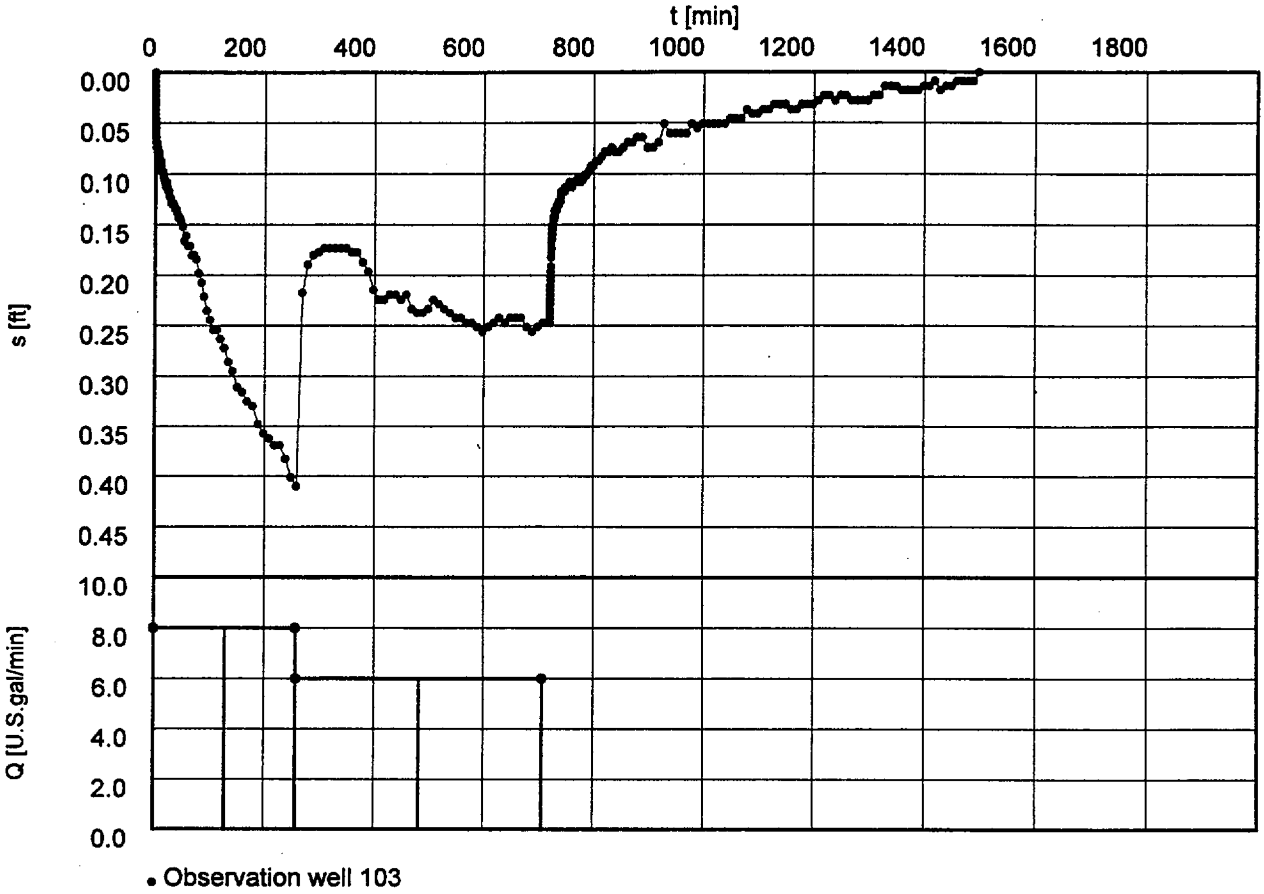
Pumping Test No. 1035 Aquifer Test	Test conducted on: 09/29/98
Observation Well 1034	Observation Well 1034
Discharge 6.73 U.S.gal/min	Distance from the pumping well 30.00 ft

Static water level: 10.38 ft below datum

	Pumping test duration [min]	Water level [ft]	Drawdown [ft]	Corrected drawdown [ft]
201	677.74	10.63	0.25	0.25
202	687.74	10.64	0.26	0.25
203	697.74	10.63	0.25	0.25
204	707.74	10.63	0.25	0.24

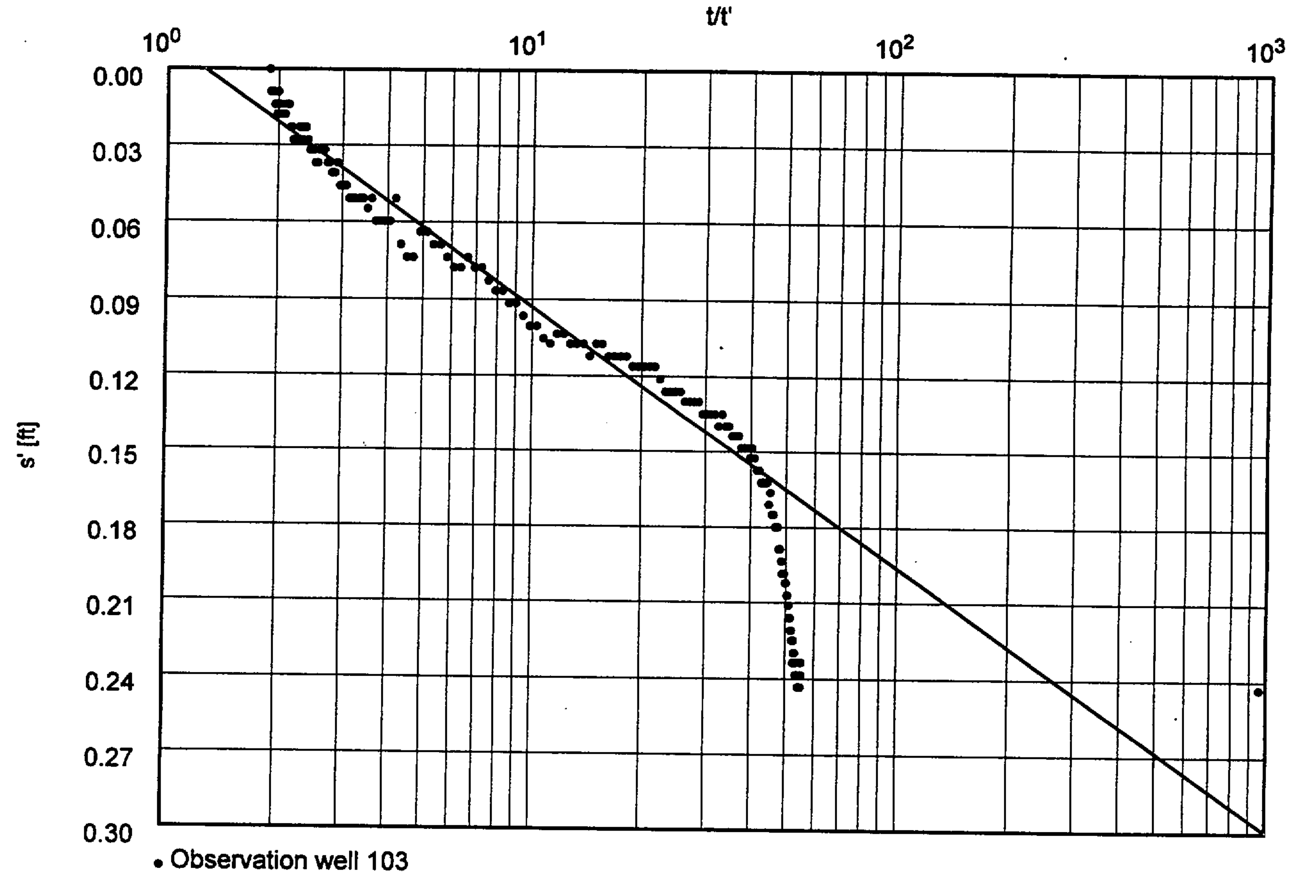
MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Time-Drawdown plot with discharge	1034OR1.HYT, Page 1	
		Project: UGW -- Grand Junction, CO	
		Evaluated by: RJH	Date: 11/18/98

Pumping Test No. 1035 Recovery Test	Test conducted on: 09/29/98
Observation Well 1034	
Discharge 6.73 U.S.gal/min	



MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1034OR1.HYT, Page 1 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/18/98

Pumping Test No. 1035 Recovery Test	Test conducted on: 09/29/98
Observation Well 1034	
Discharge 6.73 U.S.gal/min	
	Pumping test duration: 707.00 min



Transmissivity [ft²/min]: 1.59×10^0 2289.60 ft²/day

Hydraulic conductivity [ft/min]: 1.99×10^{-1} 286.56 ft/day

Aquifer thickness [ft]: 8.00

MACTEC-ERS
2597 B 3/4 Road
Grand Junction, CO 81503
970/248-6040

Pumping test analysis
Recovery method after
THEIS & JACOB
Unconfined aquifer

1034OR1.HYT, Page 2

Project: UGW -- Grand Junction, CO

Evaluated by: RJH | Date: 11/18/98

Pumping Test No. 1035 Recovery Test
Test conducted on: 09/29/98

Observation Well 1034
Observation well 1035

Discharge 6.73 U.S.gal/min
Distance from the pumping well 30.00 ft

Static water level: 10.38 ft below datum
Pumping test duration: 707.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
1	0.74	10.63	0.25	0.24
2	13.00	10.62	0.24	0.23
3	13.00	10.62	0.24	0.23
4	13.01	10.62	0.24	0.23
5	13.01	10.62	0.24	0.24
6	13.02	10.62	0.24	0.24
7	13.03	10.62	0.24	0.24
8	13.03	10.62	0.24	0.24
9	13.04	10.62	0.24	0.24
10	13.04	10.62	0.24	0.24
11	13.04	10.62	0.24	0.24
12	13.05	10.62	0.24	0.24
13	13.05	10.62	0.24	0.23
14	13.06	10.62	0.24	0.24
15	13.07	10.62	0.24	0.24
16	13.07	10.62	0.24	0.24
17	13.08	10.63	0.25	0.24
18	13.08	10.62	0.24	0.24
19	13.08	10.62	0.24	0.24
20	13.09	10.62	0.24	0.24
21	13.09	10.62	0.24	0.23
22	13.10	10.62	0.24	0.24
23	13.11	10.62	0.24	0.24
24	13.11	10.62	0.24	0.24
25	13.12	10.62	0.24	0.24
26	13.13	10.62	0.24	0.24
27	13.13	10.62	0.24	0.23
28	13.14	10.62	0.24	0.24
29	13.15	10.62	0.24	0.24
30	13.16	10.62	0.24	0.24
31	13.17	10.62	0.24	0.24
32	13.18	10.62	0.24	0.24
33	13.19	10.63	0.25	0.24
34	13.20	10.62	0.24	0.24
35	13.21	10.62	0.24	0.24
36	13.22	10.63	0.25	0.24
37	13.24	10.62	0.24	0.24
38	13.25	10.63	0.25	0.24
39	13.26	10.62	0.24	0.24
40	13.28	10.63	0.25	0.24
41	13.30	10.62	0.24	0.24
42	13.31	10.62	0.24	0.24
43	13.33	10.62	0.24	0.24
44	13.35	10.62	0.24	0.24
45	13.37	10.62	0.24	0.24
46	13.40	10.62	0.24	0.24
47	13.42	10.62	0.24	0.24
48	13.44	10.62	0.24	0.24
49	13.47	10.62	0.24	0.23
50	13.50	10.62	0.24	0.24

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1034OR1.HYT, Page 3 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/18/98

Pumping Test No. 1035 Recovery Test	Test conducted on: 09/29/98
Observation Well 1034	Observation well 1035
Discharge 6.73 U.S.gal/min	Distance from the pumping well 30.00 ft
Static water level: 10.38 ft below datum	Pumping test duration: 707.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
51	13.52	10.62	0.24	0.23
52	13.55	10.62	0.24	0.23
53	13.59	10.61	0.23	0.23
54	13.62	10.61	0.23	0.23
55	13.66	10.61	0.23	0.23
56	13.70	10.61	0.23	0.22
57	13.74	10.62	0.24	0.23
58	13.78	10.61	0.23	0.22
59	13.83	10.61	0.23	0.22
60	13.88	10.60	0.22	0.22
61	13.93	10.60	0.22	0.22
62	13.98	10.60	0.22	0.22
63	14.04	10.60	0.22	0.22
64	14.10	10.60	0.22	0.22
65	14.17	10.59	0.21	0.21
66	14.24	10.59	0.21	0.21
67	14.31	10.59	0.21	0.21
68	14.39	10.59	0.21	[illegible]
69	14.47	10.59	0.21	[illegible]
70	14.56	10.58	0.20	[illegible]
71	14.65	10.58	0.20	0.20
72	14.75	10.58	0.20	0.20
73	14.86	10.58	0.20	0.19
74	14.97	10.57	0.19	0.19
75	15.08	10.57	0.19	0.19
76	15.21	10.56	0.18	0.18
77	15.34	10.56	0.18	0.18
78	15.48	10.56	0.18	0.18
79	15.63	10.56	0.18	0.18
80	15.79	10.56	0.18	0.18
81	15.95	10.55	0.17	0.17
82	16.13	10.55	0.17	0.17
83	16.32	10.54	0.16	0.16
84	16.51	10.54	0.16	0.16
85	16.72	10.54	0.16	0.16
86	16.95	10.54	0.16	0.16
87	17.18	10.54	0.16	0.16
88	17.43	10.54	0.16	0.16
89	17.69	10.53	0.15	0.15
90	17.97	10.53	0.15	0.15
91	18.27	10.53	0.15	0.15
92	18.58	10.53	0.15	0.15
93	18.91	10.53	0.15	[illegible]
94	19.27	10.53	0.15	[illegible]
95	19.64	10.52	0.14	[illegible]
96	20.03	10.52	0.14	0.14
97	20.45	10.52	0.14	0.14
98	20.90	10.52	0.14	0.14
99	21.37	10.52	0.14	0.14
100	21.86	10.52	0.14	0.13

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1034OR1.HYT, Page 4 Project: UGW – Grand Junction, CO Evaluated by: RJH Date: 11/18/98

Pumping Test No. 1035 Recovery Test	Test conducted on: 09/29/98
Observation Well 1034	Observation well 1035
Discharge 6.73 U.S.gal/min	Distance from the pumping well 30.00 ft
Static water level: 10.38 ft below datum	Pumping test duration: 707.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
101	22.39	10.52	0.14	0.14
102	22.95	10.52	0.14	0.13
103	23.54	10.52	0.14	0.13
104	24.17	10.52	0.14	0.13
105	24.83	10.52	0.14	0.13
106	25.53	10.51	0.13	0.13
107	26.28	10.51	0.13	0.13
108	27.07	10.51	0.13	0.13
109	27.91	10.51	0.13	0.13
110	28.79	10.51	0.13	0.13
111	29.73	10.51	0.13	0.13
112	30.72	10.51	0.13	0.13
113	31.78	10.51	0.13	0.13
114	32.89	10.50	0.12	0.12
115	34.07	10.50	0.12	0.12
116	35.32	10.50	0.12	0.12
117	36.65	10.50	0.12	0.12
118	38.05	10.50	0.12	0.12
119	39.54	10.50	0.12	0.12
120	41.12	10.49	0.11	0.11
121	42.79	10.49	0.11	0.11
122	44.55	10.49	0.11	0.11
123	46.43	10.49	0.11	0.11
124	48.41	10.49	0.11	0.11
125	50.51	10.49	0.11	0.11
126	52.74	10.49	0.11	0.11
127	55.10	10.49	0.11	0.11
128	57.60	10.49	0.11	0.11
129	60.24	10.49	0.11	0.11
130	63.05	10.48	0.10	0.10
131	66.01	10.48	0.10	0.10
132	69.16	10.49	0.11	0.11
133	72.49	10.49	0.11	0.11
134	76.02	10.48	0.10	0.10
135	79.76	10.48	0.10	0.10
136	83.72	10.48	0.10	0.10
137	87.91	10.47	0.09	0.09
138	92.35	10.47	0.09	0.09
139	97.06	10.47	0.09	0.09
140	102.05	10.47	0.09	0.09
141	107.33	10.46	0.08	0.08
142	112.92	10.46	0.08	0.08
143	118.84	10.46	0.08	0.08
144	125.12	10.45	0.07	0.07
145	131.77	10.46	0.08	0.08
146	138.81	10.46	0.08	0.08
147	146.27	10.45	0.07	0.07
148	154.17	10.45	0.07	0.07
149	162.54	10.45	0.07	0.07
150	171.40	10.44	0.06	0.06

MACTEC-ERS
2597 B 3/4 Road
Grand Junction, CO 81503
970/248-6040

Pumping test analysis
Recovery method after
THEIS & JACOB
Unconfined aquifer

1034OR1.HYT, Page 5
Project: UGW -- Grand Junction, CO
Evaluated by: RJH
Date: 11/18/98

Pumping Test No. 1035 Recovery Test
Test conducted on: 09/29/98
Observation Well 1034
Observation well 1035
Discharge 6.73 U.S.gal/min
Distance from the pumping well 30.00 ft
Static water level: 10.38 ft below datum
Pumping test duration: 707.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
151	180.79	10.44	0.06	0.06
152	190.74	10.45	0.07	0.07
153	200.74	10.45	0.07	0.07
154	210.74	10.45	0.07	0.07
155	220.74	10.43	0.05	0.05
156	230.74	10.44	0.06	0.06
157	240.74	10.44	0.06	0.06
158	250.74	10.44	0.06	0.06
159	260.74	10.44	0.06	0.06
160	270.74	10.43	0.05	0.05
161	280.74	10.43	0.05	0.05
162	290.74	10.43	0.05	0.05
163	300.74	10.43	0.05	0.05
164	310.74	10.43	0.05	0.05
165	320.74	10.43	0.05	0.05
166	330.74	10.43	0.05	0.05
167	340.74	10.43	0.05	0.05
168	350.74	10.43	0.05	[illegible]
169	360.74	10.43	0.05	[illegible]
170	370.74	10.42	0.04	0.04
171	380.74	10.42	0.04	0.04
172	390.74	10.42	0.04	0.04
173	400.74	10.42	0.04	0.04
174	410.74	10.42	0.04	0.04
175	420.74	10.41	0.03	0.03
176	430.74	10.41	0.03	0.03
177	440.74	10.41	0.03	0.03
178	450.74	10.42	0.04	0.04
179	460.74	10.42	0.04	0.04
180	470.74	10.41	0.03	0.03
181	480.74	10.41	0.03	0.03
182	490.74	10.41	0.03	0.03
183	500.74	10.41	0.03	0.03
184	510.74	10.40	0.02	0.02
185	520.74	10.40	0.02	0.02
186	530.74	10.41	0.03	0.03
187	540.74	10.40	0.02	0.02
188	550.74	10.40	0.02	0.02
189	560.74	10.41	0.03	0.03
190	570.74	10.41	0.03	0.03
191	580.74	10.41	0.03	0.03
192	590.74	10.41	0.03	0.03
193	600.74	10.40	0.02	[illegible]
194	610.74	10.40	0.02	[illegible]
195	620.74	10.39	0.01	0.01
196	630.74	10.39	0.01	0.01
197	640.74	10.39	0.01	0.01
198	650.74	10.40	0.02	0.02
199	660.74	10.40	0.02	0.02
200	670.74	10.40	0.02	0.02

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1034OR1.HYT, Page 6 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/18/98

Pumping Test No. 1035 Recovery Test	Test conducted on: 09/29/98
Observation Well 1034	Observation well 1035
Discharge 6.73 U.S.gal/min	Distance from the pumping well 30.00 ft
Static water level: 10.38 ft below datum	Pumping test duration: 707.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
201	680.74	10.40	0.02	0.02
202	690.74	10.39	0.01	0.01
203	700.74	10.39	0.01	0.01
204	710.74	10.39	0.01	0.01
205	720.74	10.40	0.02	0.02
206	730.74	10.39	0.01	0.01
207	740.74	10.39	0.01	0.01
208	750.74	10.39	0.01	0.01
209	760.74	10.39	0.01	0.01
210	770.74	10.39	0.01	0.01
211	780.74	10.39	0.01	0.01
212	790.74	10.38	0.00	0.00

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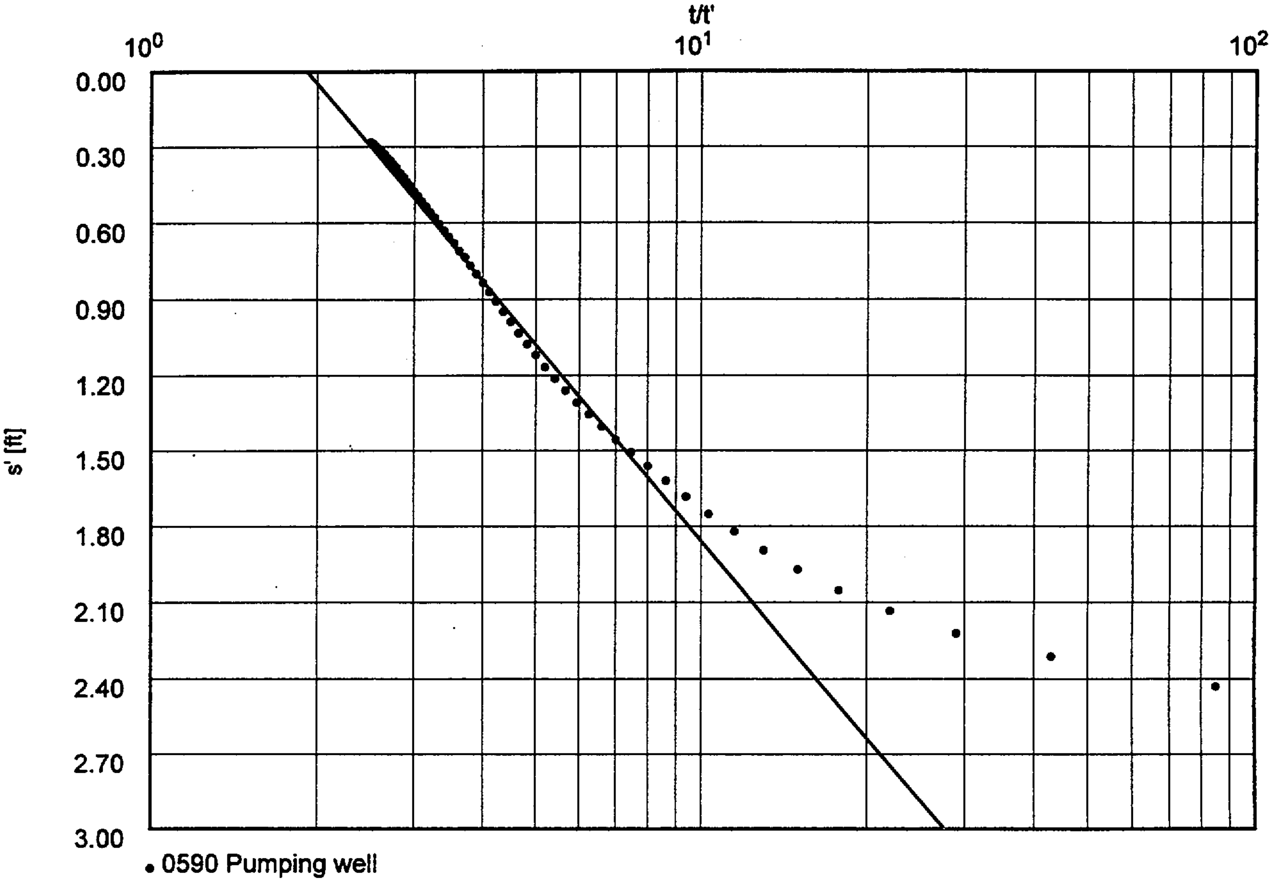
PUMPING WELL 0590

RECOVERY DATA ANALYSES

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	0590P1.HYT, Page 1 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/16/98

Pumping Test No. 0590 Recovery Test	Test conducted on: 08/10/98
Pumping Well 0590	
Discharge 30.00 U.S.gal/min	
	Pumping test duration: 840.00 min



Transmissivity [ft²/min]: 2.83×10^{-1} 407.52 ft²/day

Hydraulic conductivity [ft/min]: 4.72×10^{-2} 67.97 ft/day

Aquifer thickness [ft]: 6.00

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	0590P1.HYT, Page 2 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/16/98

Pumping Test No. 0590 Recovery Test	Test conducted on: 08/10/98
Pumping Well 0590	0590 Pumping well
Discharge 30.00 U.S.gal/min	Distance from the pumping well 1.00 ft
Static water level: 9.77 ft below datum	Pumping test duration: 840.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
1	10.00	13.15	3.38	2.43
2	20.00	12.90	3.13	2.31
3	30.00	12.71	2.94	2.22
4	40.00	12.54	2.77	2.13
5	50.00	12.40	2.63	2.05
6	60.00	12.26	2.49	1.97
7	70.00	12.13	2.36	1.90
8	80.00	12.01	2.24	1.82
9	90.00	11.90	2.13	1.75
10	100.00	11.79	2.02	1.68
11	110.00	11.70	1.93	1.62
12	120.00	11.62	1.85	1.56
13	130.00	11.54	1.77	1.51
14	140.00	11.47	1.70	1.46
15	150.00	11.40	1.63	1.40
16	160.00	11.33	1.56	1.35
17	170.00	11.26	1.49	1.31
18	180.00	11.20	1.43	1.26
19	190.00	11.14	1.37	1.21
20	200.00	11.08	1.31	1.17
21	210.00	11.02	1.25	1.12
22	220.00	10.96	1.19	1.08
23	230.00	10.91	1.14	1.03
24	240.00	10.85	1.08	0.99
25	250.00	10.81	1.04	0.95
26	260.00	10.76	0.99	0.91
27	270.00	10.71	0.94	0.87
28	280.00	10.67	0.90	0.83
29	290.00	10.63	0.86	0.80
30	300.00	10.59	0.82	0.77
31	310.00	10.55	0.78	0.73
32	320.00	10.53	0.76	0.71
33	330.00	10.49	0.72	0.68
34	340.00	10.46	0.69	0.65
35	350.00	10.44	0.67	0.63
36	360.00	10.41	0.64	0.60
37	370.00	10.38	0.61	0.58
38	380.00	10.36	0.59	0.56
39	390.00	10.33	0.56	0.54
40	400.00	10.31	0.54	0.52
41	410.00	10.29	0.52	0.49
42	420.00	10.27	0.50	0.48
43	430.00	10.24	0.47	0.46
44	440.00	10.23	0.46	0.44
45	450.00	10.21	0.43	0.42
46	460.00	10.19	0.42	0.40
47	470.00	10.17	0.40	0.38
48	480.00	10.15	0.38	0.37
49	490.00	10.14	0.37	0.36
50	500.00	10.12	0.35	0.34

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	0590P1.HYT, Page 3 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/16/98

Pumping Test No. 0590 Recovery Test	Test conducted on: 08/10/98
Pumping Well 0590	0590 Pumping well
Discharge 30.00 U.S.gal/min	Distance from the pumping well 1.00 ft
Static water level: 9.77 ft below datum	Pumping test duration: 840.00 min

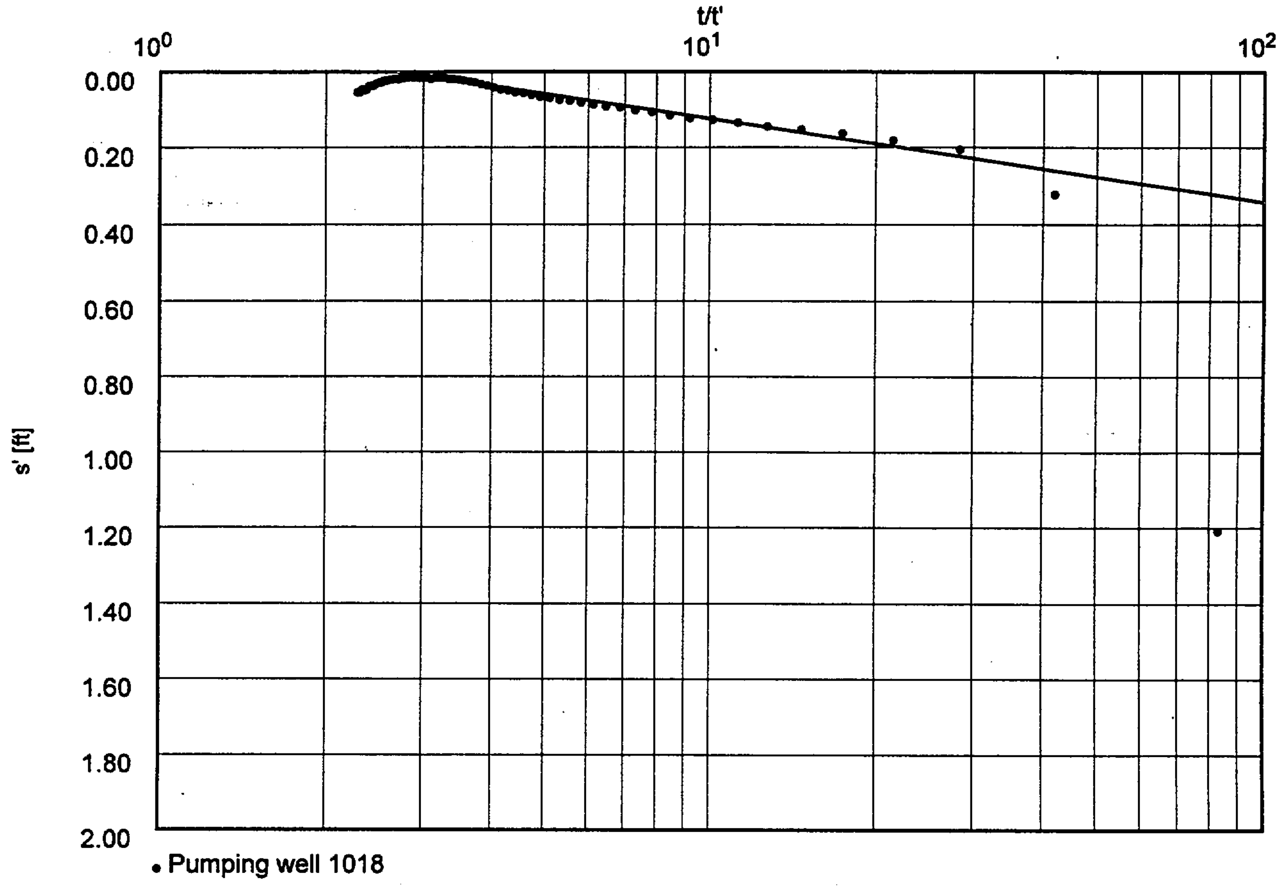
	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
51	510.00	10.11	0.34	0.33
52	520.00	10.10	0.33	0.32
53	530.00	10.09	0.32	0.31
54	540.00	10.08	0.31	0.30
55	550.00	10.07	0.29	0.29
56	560.00	10.06	0.29	0.28

PUMPING WELL 1018

RECOVERY DATA ANALYSES

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1018PR2.HYT, Page 1 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/24/98

Pumping Test No. 1018 Recovery Test	Test conducted on: 08/11/98
Pumping Well 1018	
Discharge 1.00 U.S.gal/min	
	Pumping test duration: 820.00 min



Transmissivity [ft²/min]: 1.12×10^{-1} 161.28 ft²/day

Hydraulic conductivity [ft/min]: 1.24×10^{-2} 17.86 ft/day

Aquifer thickness [ft]: 9.00

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1018PR2.HYT, Page 2 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/24/98

Pumping Test No. 1018 Recovery Test	Test conducted on: 08/11/98
Pumping Well 1018	Pumping well 1018
Discharge 1.00 U.S.gal/min	Distance from the pumping well 1.00 ft
Static water level: 7.90 ft below datum	Pumping test duration: 820.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
1	10.00	9.20	1.30	1.21
2	20.00	8.23	0.33	0.32
3	30.00	8.11	0.21	0.21
4	40.00	8.08	0.18	0.18
5	50.00	8.06	0.16	0.16
6	60.00	8.05	0.15	0.15
7	70.00	8.05	0.15	0.14
8	80.00	8.04	0.14	0.13
9	90.00	8.03	0.13	0.13
10	100.00	8.02	0.12	0.12
11	110.00	8.02	0.12	0.12
12	120.00	8.01	0.11	0.11
13	130.00	8.00	0.10	0.10
14	140.00	8.00	0.10	0.09
15	150.00	7.99	0.09	0.09
16	160.00	7.99	0.09	0.09
17	170.00	7.98	0.08	0.08
18	180.00	7.98	0.08	0.08
19	190.00	7.97	0.07	0.07
20	200.00	7.97	0.07	0.07
21	210.00	7.97	0.07	0.07
22	220.00	7.96	0.06	0.06
23	230.00	7.96	0.06	0.06
24	240.00	7.96	0.06	0.05
25	250.00	7.95	0.05	0.05
26	260.00	7.95	0.05	0.05
27	270.00	7.94	0.04	0.04
28	280.00	7.94	0.04	0.04
29	290.00	7.93	0.03	0.03
30	300.00	7.93	0.03	0.03
31	310.00	7.93	0.03	0.03
32	320.00	7.92	0.02	0.02
33	330.00	7.92	0.02	0.02
34	340.00	7.92	0.02	0.02
35	350.00	7.92	0.02	0.02
36	360.00	7.92	0.02	0.02
37	370.00	7.92	0.02	0.02
38	380.00	7.92	0.02	0.02
39	390.00	7.92	0.02	0.02
40	400.00	7.92	0.02	0.02
41	410.00	7.92	0.02	0.02
42	420.00	7.92	0.02	0.02
43	430.00	7.91	0.01	0.01
44	440.00	7.91	0.01	0.01
45	450.00	7.91	0.01	0.01
46	460.00	7.92	0.02	0.02
47	470.00	7.92	0.02	0.02
48	480.00	7.92	0.02	0.02
49	490.00	7.92	0.02	0.02
50	500.00	7.92	0.02	0.02

MACTEC-ERS 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6040	Pumping test analysis Recovery method after THEIS & JACOB Unconfined aquifer	1018PR2.HYT, Page 3 Project: UGW -- Grand Junction, CO Evaluated by: RJH Date: 11/24/98

Pumping Test No. 1018 Recovery Test	Test conducted on: 08/11/98
Pumping Well 1018	Pumping well 1018
Discharge 1.00 U.S.gal/min	Distance from the pumping well 1.00 ft
Static water level: 7.90 ft below datum	Pumping test duration: 820.00 min

	Time from end of pumping [min]	Water level [ft]	Residual drawdown [ft]	Corrected drawdown [ft]
51	510.00	7.92	0.02	0.02
52	520.00	7.92	0.02	0.02
53	530.00	7.92	0.02	0.02
54	540.00	7.93	0.03	0.03
55	550.00	7.93	0.03	0.03
56	560.00	7.93	0.03	0.03
57	570.00	7.94	0.04	0.04
58	580.00	7.94	0.04	0.04
59	590.00	7.94	0.04	0.04
60	600.00	7.95	0.05	0.05
61	610.00	7.95	0.05	0.05
62	620.00	7.95	0.05	0.05
63	630.00	7.96	0.06	0.05
64	640.00	7.96	0.06	0.05

Appendix E

Summary Data for Subsurface Waters by Upgradient, On Site, Downgradient, and Dakota Wells and Preliminary Surface Water Sample Descriptions

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	Alluvial Downgradient			Alluvial Onsite			Alluvial Upgradient			Dakota Wells		
Analyte	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Alkalinity as CaCO3	422	714	504	305	545	433	227	493	383	252	1852	757
Ammonia as NH4	<.0007	22.1	6.75	47	233	105	.0142	1.12	.154	.26	11.7	3.92
Arsenic	<.001	.0081	.00142	<.001	.0349	.007	<.001	.0014	.000612	<.001	.0061	.00168
Cadmium	<.001	<.001	.0005	<.001	.0013	.000591	<.001	<.001	.0005	<.001	<.001	.0005
Calcium	353	616	483	441	618	517	122	573	421	3.41	72.2	36.2
Chloride	213	1160	951	392	887	680	133	991	445	584	4040	1710
Cobalt	<.006	<.008	.0035	<.006	.0162	.0054	<.006	<.008	.00348	<.006	<.008	.0035
Copper	<.005	<.005	.0025	<.005	<.005	.0025	<.005	<.005	.0025	<.005	<.005	.0025
Fluoride	.244	1.89	.876	.898	7.9	2.58	.453	1.82	1.12	.309	3.52	1.69
Gross Alpha	<48.18	142.9	80	<41.78	1930	293	<12.85	83.66	39.9	<16.22	<109.95	27.9
Gross Beta	<55.32	477.3	76.3	37.4	1113	158	<13.23	254.9	33.7	<17.6	2029	221
Iron	<.003	16.8	3.13	.156	21.2	4.18	<.003	3.13	.411	<.0126	2.88	.556
Magnesium	326	491	425	173	474	361	64	502	355	.883	25.5	10.9
Manganese	.0815	3.69	1.85	2.57	4.54	3.16	.233	3.08	1.63	<.008	.0999	.0446
Molybdenum	.0147	.174	.0548	.0405	.299	.126	.0158	.186	.0767	<.001	.0244	.00423
Nickel	<.007	.0222	.0129	.0116	.111	.0432	<.007	.0281	.0117	<.007	.0239	.00984
Nitrate	<.011	65	11.5	<.011	20.4	3.38	<.0579	71.4	14.5	<.011	.175	.0376
Potassium	9.6	66.6	21.4	14.2	61.2	37.9	4.93	16.8	9.17	2.41	9.48	5.66
Radium-226	.02	.62	.105	.06	.58	.142	<.04	.34	.0888	.11	47.04	7.5
Radium-228	<.4	<.9	.307	<.48	<.9	.405	<.4	<1	.299	<.48	29.27	5.2
Redox Potential	-128	211	18.2	-141	134	1.82	-143	239	37.1	-410	-62	-212
Selenium	<.001	.0244	.00392	<.001	<.016	.00225	<.001	.137	.0319	<.001	<.001	.0005
Sodium	836	1360	1060	536	999	840	186	893	586	799	2730	1540
Specific Conductance	5540	9760	7410	5740	8040	7210	1834	7760	5030	3460	12580	6710
Strontium	5.6	8.99	7.15	3.93	8.12	6.77	1.71	8.09	5.34	.451	14.4	5.02
Sulfate	572	3930	3190	1650	3680	3040	416	3720	2600	.441	1930	459
Temperature	11.3	18	15	8.3	17.1	13.6	9.7	17.2	13.8	14.5	16.6	15.5
Total Dissolved Solids	5880	7840	6870	4440	6880	6270	1440	7400	5150	2030	7390	4240
Turbidity	.66	32.4	8.08	1.72	1000	54.3	2.64	901	51.6	1.36	1000	214
Uranium	.0318	.199	.104	.0241	2.5	.399	.0117	.0682	.0493	<.001	.0052	.0012
Uranium-234	15.3	73.5	43.7	13.2	833	143	5.4	35.2	25.5	<.8	4.6	1.42
Uranium-235	<1	3.2	1.69	<1	38	6.34	<1	1.1	.642	<1	<1	.5
Uranium-238	10.6	66.5	35.6	8.1	835	136	4.4	22.8	16.9	<1	<1	.5
Vanadium	<.001	<.0052	.00101	<.001	.832	.13	<.001	.0049	.00101	<.001	<.0041	.0012
Zinc	<.004	.0382	.00753	<.004	.352	.0478	<.004	.0051	.00238	<.004	.0119	.00495
pH	6.43	7.68	6.94	6.84	7.57	7.12	6.45	7.77	6.94	7.19	8.53	7.84

GRAND JUNCTION WATER SAMPLE LOCATIONS OF PRELIMINARY SITES
Soil samples have been taken from all sites except 51 - 58

1. North side of southeast pond at southeast corner of Struthers and Hwy 50

2. North side of northeast pond at southeast corner of Struthers and Hwy 50

3. North side of northwest pond at southeast corner of Struthers and Hwy 50

4. North bank of Colorado River at center of Hwy 50 bridge

5. North bank of Colorado River ~170 ft. east of Hwy 50 bridge where braided stream rejoins channel

6. North Bank of braided area midpoint between Hwy 50 and Watson Island bridge

7. North bank of braided area at west edge of Watson Island bridge

8. North bank of braided area straight south of west corner of Randall Industries property. Sample taken where cobble drainage joins water flow. No drainage occurring at that time.

9. North bank of braided area at the west fence line of the mill site (east of Lone House).

10. Standing water north of braided area just at pronounced Watson Island curve. (Where 9th St. would intersect.)

11. Standing water north of braided area directly south of west corner of brick mill building

12. North bank of braided area directly south of center of brick mill building

13. North bank of Colorado River at west edge of the new foot bridge

14. West end of Corn Lake

15. East end of Corn Lake

16. North bank of Colorado river at Corn Lake boat ramp (east end of Corn Lake)

17. West side of pond at American Auto Salvage

18. East side of pond at American Auto Salvage

19 Standing water just north of east end of pond at American Auto Salvage. Water stinks. Possibly communicates with pond during high water

20. Ditch at 27 5/8ths and C1/2 Rds. Just east of GJ Byproducts

21.North bank of river at 28 Rd. Checked for standing water because cattails were present, but no water available to sample

22 Standing water just west of the south end of 28 Rd.

23 North bank of braided area on path west from Corn Lake, west side of corn field, east of bench. (Approx location is where 31 ½ Rd would intersect if it came all the way south to the river

24. Southeast end of large pond that sits between 30 ½ and 31 Rd., just north of the paved trail. This pond was originally 2 ponds, but the levee separating them has been breached on the south. The parking lot for the west end of this segment of the Corn Lake trail is at the north west corner of the pond. Call this the 31 Road Pond

25. Southeast end of large pond that sits west of 30 ½ Rd, just north of the paved trail. This is on private property - need permission

26. Water pumped into north west pond at south east corner of Struthers and Hwy 50. Pump was allowed to run ~15 minutes prior to sample. Sample taken directly from pipe outflow. This is the "sump" that provides the water for the Botanical Garden's use.

27. Standing water north of braided area, east of location 10. (Where 10th St would intersect)

28. Standing water north of braided area, east of location 27, just west of location 11.

29. West end of private pond (Price's) south of Corn Lake trail, just east of 31 Rd. Limited access - need permission

30. East end of the closed pond north of the 31 Road Pond (described in location 24). This pond lies west of 31 Rd., starting closer to 31 Rd., but is not as large and does not extend as far west. This pond does not appear on the aerial photos from the '94 flyover. Limited access - need permission

31. Flowing water from Lewis Wash at inlet to 31 Road Pond

32. West end of the closed pond north of the 31 Road Pond

33 North (center) of 31 Road Pond. Straight south of the west big cottonwood tree

34. Northwest corner of the 31 Road Pond, adjacent to the parking area

35 Southeast corner of County pond at the end of 30 Rd. Limited access - need key

36 Flowing water from ditch off 29 5/8 Rd. Near road culvert on east side. Just upstream (east) from location of beaver dam that had to be removed by backhoe Limited access - need key

37 East end of pond just northwest of the ditch off 29 5/8 Rd.

38 North east end of large state-owned pond southwest of ditch crossing 29 5/8 Rd. Mined wetlands, fills from river backflow at southwest corner (lots of cobble, communicates with river at high flow)

39 North bank of river at inlet to the large state-owned pond, location 38

40 East end of state-owned pond west of 29 Road, just north of river. Would be bisected by 28 3/4 Rd. if that road went through

41 North bank of river just south of location 40

42 North bank of braided area south of the Corn Lake trail at the 31 Road Pond (~1/4 of the length of the pond, starting at the west end, ~1/2 way between the west end and the breached levee)

43 Flowing water from Lewis Wash at the northeast corner of 31 and D Rd.

44 North bank of braided area just west of the east end of Watson Island If you drew a line south from the east side of the mill building, this location would form ~ 30* angle with the southeast corner of the building.

45 North bank of braided area just south of the west boundary of Jones Lumber. East of the east end of Watson Island as it appears on aerial photo. In reality, at this lowered flow, Watson Island extends ~100' farther east.

46 North bank of braided area even with the current tip of Watson Island. On aerial photo it is ~100' past the pictured end of the island

47 River channel west of railroad bridge, south of brick house, where 4th St would intersect if extended

48 Standing ditch water at northeast corner of mill site boundary. West of second building on Bonny Lane (counting from the south end). NOTE: the property immediately northeast of this ditch is being remediated (soil removal to 6") at this time due to windborn tailings contamination.

49 North bank of braided area ~50 yds east of the west end of the 31 Road Pond, south of the Corn Lake Trail

50 North bank of the braided area south of the Corn Lake Trail. Straight south of the gazebo that sits at the south point of the breached levee

51 Flowing ditch water at 28 and D Rds.

52 Flowing ditch water at 27 3/4 and D Rds.

53 Flowing ditch water at 29 1/4 and D Rds.

54 Flowing ditch water at 29 3/4 and D Rds.

55 Flowing ditch water at 30 1/4 and D Rds.

56 Flowing ditch water at 31½ and D Rds.

57 Flowing ditch water at 33 3/4 and E1/2 Rds. (Grand Valley Canal)

58 Flowing ditch water at 34 and F3/4 Rds (~100 yds south of G Rd) (Highline Canal)

Appendix F

Calculation Set for Distribution Coefficients (Kds)

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Calculation No.: U0032900

Technical Task Cover Sheet

Discipline Geochemistry **Number of Sheets** 7

Project:
UMTRA Groundwater

Site:
Grand Junction (Climax)

Subject:
Determination of Distribution Coefficients

Sources of Data:
Calculated from results of chemical analyses.

Task Order No. MAC98-05-13 **File Index No.** GWGRJ13.1

Proj. No. 321413001 **Calc. No.** U0032900 **Supersedes Calc. No.** none

Calculated by	Date	Checked by	Date	Approved by	Date
Stan Morrison	7/7/98		7/7/98	Roberta C	7/15/98

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mactec-ers
U.S. Department of Energy Grand Junction Office

Problem Statement: As contaminated ground water migrates through pore spaces within soils and rocks, some of the contamination transfers between the solid and liquid phases. This phenomenon causes the contamination to travel at a slower rate than the average ground-water velocity. The chemical processes that cause this retardation can include adsorption, absorption, precipitation, diffusion into immobile porosity, transfer to vapor phases, and so on. It is generally not possible to differentiate among all of these processes. However, for many aquifer systems, a bulk parameter (the distribution coefficient or Kd) has been used with some success to describe the retardation of contamination. Most numerical ground-water models use the Kd concept in simulations of contaminant transport. Thus, a laboratory study was conducted to determine Kd values for the Grand Junction UMTRA Site.

Method of Solution: Laboratory data were collected using ASTM procedure D4646–87 titled " Standard Test Method for 24-h Batch-Type Measurement of Contaminant Sorption by Soils and Sediments". The procedure is summarized as follows:

A representative portion of a core sample is air dried at room temperature. All samples were collected in background areas so as to avoid the complication of having contamination present in the solid prior to the analysis. If contamination is present in the solids then it needs to be accounted for by measuring concentrations in both the solid and aqueous phases; whereas, if no contamination is present in the solid phase, only the aqueous solution need be analyzed. Analysis of only the aqueous phase will often result in negative values of Kd if contamination is present in the solid phase. It is assumed that the sediment mineralogy in the background areas is similar to that at the Grand Junction processing site.

The sample is sieved to less than 10 mesh (2 mm). A riffle splitter is used to separate a sample for oven drying at 105 degrees C to determine moisture content. The difference between the air-dried and oven-dried weights was always less than 2% and usually less than 1% so no correction was made for the water contents of the air-dried samples.

A synthetic solution was prepared that simulates ground water at the Grand Junction site. The solution is based on the analyses provided for plume water in Table 3.4 of the SOWP Rev. 0 (DOE, 1996). The composition of the synthetic ground water is as follows (in mg/L): Na = 960, K = 99, Ca = 452, Mg = 296, SO_4 = 2965, Cl = 770, and C (inorganic) = 93. Contaminants were added to the following concentrations (in mg/L): As = 0.38, Cd = 0.454, Mo = 2.01, and U = 1.95. These contaminants were selected because they are the regulated COPCs. Radium-226, also a regulated COPC was not included because a much larger sample would have been required and most concentrations that have been measured in ground water at the site were below the standard. The pH was adjusted to about 7.0 and the measured alkalinity was about 260 mg/L as $CaCO_3$ (approximately the pH and alkalinity at the site).

Five grams of each core sample was placed in a 125-mL Nalge bottle with 100 mL of the synthetic ground water. Samples were rotated end-over-end at 8 rpm for 24 hours. They were then centrifuged at 3000 rpm and filtered through a 0.45 um filter. Samples were preserved with 1% nitric acid and submitted to the analytical chemistry laboratory for analysis of As, Cd, Mo, and U. Controls run through the same process (but without sediment) showed no decrease in contaminant concentrations.

For uranium only, Kd values were measured for a range of final uranium concentrations. This was accomplished by varying the masses of core samples from 2.5 to 50 grams while using an initial uranium concentration of 2 mg/L.

Assumptions: To use Kd values in ground-water transport models the following assumptions must be made: (1) the 24-hour shake time is sufficient to bring the system to chemical equilibrium, (2) the modeled system is always in chemical equilibrium, (3) an adequate portrayal of the areal and vertical distributions of Kd values is manifested in the model domain, (4) Kd values do not vary within the range of major ion chemistry or pH values present in the ground water, and (5) Kd values do not vary with contaminant concentrations present in the ground water.

Assumption (5) was tested for uranium by measuring Kd values for a range of initial uranium concentrations.

Sources of Formulas and References:

ASTM Designation D 4646–87, 1993 (Reapproved). Standard Test Method for 24-h Batch-Type Measurement of Contaminant Sorption by Soils and Sediments.

DOE, 1996. Site Observational Work Plan for the UMTRA Project Site at Grand Junction, Colorado, DOE/AL/62350–215 rev. 0.

Calculation: The Kd values are calculated by:

$$Kd = \frac{(A - B)V}{(M_s)B} \quad \text{where}$$

A = initial concentration of the COPC (mg/L)
B = final concentration of the COPC (mg/L)
V = volume of solution (100 mL in all cases)
M_s = mass of soil used (g)
Kd = distribution coefficient (mL/g)

Note that the Kd is the same as the Rd in the ASTM procedure. They are reported here as Kd values because the intent is to provide coefficients that can be used in modeling. It is understood that for the modeling to be realistic all of the assumptions discussed above must be met.

Discussion: Single-point Kd values were determined for As, Cd, Mo, and U on 10 samples from 6 wells. Multiple point Kd values were determined for U only on 2 samples from 1 well. The results are presented in Table 1.

Kd values for As range from 75 to 8241 mL/g and have a mean of 1149 mL/g. The sample with the Kd value of 8241 mL/g was collected in soil immediately above the alluvial aquifer. Kd values for the alluvial aquifer range from 75 to 1168 mL/g and have a mean of 361 mL/g. The two alluvial aquifer samples with the highest Kd values (1168 and 635 mL/g) have roots in them which may have caused some of the As uptake. Even without the root-bearing samples, however, Kd values are relatively high ranging from 75 to 358 mL/g and having a mean of 207 mL/g. The high Kd values indicate that As will be retarded as ground water migrates through the alluvial aquifer.

Kd values for Cd range from 49 to 356 mL/g and have a mean of 181 mL/g. Kd values for the alluvial aquifer (omitting the one sample collected from the soil above the alluvial aquifer) have a mean of 177 mL/g. This mean is nearly the same as that of As and indicates that Cd also will be retarded as ground water migrates through the alluvial aquifer. Similar to As, the Kd values for the root-bearing sediments are well above the mean suggesting that some Cd may have been sorbed by the roots.

Kd values for Mo ranged from 0.1 to 1.5 mL/g and have a mean of 0.7 mL/g. All of the final concentrations are within 10% of the initial concentration and within the analytical uncertainty some of these Kd values could be close to 0 mL/g. One of the three highest Kd values is from the soil that occurs just above the alluvial aquifer. By omitting this value, the mean of the alluvial aquifer is calculated as 0.6 mL/g. The other two highest values are from the root-bearing samples. Without the 3 highest values, the mean is 0.4 mL/g. The results indicate that Mo is relatively mobile in the alluvial aquifer.

Kd values for the single-point Kd values for U ranged from 1.0 to 3.6 mL/g and have a mean of 2.2 mL/g. The values show little correlation to sample type (such as root-bearing samples). These results indicate that similar to Mo, U is somewhat retarded in the alluvial aquifer but much less so than As or Cd.

Kd values have been shown to sometimes vary with the concentration of contaminant. Therefore, multiple Kd determinations for U were made on two samples collected from well 1023. In Figure 1, the final concentration of dissolved U is plotted against the mass of sediment used for one of the samples (depth 10 to 12 feet). Data are plotted with 10% error bars (a reasonable value for analytical uncertainty) and are compared to calculated curves for various Kd values. Within the 10% uncertainty, all but one data point are consistent with a Kd value of 1 mL/g. Data from the other sample are plotted on Figure 2. Within the 10% error bars, all of these data are consistent with a Kd value of 1 mL/g.

Conclusion and Recommendations: The results indicate that As and Cd are much more retarded in the alluvial aquifer sediments than are Mo or U. This finding is consistent with the observation at other mill tailings sites at which the U and Mo plumes have migrated further from the processing sites than have the As or Cd plumes.

Recommended Kd values for the alluvial aquifer are as follows:

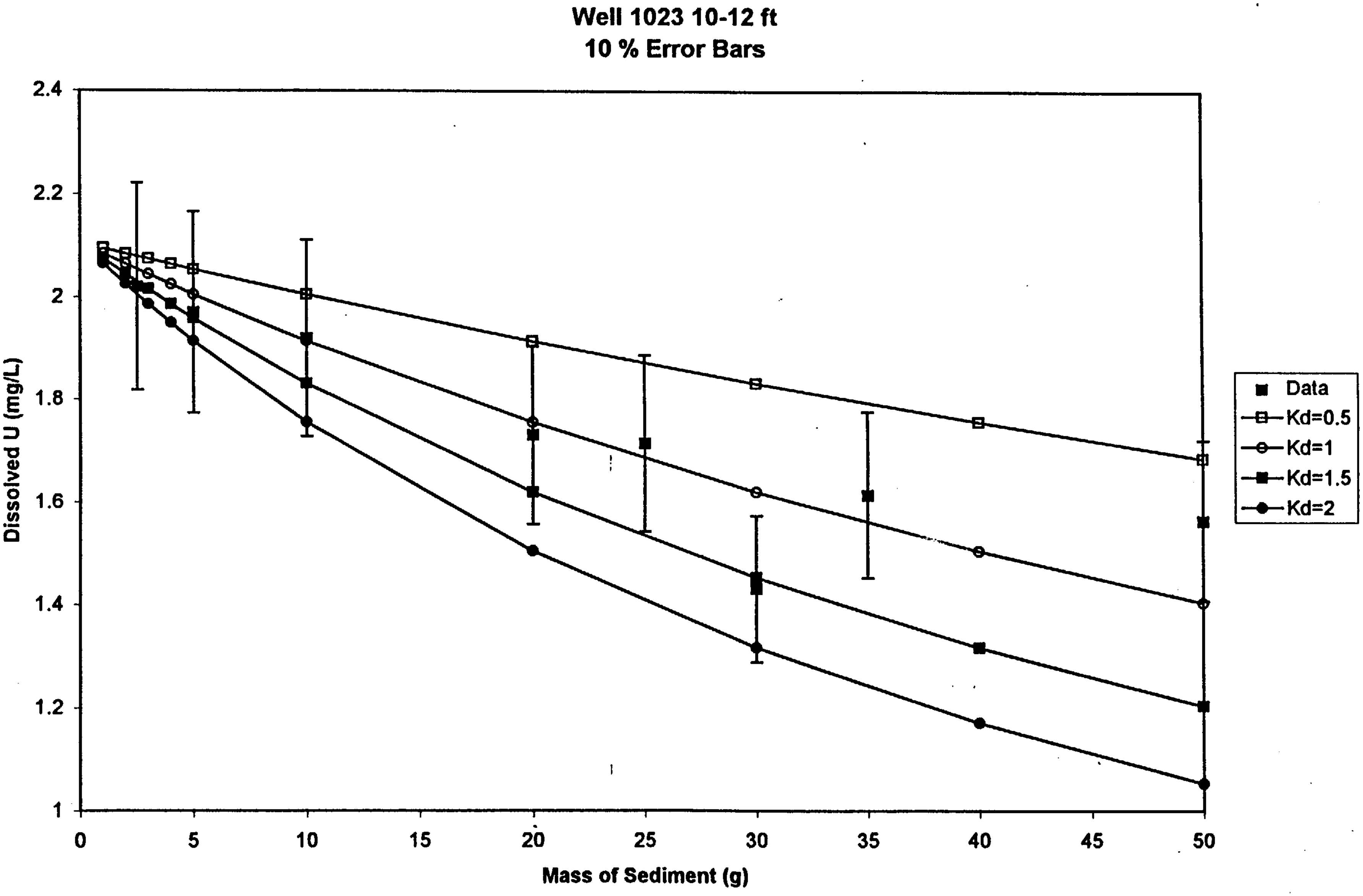
COPC	Kd (mL/g)
As	361
Cd	177
Mo	0.6
U	1.0

For As, Cd, and Mo these values are the means of the alluvial aquifer samples. For U the value is the best fit to the plots of the multiple-point determinations.

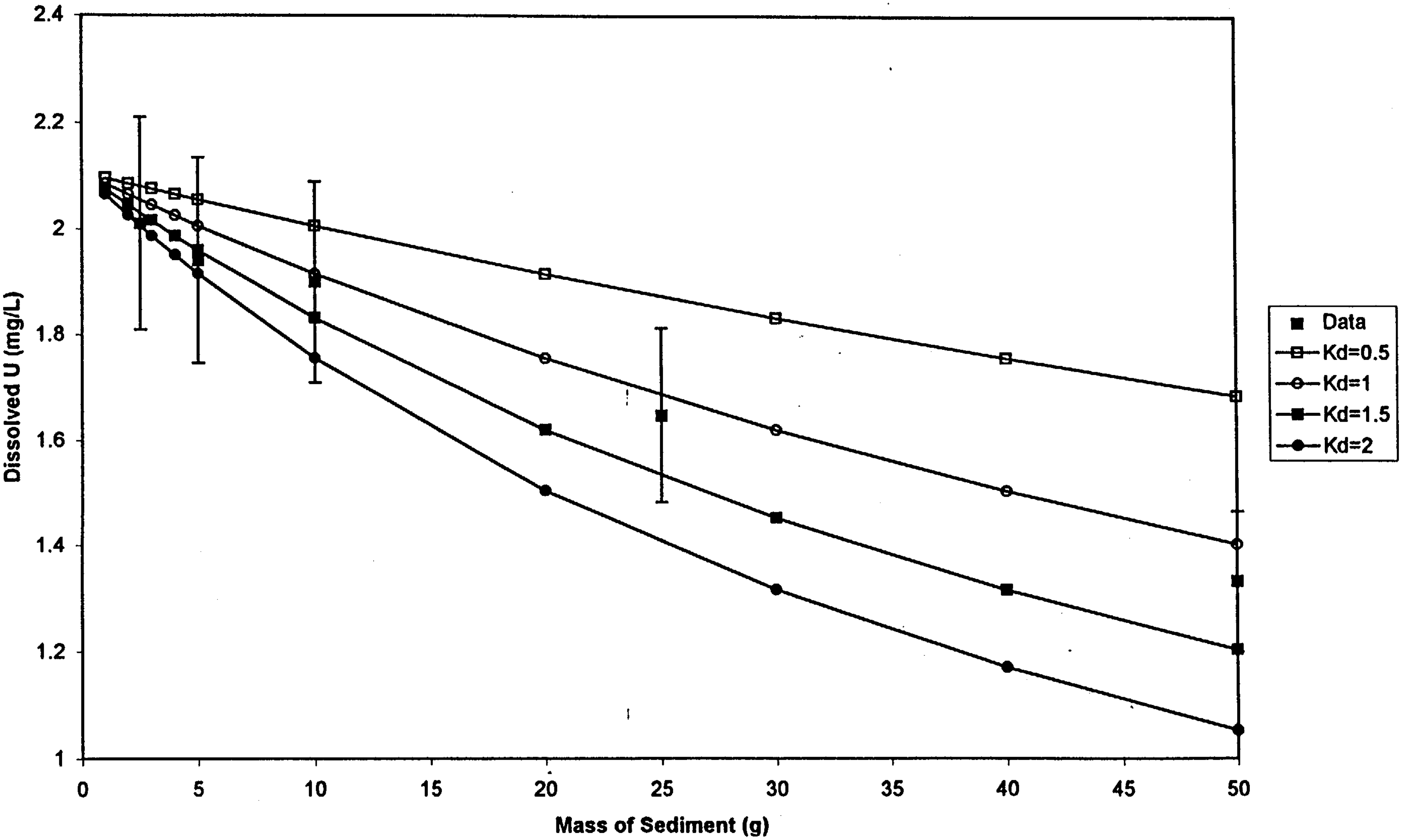
Computer Source: All calculations were made in an Excel spreadsheet.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Table 1. Data and Calculations for Grand Junction Kd Values																	
2																		
3	SINGLE POINT MEASUREMENTS						Initial Compositions				Final Compositions				Kd Values			
4	Sample	Well	Depth	Description	Fluid Vol	Sed wgt	As	Cd	Mo	U	As	Cd	Mo	U	Kd, As	Kd, Cd	Kd, Mo	Kd, U
5	No.	No.	ft		mL	g	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mL/g	mL/g	mL/g	mL/g
6																		
7	1020-1	1020	10-12	Qal, sndy gr	100	5	0.38	0.454	2.01	1.95	0.0732	0.0449	2	1.74	83.83	182.23	0.1	2.414
8	1021-1	1021	5-7	Qal, Slty snd, dk br	100	5	0.38	0.454	2.01	1.95	0.0201	0.0241	1.94	1.65	358.1	356.76	0.7216	3.636
9	1023-1	1023	5-7	Soil, Cly slt	100	5	0.38	0.454	2.01	1.95	0.0009	0.0338	1.89	1.79	8241	248.64	1.2698	1.788
10	1023-2	1023	10-12	Qal, Slty snd, dk br	100	5	0.38	0.454	2.01	1.95	0.0798	0.132	2	1.86	75.24	48.788	0.1	0.968
11	1023-3	1023	15-15.4	Qal, Sndy gr	100	5	0.38	0.454	2.01	1.95	0.0484	0.108	1.96	1.85	137	64.074	0.5102	1.081
12	1024-1	1024	5-7	Qal, Slty snd, wet, dk br	100	5	0.38	0.454	2.01	1.95	0.0202	0.059	1.94	1.67	356.2	133.9	0.7216	3.353
13	1025-1	1025	5-7	Qal, Cly slt, dk br, roots	100	5	0.38	0.454	2.01	1.95	0.0116	0.0303	1.89	1.75	635.2	279.67	1.2698	2.286
14	1025-2	1025	10-12	Qal, Cly slt, dk br, roots	100	5	0.38	0.454	2.01	1.95	0.0064	0.0304	1.87	1.72	1168	278.68	1.4973	2.674
15	1025-3	1025	15-17	Qal, Slt snd, dk br	100	5	0.38	0.454	2.01	1.95	0.0306	0.108	1.98	1.82	228.4	64.074	0.303	1.429
16	1028-1	1028	5-7	Qal, cly slt, gr br	100	5	0.38	0.454	2.01	1.95	0.0332	0.0451	1.97	1.78	208.9	181.33	0.4061	1.91
17	B1	Blank	na	no sed, run thru process	100	5					0.37	0.453	2.03	1.96				
18	B2	Blank	na	no sed, run thru process	100	5					0.383	0.455	2	1.93				
19	B3	Blank	na	no sed, run thru process	100	5					0.379	0.453	2.01	1.94				
20																		
21														Means	1149	183.81	0.69	2.154
22	URANIUM - MULTIPLE-POINT MEASUREMENTS																	
23	1	1023	10-12	Qal, Slty snd, dk br	100	2.5				2.106				2.02				1.703
24	2	1023	10-12	Qal, Slty snd, dk br	100	5				2.106				1.97				1.381
25	3	1023	10-12	Qal, Slty snd, dk br	100	10				2.106				1.92				0.969
26	4	1023	10-12	Qal, Slty snd, dk br	100	20				2.106				1.731				1.083
27	5	1023	10-12	Qal, Slty snd, dk br	100	25				2.106				1.715				0.912
28	6	1023	10-12	Qal, Slty snd, dk br	100	30				2.106				1.431				1.572
29	7	1023	10-12	Qal, Slty snd, dk br	100	35				2.106				1.614				0.871
30	8	1023	10-12	Qal, Slty snd, dk br	100	50				2.106				1.564				0.693
31	9	1023	15-15.4	Qal, Sndy gr	100	2.5				2.106				2.01				1.91
32	10	1023	15-15.4	Qal, Sndy gr	100	5				2.106				1.94				1.711
33	11	1023	15-15.4	Qal, Sndy gr	100	10				2.106				1.899				1.09
34	12	1023	15-15.4	Qal, Sndy gr	100	25				2.106				1.647				1.115
35	13	1023	15-15.4	Qal, Sndy gr	100	50				2.106				1.333				1.16
36	14	Blank			100	0				2				2.106				
37																		Mean =	1.244

Figure 1.


Well 1023 10-12 ft
10 % Error Bars
Dissolved U (mg/L)
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0
5
10
15
20
25
30
35
40
45
50
Mass of Sediment (g)
Data
Kd=0.5
Kd=1
Kd=1.5
Kd=2

Well 1023 15-15.4 ft
10 % Error Bars



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Appendix G

Calculations Set for Subpile Samples

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Technical Task Cover Sheet

Discipline Geochemistry **Number of Sheets** 15

Project:
UMTRA Ground Water

Site:
Grand Junction (Climax)

Subject:
Subpile Soil Investigation

Sources of Data:

(1) Lithologic logs of 9 soil borings (included in Grand Junction SOWP; DOE 1999)

(2) Descriptions of 2 hand dug samples

(3) Analytical data from 17 single extractions

(4) Previous documentation/data prepared for the site

(5) SEE UMTRA database (most recent sampling data)

Task Order No. MAC 99-05 **File Index No.** GWGRJ 13.1

Proj. No. 331413006 **Calc. No.** U0046600 **Supersedes Calc. No.** None

Calculated by	Date	Checked by	Date	Approved by	Date
Laura Cummins	12/10/98		2/2/99	Roberta C	2/9/99

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Problem Statement:

During the uranium milling operations at the Grand Junction site, several ponds were used for evaporation of milling fluids; mill tailings were stored in piles on the surface of the site. Tailings recovered from vicinity properties around Grand Junction were temporarily stored in and around the evaporation ponds at the site. Tailings and radioactively contaminated soils were removed from the site for off-site disposal; removal was based strictly on radioactive cleanup criteria (everything in excess of 15 pCi/g was removed). The potential exists for nonradiogenic contaminants to remain in the soil at levels that could pose a threat to ground water through their eventual migration into the ground water system (by infiltrating precipitation or a raising of the water table, for example).

This document provides an analysis of data collected during an investigation into the distribution of constituents of potential concern (COPCs) in the soils underlying the former tailings piles and evaporation ponds. These results are compared with results obtained for samples collected from areas unaffected by milling activities (background samples).

Method of Solution:

Subpile Soil Sampling

Samples of the soils from directly beneath the former tailings piles and evaporation ponds were collected. These samples were subjected to a one-step chemical extraction process and the extractant was analyzed. Seventeen samples from 11 locations were extracted and the extractant was analyzed. Figure 1 shows the sample locations. One sample was collected from each of the three former mill ponds. Five locations were sampled on the former millsite; 3 background locations also were sampled.

Samples Sub1 and Sub2 were hand-dug through the fill material that had been placed on site during regrading after tailings removal. Samples were double-bagged in clean plastic bags and placed in 5-gallon plastic buckets for transport to the lab. All other samples were obtained by split-spoon sampling during installation of monitoring wells. Split-spoon samples were boxed and sent to the laboratory.

Lithologic logs of the soil material were prepared in the field (see SOWP for Grand Junction site; DOE 1999). Up to 12 feet of fill covered actual site soil at the millsite locations. The fill was placed there during grading operations after removal of the mill tailings and is not representative of the subpile soils. Samples were obtained from beneath this fill layer. Two samples were collected from different depths at 6 of the sample locations. Sample depths are shown on Table 1.

Sample Preparation and Chemical Extraction Methods

Samples were air-dried (no oven heat) and sieved to less than 2 millimeters (mm). Extractions were then performed on a 2-gram sample using 5% nitric acid solution. A 5% nitric acid solution will dissolve most amorphous oxides that are likely to contain adsorbed contaminants as well as any water-soluble constituents. As such, it is likely to extract more contamination than would rain water or ground water that may come in contact with the soils. As desired, 5% nitric acid will not remove contaminants locked in recalcitrant minerals such as apatites or other heavy mineral grains.

The specific steps in the extraction procedure are as follows:

- Two grams of soil (accurately weighed) was divided between two 50-mL centrifuge tubes; each tube was filled to a 50 mL volume with 5% nitric acid.

- Tubes were placed in an end-over-end rotary shaker for 4 hours.

- Tubes were removed from shaker and centrifuged for 30 seconds at 3000 rpm to remove particles less than 2 microns.. Supernatant from both tubes was decanted to a 100ml volumetric flask and filled to volume with 5% nitric acid.
- Centrifuge tubes were refilled to 50 ml volume with 5% nitric acid and placed in an end over end rotary shaker for 30 minutes.
- Tubes were removed from shaker and centrifuged for 30 seconds at 3000 rpm. Supernatant from both tubes was decanted to a 100 ml volumetric flask and filled to volume with 5% nitric acid.
- Contents of the two volumetric flasks were combined and filtered through a 0.45 micron filter. Samples were refrigerated for storage prior to submitting for laboratory analysis.
- All extracted samples were analyzed for As, Cd, Mo, Ra-226, and U.

Assumptions:

(1) The soils sampled are representative of those that could serve as a continuing contaminant source at the site.

(2) Concentrations of contaminants extracted by 5% nitric solution represent those that could reasonably be extracted through natural processes.

(3) Background soils and subpile soils behave similarly with respect to adsorption and leaching processes.

Sources of Formulas and References:

Fetter, C.W., 1993. *Contaminant Hydrogeology*, Macmillan Publishing Company, New York, 458 p.

Research and Education Association, 1978. *The Statistics Problem Solver*, Research and Education Association, New York, 1044 p.

U.S. Department of Energy, 1996. *Site Observational Work Plan for the UMTRA Project Site at Grand Junction, Colorado.* DOE/AL/62350.215, Rev. 0.

Kd Calculation set

Calculation:

Analysis of the extractant resulted in a concentration in ug/L. To get an estimate of the amount of extractable contaminant per volume of soil, the raw values were converted to mg/kg. These values are presented in Table 1 and were obtained as described in the following discussion, using the arsenic analysis for sample SUB1.

Two grams of sample were extracted with 200 mL of 5% nitric acid. Thus:

$$\frac{200mL}{2g} x \frac{9.8\mu g}{L} x \frac{L}{1{,}000mL} x \frac{mg}{1{,}000\mu g} = 0.98mg/Kg$$

The values obtained in this manner estimate the amount of leachable contaminants per volume of soil. Using these values in conjunction with the distribution coefficients (K_ds) calculated for the site, it is possible to estimate the concentration of contaminants in ground water that would be in equilibrium with the calculated soil concentrations.

The distribution coefficient is defined as:

$$K_d \text{ (units of L/kg or ml/g)} = C_{soil}/C_{water}$$

where C_{soil} = contaminant concentration in soil
C_{water}=contaminant concentration in water

Therefore, $C_{water} = C_{soil}/K_d$ (1)

Using this equation, water concentrations were calculated for the soil concentrations presented in Table 1 and are shown on that same table. K_d values used were the recommended values determined for background soils in the vicinity of the site; these are shown on the table along with the UMTRA ground-water standards for comparison.

As an example, soil concentrations for sample SUB1 were determined to be: As = 0.98, Cd = 0.4, Mo = 0.33, and U = 1.2. K_ds for As, Cd, Mo and U were calculated to be 361, 177, 0.6 and 1.0, respectively. Using equation (1) above to calculate the concentration of water in equilibrium with a soil arsenic concentration of 0.98, and a K_d of 361, the calculation is as follows:

$$C_{water,\,As} \text{ mg/L} = 0.98 \text{ mg/kg} \div 361 \text{ L/kg} = .00271 \text{ mg/L}$$

Likewise,

$$C_{water,\,Cd} \text{ mg/L} = 0.4 \text{ mg/kg} \div 177 \text{ L/kg} = .0023 \text{ mg/L}$$

$$C_{water,\,Mo} \text{ mg/L} = 0.33 \text{ mg/kg} \div 0.6 \text{ L/kg} = .055 \text{ mg/L}$$

$$C_{water,\,U} \text{ mg/L} = 1.2 \text{ mg/kg} \div 1.0 \text{ L/kg} = 1.20 \text{ mg/L}$$

Estimated water concentrations using soil concentrations and K_ds for other samples are provided in Table 1.

A statistical analysis was also performed to determine whether results obtained by extraction of the on-site samples were statistically different than background samples. F-test results indicated that the two groups differed in terms of population variance (F values exceed the Critical One-Tail F); therefore a t-test for sample means was performed that assumed unequal population variances. Statistics were performed using Excel software; results are attached as Tables 2 and 3. Because tests were being performed to determine if subpile soils had contaminant concentrations **greater** than background, one-sided t-test results apply. If the t Stat calculated for the two sets of data (on-site and background) exceeds the critical one-tail t, it indicates that the mean of the on-site contaminant concentrations exceed mean background concentrations at the 95% confidence level.

Discussion:

Statistical analysis showed that means for estimated soil concentrations for on-site samples do not vary significantly from background for cadmium and Ra-226 at the 95% confidence level. For cadium, the t-statistic is 0.3308, which is less than the critical one-tail t of 1.753. For Ra-226, the t-statistic is -0.864; the critical one-tail t is 2.131. On-site samples do contain significantly elevated levels of arsenic, molybdenum and uranium compare to background. For all of these contaminants, their computed t-statistic is greater than the computed critical one-tail t.

Qualitatively, for locations where samples were obtained from two different depths, the shallower depth samples generally have higher calculated soil concentrations. For locations 1013 and 1023, well logs note the presence of organic matter at the shallower depth, which may account for a higher degree of contaminant adsorption. In addition, shallower samples are probably in less continuous contact with ground water, which may leach contaminants. For a number of locations, the shallower samples were obtained from above the water table and the deeper samples from below.

Water concentrations calculated from estimated soil concentrations and K_d values provide a "worst-case" scenario with respect to ground-water contamination. The acid extraction process resulted in leaching of greater levels of contaminants than would be expected under natural conditions. In reality, contamination would be released more gradually over time. Additionally, as soon as leaching of soils is started, the concentration of contaminants in the soil begins to decrease resulting in a concurrent decrease in equilibrium water concentration. Therefore, the water concentrations provided in Table 1 provide a "starting point" that would slowly diminish through time. The results are also "worst case" in that only finer sized sample fractions were used in the analyses. These are the particles most likely to concentrate metals—adsorbed to clay particles, organic matter, or coatings on quartz grains. (Well logs for sampled locations are attached.) Because of this bias, calculated water concentrations should not be used in a quantitative sense as a prediction of what can actually be expected in the future. Other data such as contaminant solubilities, Eh and pH conditions, and aquifer porosity are not accounted for in this simplistic approach. However, these results are useful in a qualitative sense, in combination with actual observed trends, to refine future activities and guide decisions associated with the site.

Because of their high K_d values, and therefore relative immobility, water concentrations estimated for arsenic and cadmium were low—maximum estimated levels are all below UMTRA groundwater standards (one analysis is just at the standard level for arsenic). Molybdenum and uranium, however, being much more mobile, have much higher calculated values that do exceed UMTRA standards. [Note that some of the estimated levels are unrealistic based on solubility data; these values should only be used in a qualitative sense.] Even estimated water concentrations for background samples exceed UMTRA standards for molybdenum and uranium. The high leachability of these constituents is consistent with the high concentrations at which they are observed in background locations at the site (as reported in the SOWP, some background samples exceeded standards). However, because of their high mobilities, it is possible that uranium and molydenum can be flushed from the residual source area in a relatively short period of time.

Conclusions and Recommendations:

Data from this study indicate that of the COPCs with UMTRA standards, only molybdenum and uranium are of concern in subpile soils as representing a continuing source of groundwater contamination. Arsenic, cadmium, and Ra-226 are not present in sufficient concentrations to result in contamination above permissible levels. This conclusion is supported by the fact that since surface remediation of the site was completed, levels of arsenic, cadmium, and Ra-226 in groundwater from on-site wells have dropped back down below UMTRA standards (based on the most recent round of sampling; see Table 4). Molybdenum and uranium, however, remain at levels above standards in the vicinity of the site. Uranium is not only detected at levels within the historical range for the groundwater plume, but most recent sampling indicates levels exceeding historical values. Molybdenum is within the range of historical plume values in the vicinity of the site.

It is recommended that future work regarding the Grand Junction site be focused around uranium and molybdenum contamination. In terms of modeling and development of a compliance strategy, these contaminants will pose the greatest concern and be the limiting factors in reaching a decision for the site.

TABLE 1. Results of Subpile Soil Testing

GRAND JUNCTION SITE - 5% NITRIC ACID EXTRACTION

			Calculated Soil Concentrations					*Equilibrium Water Concentrations*			
Sample #	Area	Depth (ft)	As mg/kg	Cd mg/kg	Mo mg/kg	Ra-226 pCi/g	U mg/kg	Cw - As mg/L Kd=361	Cw - Cd mg/L Kd=177	Cw - Mo mg/L Kd=0.6	Cw - U mg/L Kd=1.0
SUB 1	pile/pond	.5'+	0.98	0.4	0.33	0.602	1.2	0.00271	0.0023	0.55	1.20
SUB 2	pile/pond	1'+	1.8	0.22	0.5	0.614	1.4	0.00499	0.0012	0.83	1.40
1012-1	pile	12-13.25'	0.74	0.4	1.4	0.473	1.5	0.00205	0.0023	2.33	1.50
1013-1	pile	9-11'	3.3	0.28	7.5	0.423	23.9	0.00914	0.0016	12.5	23.90
1013-2	pile	11-13'	3.7	0.23	3.5	0.289	10.4	0.01025	0.0013	5.833	10.40
1014-1	pile	13-14.25'	3.2	0.97	1.3	0.492	45.2	0.00886	0.0055	2.167	45.20
1014-2	pile	17-19'	1.4	0.73	0.8	0.309	7.7	0.00388	0.0041	1.333	7.70
1015-1	pile	10-12'	1.1	0.36	0.79	0.443	0.95	0.00305	0.0020	1.317	0.95
1015-2	pile	14-15.4'	0.82	0.37	1	0.249	0.56	0.00227	0.0021	1.667	0.56
1016-1	pile	9-11'	1.5	0.18	0.77	0.229	1.7	0.00416	0.0010	1.283	1.70
1016-2	pile	13-14.3'	1.2	0.23	0.34	0.319	0.6	0.00332	0.0013	0.567	0.60
1017-1	pond	9-11'	1	0.29	0.68	0.472	0.99	0.00277	0.0016	1.133	0.99
1017-2	pond	11-13'	1.6	0.18	0.53	0.38	0.59	0.00443	0.0010	0.883	0.59
1020-1	bkgd	5-7'	1.2	0.4	0.3	0.646	0.78	0.00332	0.0023	0.5	0.78
1021-1	bkgd	5-7'	0.9	0.32	0.33	0.472	1.1	0.00249	0.0018	0.55	1.10
1023-1	bkgd	5-7'	1	0.42	0.14	0.611	0.74	0.00277	0.0024	0.233	0.74
1023-2	bkgd	10-12'	0.92	0.25	0.21	0.24	0.44	0.00255	0.0014	0.35	0.44
UMTRA STANDARDS	(mg/L)		0.05	0.01	0.1	5.0	0.044				

TABLE 2

F-Test Two-Sample for Variances		Arsenic - onsite v. background
	On Site	*Background*
Mean	1.718461538	1.005
Variance	1.022497436	0.018766667
Observations	13	4
df	12	3
F	54.48476568	
P(F<=f) one-tail	0.003571722	
F Critical one-tail	8.744677871	

F-Test Two-Sample for Variances		Cadmium - On site v. bkgd
	On Site	*Background*
Mean	0.372307692	0.3475
Variance	0.053319231	0.006091667
Observations	13	4
df	12	3
F	8.752814901	
P(F<=f) one-tail	0.049935712	
F Critical one-tail	8.744677871	

F-Test Two-Sample for Variances		Moly - on site v. background
	On Site	*Background*
Mean	1.495384615	0.245
Variance	3.92954359	0.0075
Observations	13	4
df	12	3
F	523.9391453	
P(F<=f) one-tail	0.000122003	
F Critical one-tail	8.744677871	

TABLE 2 (CONT.)		
F-Test Two-Sample for Variances		Ra226- On site v. background
	On Site	*Background*
Mean	0.407230769	0.49225
Variance	0.015573359	0.033926917
Observations	13	4
df	12	3
F	0.459026652	
P(F<=f) one-tail	0.715962185	
F Critical one-tail	0.114355636	
F-Test Two-Sample for Variances		Uranium - onsite v. background
	On Site	*Background*
Mean	7.437692308	0.765
Variance	172.8328192	0.0729
Observations	13	4
df	12	3
F	2370.820566	
P(F<=f) one-tail	1.26961E-05	
F Critical one-tail	8.744677871	

TABLE 3

t-Test: Two-Sample Assuming Unequal Variances		Arsenic - On site v. background
	On Site	*Background*
Mean	1.718461538	1.005
Variance	1.022497436	0.018766667
Observations	13	4
Hypothesized Mean Difference	0	
df	13	
t Stat	2.471325602	
P(T<=t) one-tail	0.014032302	
t Critical one-tail	1.770931704	
P(T<=t) two-tail	0.028064604	
t Critical two-tail	2.16036824	

t-Test: Two-Sample Assuming Unequal Variances		Cadmium - on site v. background
	On Site	*Background*
Mean	0.372307692	0.3475
Variance	0.053319231	0.006091667
Observations	13	4
Hypothesized Mean Difference	0	
df	15	
t Stat	0.330786992	
P(T<=t) one-tail	0.372690446	
t Critical one-tail	1.753051038	
P(T<=t) two-tail	0.745380892	
t Critical two-tail	2.131450856	

t-Test: Two-Sample Assuming Unequal Variances		Moly - on site v. background
	On Site	*Background*
Mean	1.495384615	0.245
Variance	3.92954359	0.0075
Observations	13	4
Hypothesized Mean Difference	0	
df	12	
t Stat	2.267260575	
P(T<=t) one-tail	0.021324202	
t Critical one-tail	1.782286745	
P(T<=t) two-tail	0.042648405	
t Critical two-tail	2.178812792	

TABLE 3 (CONT.)		
t-Test: Two-Sample Assuming Unequal Variances		Ra226 - onsite v. background
	On site	*Background*
Mean	0.407230769	0.49225
Variance	0.015573359	0.033926917
Observations	13	4
Hypothesized Mean Difference	0	
df	4	
t Stat	-0.864145105	
P(T<=t) one-tail	0.218124718	
t Critical one-tail	2.131846486	
P(T<=t) two-tail	0.436249436	
t Critical two-tail	2.776450856	
t-Test: Two-Sample Assuming Unequal Variances		Uranium - onsite v. background
	On Site	*Backgrou*
Mean	7.437692308	0.765
Variance	172.8328192	0.0729
Observations	13	4
Hypothesized Mean Difference	0	
df	12	
t Stat	1.828783098	
P(T<=t) one-tail	0.046189878	
t Critical one-tail	1.782286745	
P(T<=t) two-tail	0.092379756	
t Critical two-tail	2.178812792	

GROUND WATER QUALITY DATA BY PARAMETER (USEE200) FOR SITE GRJ01, GRAND JUNCTION
REPORT DATE: 11/19/98 6:59:21

PARAMETER	UNITS	LOCATION ID	SAMPLE: DATE	SAMPLE: ID	ZONE COMPL	FLOW REL.	RESULT	QUALIFIERS: LAB	QUALIFIERS: DATA	QUALIFIERS: QA	DETECTION LIMIT	UN-CERTAINTY
Arsenic	mg/L	1012	01/22/98	0001	AL		0.0020	B		#	-	-
	mg/L	1012	06/25/98	0001	AL		0.0024	B		#	-	-
	mg/L	1013	01/26/98	0001	AL		0.0048	B		#	-	-
	mg/L	1013	06/24/98	0001	AL		0.0071			#	-	-
	mg/L	1014	01/23/98	0001	AL		0.0191			#	-	-
	mg/L	1014	06/24/98	0001	AL		0.0170			#	-	-
	mg/L	1014	06/24/98	0002	AL		0.0144			#	-	-
	mg/L	1015	01/23/98	0001	AL		0.0023	B		#	-	-
	mg/L	1015	06/22/98	0001	AL		0.0013	B		#	-	-
	mg/L	1016	01/26/98	0001	AL		0.0055			#	-	-
	mg/L	1016	06/29/98	0001	AL		0.0063			#	-	-
	mg/L	1017	01/23/98	0001	AL		0.0010	U		#	0.001	-
	mg/L	1017	06/22/98	0001	AL		0.0010	U		#	0.001	-
	mg/L	1020	01/26/98	0001	AL		0.0010	U		#	0.001	-
	mg/L	1020	06/22/98	0001	AL		0.0010	U		#	0.001	-
	mg/L	1021	01/26/98	0001	AL		0.0010	U	L	#	0.001	-
	mg/L	1021	06/23/98	0001	AL		0.0010	U	L	#	0.001	-
	mg/L	1023	01/22/98	0001	AL		0.0010	U		#	0.001	-
	mg/L	1023	06/18/98	0001	AL		0.0010	U		#	0.001	-
Cadmium	mg/L	1012	01/22/98	0001	AL		0.0010	U		#	0.001	-
	mg/L	1012	06/25/98	0001	AL		0.0010	U		#	0.001	-
	mg/L	1013	01/26/98	0001	AL		0.0010	U		#	0.001	-
	mg/L	1013	06/24/98	0001	AL		0.0010	U		#	0.001	-
	mg/L	1014	01/23/98	0001	AL		0.0010	U		#	0.001	-
	mg/L	1014	06/24/98	0001	AL		0.0012			#	-	-
	mg/L	1014	06/24/98	0002	AL		0.0014			#	-	-
	mg/L	1015	01/23/98	0001	AL		0.0010	U		#	0.001	-

GROUND WATER QUALITY DATA BY PARAMETER (USEE200) FOR SITE GRJ01, GRAND JUNCTION
REPORT DATE: 11/19/98 6:59:22

		LOCATION	SAMPLE:		ZONE	FLOW		QUALIFIERS:			DETECTION	UN-
PARAMETER	UNITS	ID	DATE	ID	COMPL	REL.	RESULT	LAB	DATA	QA	LIMIT	CERTAINTY
Cadmium	mg/L	1015	06/22/98	0001	AL		0.0010	U		#	0.001	-
	mg/L	1016	01/26/98	0001	AL		0.0010	U		#	0.001	-
	mg/L	1016	06/29/98	0001	AL		0.0010	U		#	0.001	-
	mg/L	1017	01/23/98	0001	AL		0.0010	U		#	0.001	-
	mg/L	1017	06/22/98	0001	AL		0.0010	U		#	0.001	-
	mg/L	1020	01/26/98	0001	AL		0.0010	U		#	0.001	-
	mg/L	1020	06/22/98	0001	AL		0.0010	U		#	0.001	-
	mg/L	1021	01/26/98	0001	AL		0.0010	U	L	#	0.001	-
	mg/L	1021	06/23/98	0001	AL		0.0010	U	L	#	0.001	-
	mg/L	1023	01/22/98	0001	AL		0.0010	U		#	0.001	-
	mg/L	1023	06/18/98	0001	AL		0.0010	U		#	0.001	-
Molybdenum	mg/L	1012	01/22/98	0001	AL		0.192			#	-	-
	mg/L	1012	06/25/98	0001	AL		0.188			#	-	-
	mg/L	1013	01/26/98	0001	AL		0.108			#	-	-
	mg/L	1013	06/24/98	0001	AL		0.0977			#	-	-
	mg/L	1014	01/23/98	0001	AL		0.299			#	-	-
	mg/L	1014	06/24/98	0001	AL		0.296			#	-	-
	mg/L	1014	06/24/98	0002	AL		0.308			#	-	-
	mg/L	1015	01/23/98	0001	AL		0.0517			#	-	-
	mg/L	1015	06/22/98	0001	AL		0.0474			#	-	-
	mg/L	1016	01/26/98	0001	AL		0.0421			#	-	-
	mg/L	1016	06/29/98	0001	AL		0.0405			#	-	-
	mg/L	1017	01/23/98	0001	AL		0.0893			#	-	-
	mg/L	1017	06/22/98	0001	AL		0.0894			#	-	-
	mg/L	1020	01/26/98	0001	AL		0.0279			#	-	-
	mg/L	1020	06/22/98	0001	AL		0.0286			#	-	-
	mg/L	1021	01/26/98	0001	AL		0.0311		L	#	-	-

GROUND WATER QUALITY DATA BY PARAMETER (USEE200) FOR SITE GRJ01, GRAND JUNCTION
REPORT DATE: 11/19/98 6:59:22

PARAMETER	UNITS	LOCATION ID	SAMPLE: DATE	SAMPLE: ID	ZONE COMPL	FLOW REL.	RESULT	QUALIFIERS: LAB	QUALIFIERS: DATA	QUALIFIERS: QA	DETECTION LIMIT	UN-CERTAINTY
Molybdenum	mg/L	1021	06/23/98	0001	AL		0.0217		L	#	-	-
	mg/L	1023	01/22/98	0001	AL		0.124			#	-	-
	mg/L	1023	06/18/98	0001	AL		0.120			#	-	-
Radium-226	pCi/L	1012	01/22/98	0001	AL		0.31			#	0.01	± 0.08
	pCi/L	1012	06/25/98	0001	AL		0.13	U		#	0.13	± 0.07
	pCi/L	1013	01/26/98	0001	AL		0.16			#	0.01	± 0.07
	pCi/L	1013	06/24/98	0001	AL		0.13	U		#	0.13	± 0.08
	pCi/L	1014	01/23/98	0001	AL		0.18			#	0.02	± 0.08
	pCi/L	1014	06/24/98	0001	AL		0.12	U		#	0.12	± 0.07
	pCi/L	1014	06/24/98	0002	AL		0.12	U		#	0.12	± 0.07
	pCi/L	1015	01/23/98	0001	AL		0.15			#	0.01	± 0.06
	pCi/L	1015	06/22/98	0001	AL		0.12	U		#	0.12	± 0.06
	pCi/L	1016	01/26/98	0001	AL		0.09			#	0.01	± 0.05
	pCi/L	1016	06/29/98	0001	AL		0.12	U		#	0.12	± 0.06
	pCi/L	1017	01/23/98	0001	AL		0.15			#	0.02	± 0.06
	pCi/L	1017	06/22/98	0001	AL		0.14	U		#	0.14	± 0.07
	pCi/L	1020	01/26/98	0001	AL		0.10			#	0.01	± 0.05
	pCi/L	1020	06/22/98	0001	AL		0.13	U		#	0.13	± 0.07
	pCi/L	1021	01/26/98	0001	AL		0.34		L	#	0.02	± 0.10
	pCi/L	1021	06/23/98	0001	AL		0.13	U	L	#	0.13	± 0.07
	pCi/L	1023	01/22/98	0001	AL		0.08			#	0.01	± 0.04
	pCi/L	1023	06/18/98	0001	AL		0.14	U		#	0.14	± 0.07
Uranium	mg/L	1012	01/22/98	0001	AL		0.220			#	-	-
	mg/L	1012	06/25/98	0001	AL		0.224			#	-	-
	mg/L	1013	01/26/98	0001	AL		0.604			#	-	-
	mg/L	1013	06/24/98	0001	AL		0.582			#	-	-
	mg/L	1014	01/23/98	0001	AL		2.500			#	-	-

GROUND WATER QUALITY DATA BY PARAMETER (USEE200) FOR SITE GRJ01, GRAND JUNCTION
REPORT DATE: 11/19/98 6:59:22

PARAMETER	UNITS	LOCATION ID	SAMPLE: DATE	SAMPLE: ID	ZONE COMPL	FLOW REL.	RESULT	QUALIFIERS: LAB	QUALIFIERS: DATA	QUALIFIERS: QA	DETECTION LIMIT	UN-CERTAINTY
Uranium	mg/L	1014	06/24/98	0001	AL		2.290			#	-	-
	mg/L	1014	06/24/98	0002	AL		2.310			#	-	-
	mg/L	1015	01/23/98	0001	AL		0.0641			#	-	-
	mg/L	1015	06/22/98	0001	AL		0.0700			#	-	-
	mg/L	1016	01/26/98	0001	AL		0.113			#	-	-
	mg/L	1016	06/29/98	0001	AL		0.116			#	-	-
	mg/L	1017	01/23/98	0001	AL		0.0241			#	-	-
	mg/L	1017	06/22/98	0001	AL		0.0255			#	-	-
	mg/L	1020	01/26/98	0001	AL		0.0566			#	-	-
	mg/L	1020	06/22/98	0001	AL		0.0573			#	-	-
	mg/L	1021	01/26/98	0001	AL		0.0305		L	#	-	-
	mg/L	1021	06/23/98	0001	AL		0.0228		L	#	-	-
	mg/L	1023	01/22/98	0001	AL		0.0468			#	-	-
	mg/L	1023	06/18/98	0001	AL		0.0452			#	-	-

PARAMETER	UNITS	LOCATION ID	SAMPLE: DATE	ID	ZONE COMPL	FLOW REL.	RESULT	QUALIFIERS: LAB	DATA	QA	DETECTION LIMIT	UN-CERTAINTY

RECORDS: SELECTED FROM USEE200 WHERE site_code='GRJ01' AND location_code in('1012','1013','1014','1015','1016','1017','1020','1021','1023') AND quality_assurance = TRUE AND (NOT (data_validation_qualifiers LIKE "*R*" OR data_validation_qualifiers LIKE "*X*") OR IsNull(data_validation_qualifiers)) AND cas in('07440-38-2 ','07440-43-9 ','07439-98-7 ','RA-226 ','07440-61-1 ') AND DATE_SAMPLED between #1/1/98# and #12/30/98#

SAMPLE ID CODES: 000X = Filtered sample (0.45 µm). N00X = Unfiltered sample. X = replicate number.

LAB QUALIFIERS:

*	Replicate analysis not within control limits.
+	Correlation coefficient for MSA < 0.995.
A	TIC is a suspected aldol-condensation product.
B	Inorganic: Result is between the IDL and CRDL. Organic: Analyte also found in method blank.
E	Inorganic: Estimate value because of interference, see case narrative. Organic: Analyte exceeded calibration range of the GC-MS.
Z	Laboratory defined (USEPA CLP organic) qualifier, see case narrative.
H	Holding time expired, value suspect.
I	Increased detection limit due to required dilution.
C	Pesticide result confirmed by GC-MS.
M	GFAA duplicate injection precision not met.
N	Inorganic or radiochemical: Spike sample recovery not within control limits. Organic: Tentatively identified compund (TIC).
S	Result determined by method of standard addition (MSA).
U	Analytical result below detection limit.
W	Post-digestion spike outside control limits while sample absorbance < 50% of analytical spike absorbance.
D	Analyte determined in diluted sample.
P	> 25% difference in detected pesticide or Arochlor concentrations between 2 columns.
X	Laboratory defined (USEPA CLP organic) qualifier, see case narrative.
Y	Laboratory defined (USEPA CLP organic) qualifier, see case narrative.
>	Result above upper detection limit.

DATA QUALIFIERS:

J	Estimated value.	F	Low flow sampling method used.	G	Possible grout contamination, pH > 9.
L	Less than 3 bore volumes purged prior to sampling.	R	Unusable result.	X	Location is undefined.
U	Parameter analyzed for but was not detected.				

QA QUALIFIER: # = validated according to Quality Assurance guidelines.

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Appendix H

Calculation Set for Ambient Ground Water Contamination

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Technical Task Cover Sheet

Discipline Geochemistry **Number of Sheets** 10

Project:

UMTRA Ground Water

Site:

Grand Junction (Climax)

Subject:

Ambient Ground Water Contamination

Sources of Data:

Ground Water and Surface Water chemical analyses

40 CFR 192, 40 CFR 141, 40 CFR 143

Baseline Risk Assessment of Ground Water Contamination at the Uranium Mill Tailings Site at Grand Junction Colorado, DOE/AL/62350-104, Rev. 2

Detailed Study of Selenium and Other Constituents in Water, Bottom Sediment, Soil, Alfalfa, and Biota Associated with the Irrigation Drainage in the Uncompahgre Project Area and in the Grand Valley, West-Central Colorado, 1991-93; U.S.G.S. Water-Resources Investigations Report 96-4138.

Task Order No. MAC 99-05 **File Index No.** GWGRJ 13.1

Proj. No. 331413006 **Calc. No.** U0046700 **Supersedes Calc. No.** None

Calculated by	Date	Checked by	Date	Approved by	Date
Laura Cummins	12/14/98	R. Dayvault	2/3/59	Roberta C	2/9/99

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mactec-ers

U.S. Department of Energy Grand Junction Projects Office

Problem Statement:

Supplemental standards may be applied to an UMTRA ground water site if it can be demonstrated that the background concentrations of ground water contaminated by past uranium processing activities meets the definition of "limited use" ground water. According to the regulations (40 CFR Part 192.11(e)(2)), one of the definitions of limited use ground water is "groundwater that is not a current or potential source of drinking water because... (2) widespread, ambient contamination not due to activities involving residual radioactive materials from a designated processing site exists that cannot be cleaned up using treatment methods reasonably employed in public water systems..." Past studies have noted the poor quality of alluvial ground water that exists in the Grand Junction area (DOE/AL/62350-104 Rev.2; U.S.G.S. W.R.I. 96-4138). Calculations were performed to better quantify the nature of background alluvial ground water quality in the Grand Valley to help determine if it meets the limited use definition based on widespread ambient contamination.

Method of Solution:

Data from monitoring wells upgradient from the former mill processing site were evaluated to determine which wells yielded results that are representative of background conditions. Statistical analyses were performed on the selected background wells for several contaminants measured during 1998 sampling events to determine if the background population contained contaminant concentrations that could be characterized as widespread ambient contamination. UMTRA ground water standards (40 CFR 192) and Primary and Secondary Drinking Water standards (40 CFR 141 & 143) were used as benchmarks against which to make this determination.

Assumptions:

(1) Samples from alluvial wells used in the analysis are representative of background alluvial water quality in the Grand Valley, outside the influence of uranium processing activities.

Sources of Formulas and References:

All calculations were performed using Excel spreadsheets and statistical programs.

Calculation:

Wells representative of background were selected for analysis. Locations were selected that were upgradient of the Grand Junction site and outside the potential influence of UMTRA vicinity properties. Initial candidates for background wells included: 588, 713, 715, 744, 745, 746, 1020, 1021, 1023, 1024, 1025, and 1121 (see Figure 1). Well 1024 was subsequently eliminated because of its location immediately downgradient from discharge ponds at the Clifton Water Treatment Plant. Discharge from the ponds would have a dilutional effect on natural background water concentrations and therefore not be considered representative of the alluvial aquifer. Wells 588 and 744 were installed adjacent to a surface water pond and a surface drainage feature, respectively. They are also located very close to the Colorado River. Analyses from these wells were examined to determine if water actually sampled to alluvial aquifer or if it more closely resembled surface water. Major ion chemistry for those wells was compared with data from two wells farther upgradient and away from the river--wells 745 and 746--along with surface water samples from location 424, collected from the river near well 588. Scattergrams for selected pairs of ions are shown in figures 2a through 3c for both the January and June 1998 sampling rounds; these plots show a fairly linear relationship for the data. River samples plot in the corner of the diagrams near the origin, while upgradient wells 745 and 746 plot farthest from that point. Wells 588 and 744 plot in between and closer to the river sample. This suggests a mixing relationship between ground and surface water, with surface water being dominant. Therefore, wells 588 and 744 were eliminated from the background data set as unrepresentative of the alluvial aquifer.

At the request of the Colorado Department of Public Health and Environment, well 746 was also eliminated from the background data set because of its proximity to a former vicinity property. The remainder of the background wells were retained and descriptive statistics were performed on the data for selected contaminants. Results for uranium expressed as total in mg/L and uranium 234&238 in pCi/L are presented in Tables 1 and 2, respectively. Results for selenium are located in Table 3. Background wells were also examined to determine concentrations of chloride, iron, manganese, sulfate, and total dissolved solids (TDS). While no UMTRA ground water standards exist for these contaminants, secondary maximum contaminant levels (SMCLs) have been developed for them largely based on considerations of taste or odor. Data for all these contaminants were obtained from the SEE UMTRA data base.

Discussion:

The statistics in Tables 1 and 2 indicate that data for uranium fit both a normal and a lognormal distribution. As noted in Table 1, with concentrations based on mass, the mean of this data set is 0.0469 mg/L, above the UMTRA MCL of 0.044 mg/L. Approximately 60% of the background analyses exceeded the UMTRA standard. Table 2, with analyses based on activities of U-234 and U-238, indicates that all but one sample exceed the 30 pCi/L standard, with a mean activity for background of 41.6 pCi/L.

For selenium (Table 3), half of the samples were at the detection limit of 0.001 mg/L; samples in which selenium was detected were all above the UMTRA MCL of .01 mg/L. Therefore the scattergrams in Table 3 show a bimodal distribution that is neither normal or lognormal. The mean of the background samples is 0.0359, more than 3 times the UMTRA selenium standard.

Spatially, the wells exceeding standards come from across the entire area from which background samples were collected. Therefore, the contamination does not appear to be a localized phenomenon.

For contaminants with secondary drinking water standards, only the means of the background wells for 1998 were determined (raw data in the SEE UMTRA database). Results are as follows in mg/L:

Table 4.

Contaminant	Mean	SMCL
Chloride	437	250
Iron	0.552	0.3
Manganese	1.4	0.05
Sulfate	2566	250
TDS	5238	500

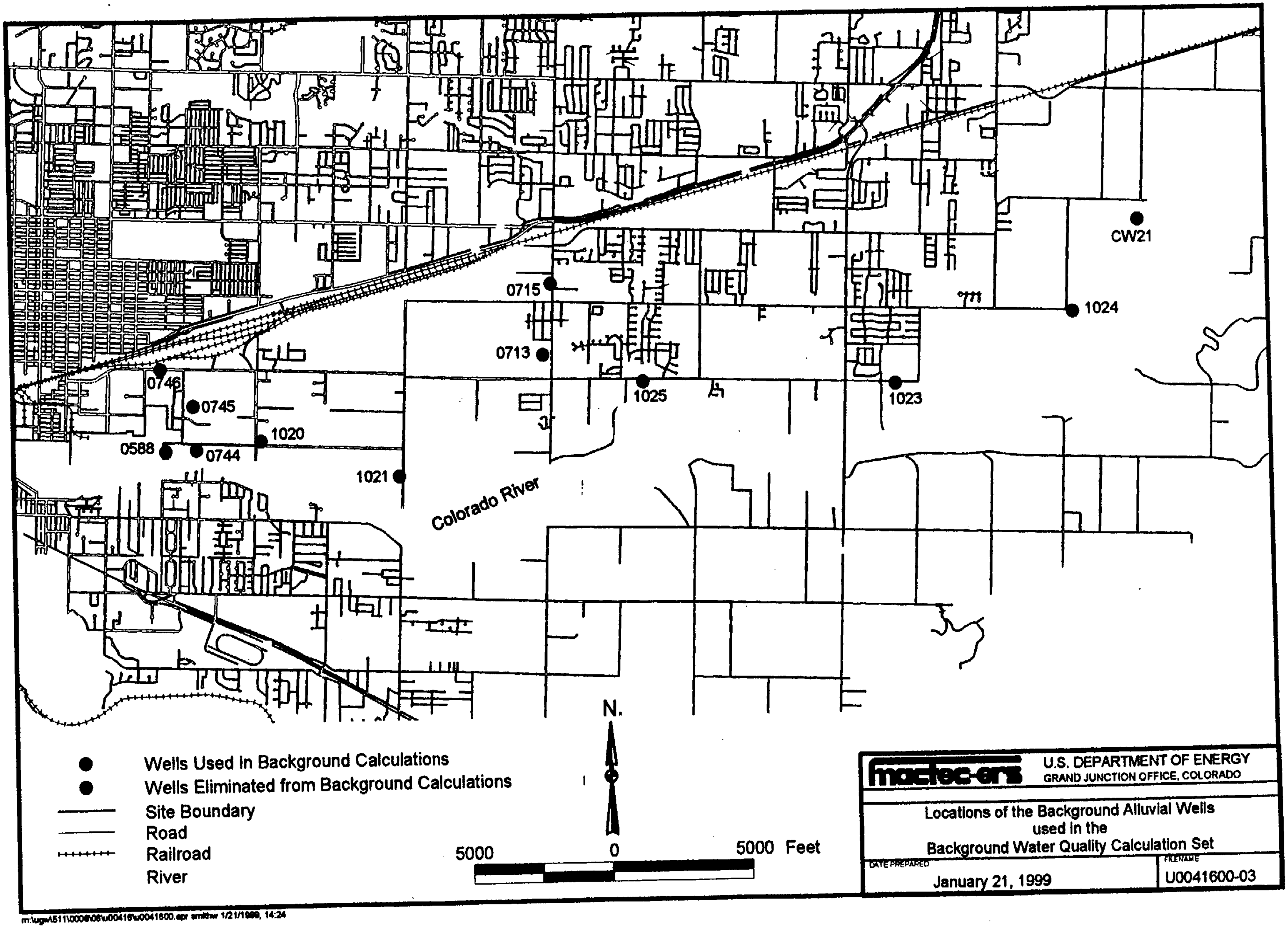
The means of all of these contaminants exceed secondary drinking water standards, particularly manganese, sulfate, and TDS.

Conclusions and Recommendations:

On the average, background alluvial water quality in the Grand Valley exceeds UMTRA ground water protection standards for uranium and selenium. SMCLs are exceeded for chloride, iron, manganese, sulfate, and TDS. Non-site-related contamination is widespread across the area. These data support the conclusion that the background alluvial water quality can be considered to be "limited use groundwater" as defined by the UMTRA regulations. Although some background samples had contaminant concentrations below standards, particularly for selenium, the average (mean) concentrations probably more realistically approximate the concentrations that would be obtained over time from a well installed for domestic purposes into the alluvial aquifer. However, while widespread ambient contamination exists in the Grand Valley, an evaluation must be performed to assess whether the alluvial ground water "cannot be cleaned up using treatment methods reasonably employed in public water systems" before a determination of the applicability of supplemental standards can be made for the Grand Junction UMTRA Ground Water site (calculations on costs of water treatment are currently in progress).

Computer Source:

All calculations were done using Excel spreadsheets and statistical programs.



mactec-ers

U.S. DEPARTMENT OF ENERGY
GRAND JUNCTION OFFICE, COLORADO

Locations of the Background Alluvial Wells
used in the
Background Water Quality Calculation Set

DATE PREPARED	FILENAME
January 21, 1999	U0041600-03

m:\ugw\511\0006\06\u00416\u0041600.apr smithw 1/21/1999, 14:24

Major Ion Mixing Diagram - January 1998

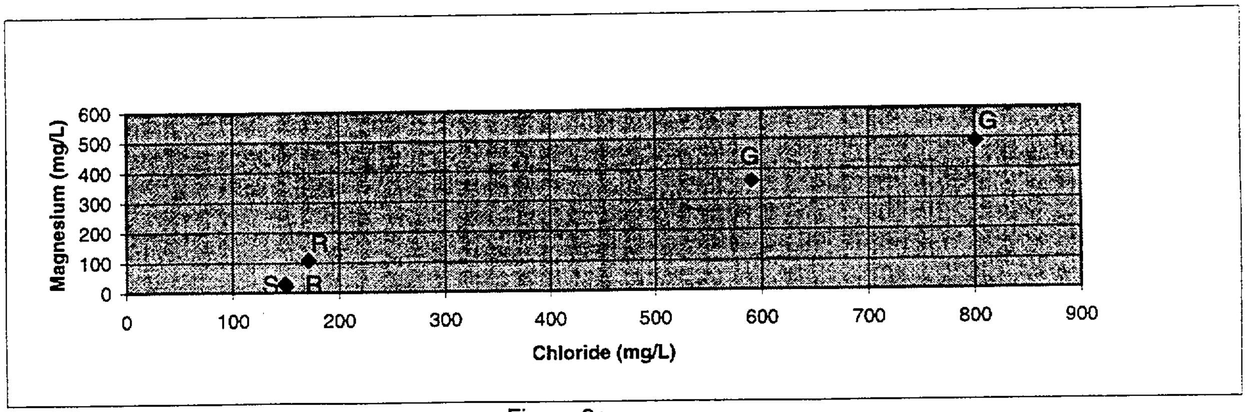


Figure 2a

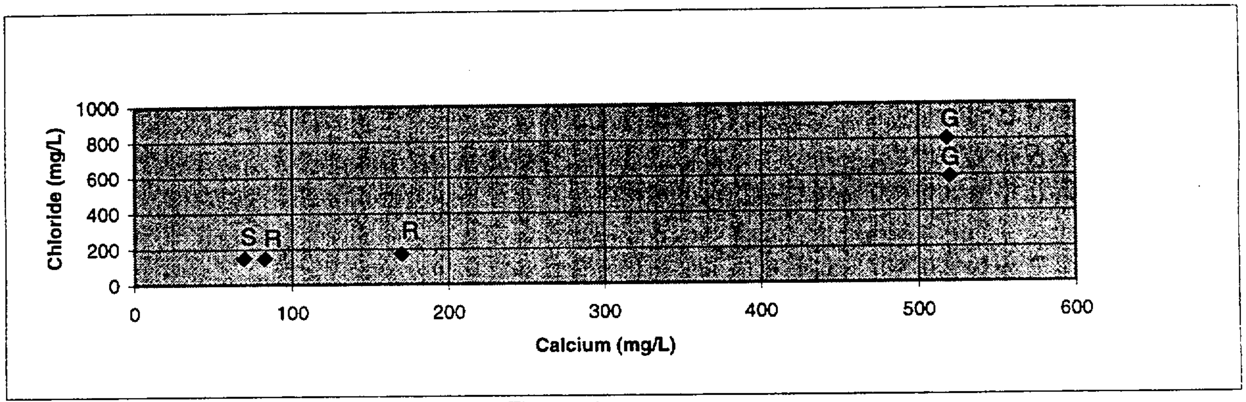


Figure 2b

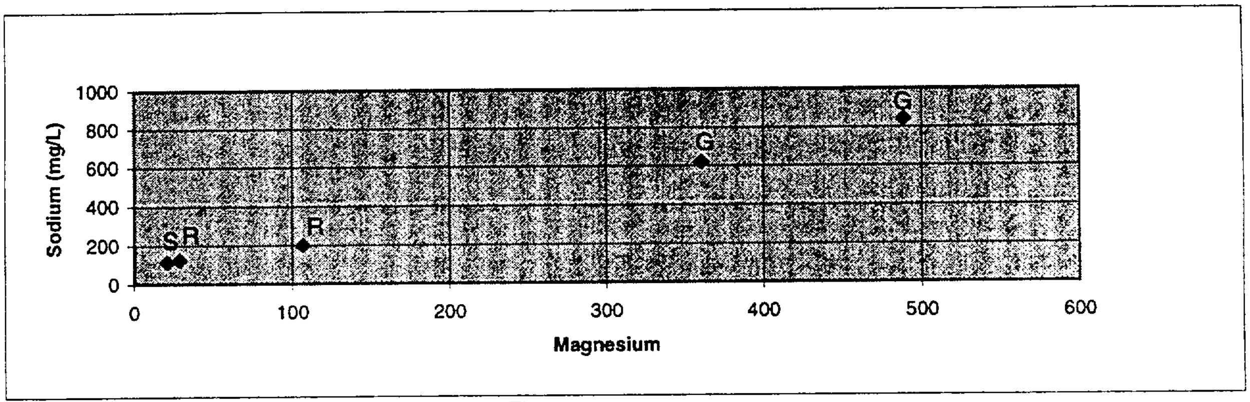


Figure 2c

S = Surface Water Location 424
R = Wells 588 and 744 Located New Colorado River
G = Background Ground Water Wells 745 and 746

Major Ion Mixing Diagram - July 1998

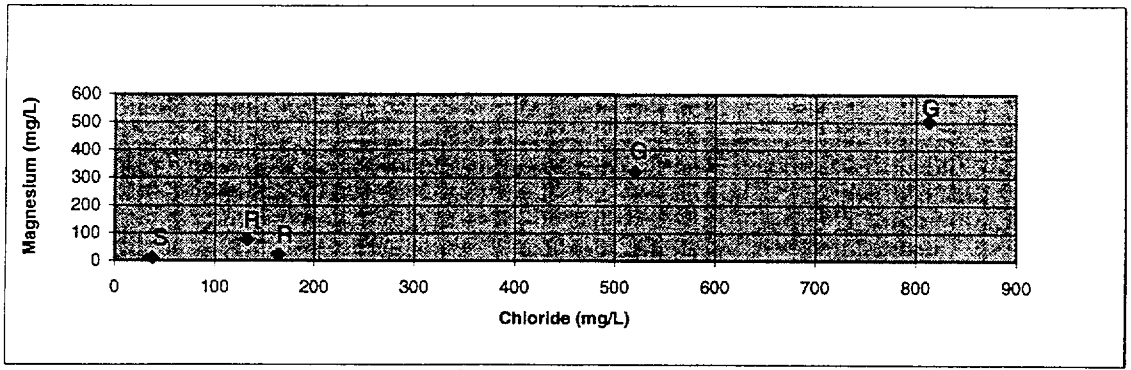


Figure 3a

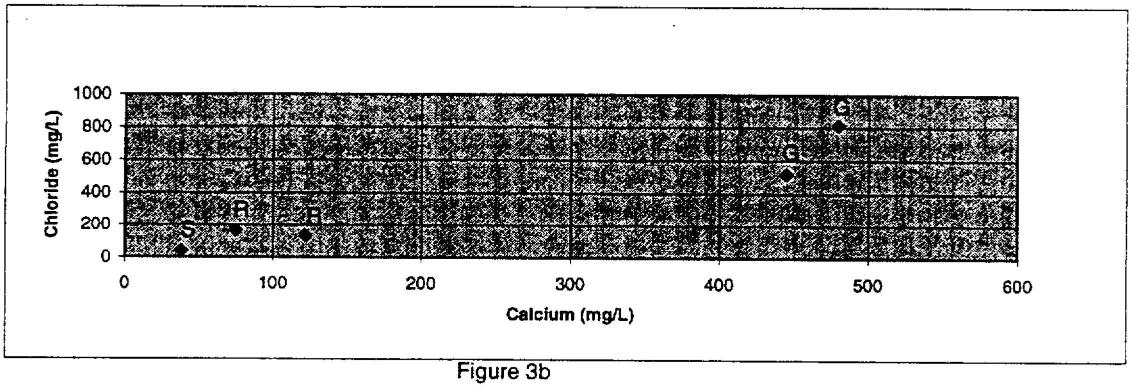


Figure 3b

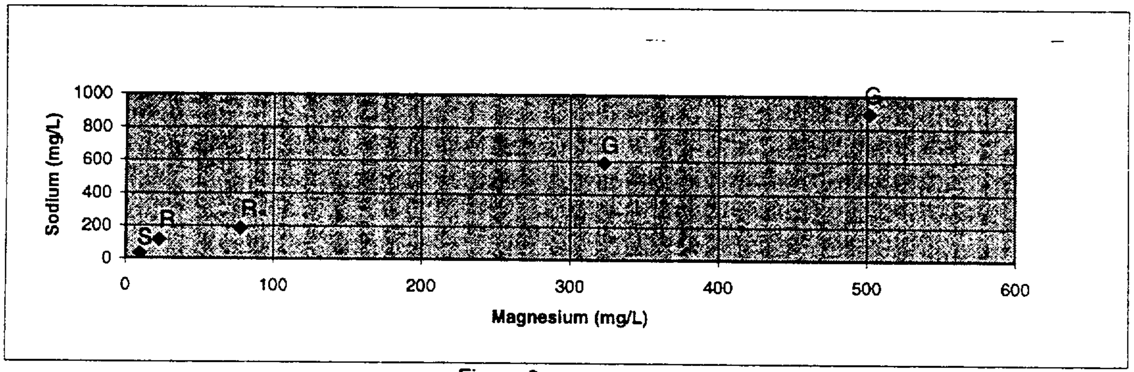


Figure 3c

S = Surface Water Location 424
R = Wells 588 and 744 Located New Colorado River
G = Background Ground Water Wells 745 and 746

TABLE 1.

DATA EVALUATION STATISTICS
Grand Junction Background Alluvial Ground Water

ata Description

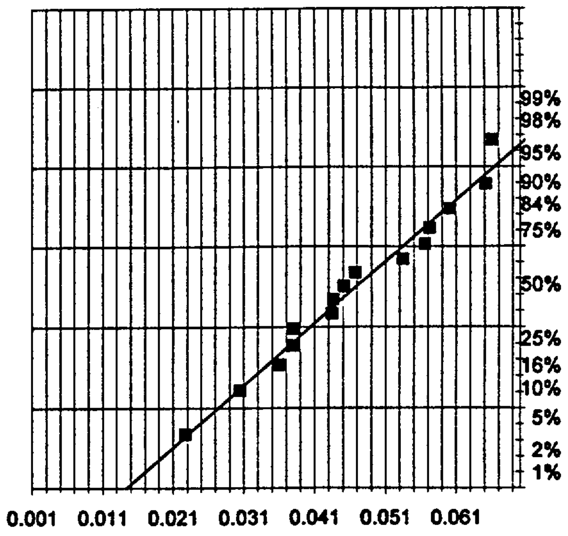
Uranium

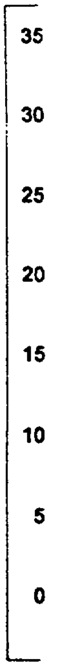
'ion Level 0.044

Sample Data
UNITS - mg/L
0.0652
0.0662
0.0602
0.0535
0.0381
0.038
0.0566
0.0573
0.0305
0.0228
0.0468
0.0452
0.0435
0.0437
0.036

	Descriptive Statistics	
	Number of Samples	15.000
	Mean	0.0469
	Median	0.0452
	Standard Deviation	0.0128
	CV	0.2721
	Range	0.0434
	Minimum	0.0228
	Maximum	0.0662
	GM	0.0451
	GSD	1.3459
	Mean of LN(Data)	-3.0981
	SD of LN(Data)	0.2970
	Percent > Limit	53.3333
	Normal Statistics	
n>30	Upper (95% CI mean) - Z	0.0534
n>30	Lower (95% CI mean) - Z	0.0404
	Upper (95% 1-tail CL mean) - Z	0.0523
	Upper (95%ile data) - Z	0.0679
n<30	Upper (95% CI mean) - Norm t	0.0540
n<30	Lower (95% CI mean) - Norm t	0.0398
	Upper (95% 1-tail CL mean) - Normal	0.0527
	UTL (min 95%, 95%) - K	0.0797
	UTL (avg 95%, 95%) - K	0.0701
	Percent > Limit	59.0086
	W Test (Data)	0.9690
	Normal (a=0.05)?	Yes
	Lognormal Statistics	
n>30	Upper (95% CI mean) - Z	0.0548
n>30	Lower (95% CI mean) - Z	0.0406
	Upper (95% 1-tail CL mean) - Z	0.0535
	Upper (95%ile data) - Z	0.0736
n<30	Upper (95% CI mean) - LogNorm t	0.0556
n<30	Lower (95% CI mean) - LogNorm t	0.0400
	Upper (95% 1-tail CL mean) - LogNorm	0.0540
	UTL (min 95%, 95%) - K	0.0967
	UTL (avg 95%, 95%) - K	0.0775
	Percent > Limit	53.4150
	W Test (Data)	0.9448
	Normal (a=0.05)?	Yes

Probability Plot and Least Squares Best Fit Line





Log-Probability Plot and Least Squares Best Fit Line

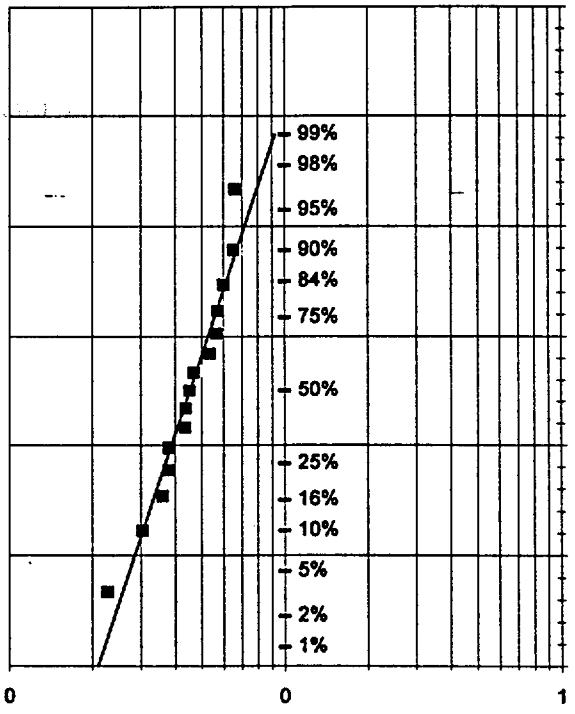


TABLE 2.

DATA EVALUATION STATISTICS
Grand Junction Background Alluvial Ground Water

ata Description

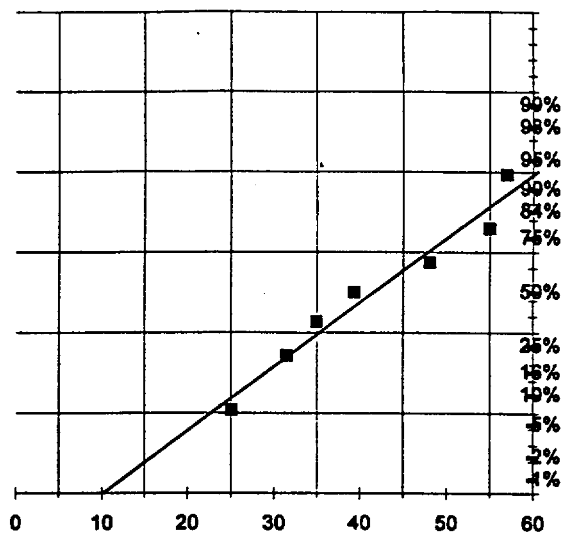
U234&
U238

Action Level	30

Sample Data
UNITS - pCi/L
57
55
31.5
48.1
25.1
39.4
35

	Descriptive Statistics	
	Number of Samples	7.000
	Mean	41.5857
	Median	39.4000
	Standard Deviation	12.1218
	CV	0.2915
	Range	31.9000
	Minimum	25.1000
	Maximum	57.0000
	GM	40.0199
	GSD	1.3548
	Mean of LN(Data)	3.6894
	SD of LN(Data)	0.3036
	Percent > Limit	85.7143
	Normal Statistics	
n>30	Upper (95% CI mean) - Z	50.5657
n>30	Lower (95% CI mean) - Z	32.6058
	Upper (95% 1-tail CL mean) - Z	49.1225
	Upper (95%ile data) - Z	61.5261
n<30	Upper (95% CI mean) - Norm t	52.7965
n<30	Lower (95% CI mean) - Norm t	30.3749
	Upper (95% 1-tail CL mean) - Normal	50.4886
	UTL (min 95%, 95%) - K	82.7877
	UTL (avg 95%, 95%) - K	66.7669
	Percent > Limit	83.0407
	W Test (Data)	0.9435
	Normal (a=0.05)?	Yes
	Lognormal Statistics	
n>30	Upper (95% CI mean) - Z	52.4786
n>30	Lower (95% CI mean) - Z	33.4663
	Upper (95% 1-tail CL mean) - Z	50.6153
	Upper (95%ile data) - Z	65.9468
n<30	Upper (95% CI mean) - LogNorm t	55.4945
n<30	Lower (95% CI mean) - LogNorm t	31.6476
	Upper (95% 1-tail CL mean) - LogNorm	52.3774
	UTL (min 95%, 95%) - K	112.3272
	UTL (avg 95%, 95%) - K	75.1978
	Percent > Limit	82.8718
	W Test (Data)	0.9494
	Normal (a=0.05)?	Yes

Probability Plot and Least Squares Best Fit Line



Log-Probability Plot and Least Squares Best Fit Line

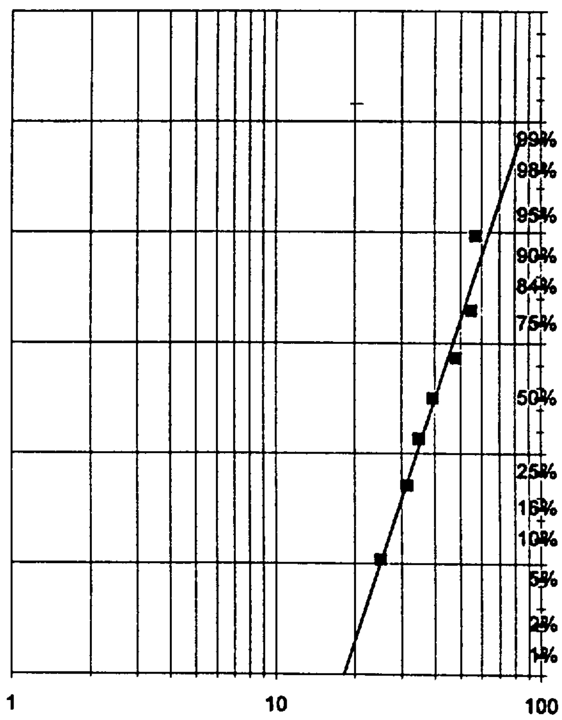


TABLE 3.

DATA EVALUATION STATISTICS
Grand Junction Background Alluvial Ground Water

Data Description

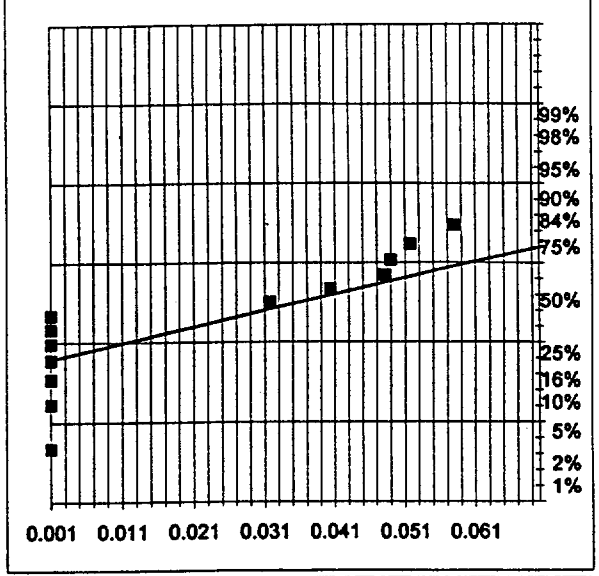
Selenium

Action Level 0.010

Sample Data UNITS - mg/L
0.048
0.049
0.0318
0.0404
0.001
0.001
0.001
0.001
0.001
0.001
0.137
0.116
0.0518
0.001
0.058

	Descriptive Statistics	
	Number of Samples	15.000
	Mean	0.0359
	Median	0.0318
	Standard Deviation	0.0433
	CV	1.2053
	Range	0.1360
	Minimum	0.0010
	Maximum	0.1370
	GM	0.0088
	GSD	8.4536
	Mean of LN(Data)	-4.7342
	SD of LN(Data)	2.1346
	Percent > Limit	53.3333
	Normal Statistics	
n>30	Upper (95% CI mean) - Z	0.0579
n>30	Lower (95% CI mean) - Z	0.0140
	Upper (95% 1-tail CL mean) - Z	0.0543
	Upper (95%ile data) - Z	0.1072
n<30	Upper (95% CI mean) - Norm t	0.0599
n<30	Lower (95% CI mean) - Norm t	0.0119
	Upper (95% 1-tail CL mean) - Normal	0.0556
	UTL (min 95%, 95%) - K	0.1471
	UTL (avg 95%, 95%) - K	0.1147
	Percent > Limit	72.5345
	W Test (Data)	0.7914
	Normal (a=0.05)?	No
	Lognormal Statistics	
n>30	Upper (95% CI mean) - Z	0.2527
n>30	Lower (95% CI mean) - Z	0.0291
	Upper (95% 1-tail CL mean) - Z	0.2124
	Upper (95%ile data) - Z	0.2944
n<30	Upper (95% CI mean) - LogNorm t	0.2797
n<30	Lower (95% CI mean) - LogNorm t	0.0263
	Upper (95% 1-tail CL mean) - LogNorm	0.2264
	UTL (min 95%, 95%) - K	2.1025
	UTL (avg 95%, 95%) - K	0.4269
	Percent > Limit	47.5892
	W Test (Data)	0.7436
	Normal (a=0.05)?	No

Probability Plot and Least Squares Best Fit Line



Log-Probability Plot and Least Squares Best Fit Line

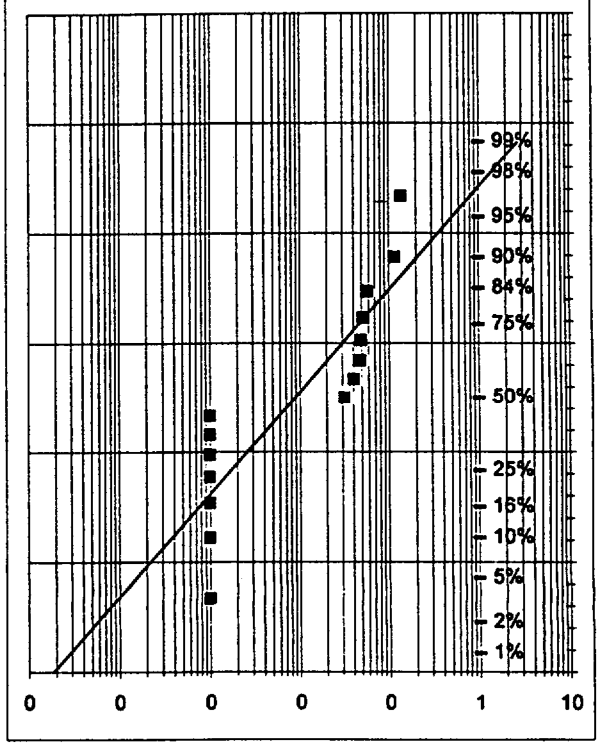


TABLE 3.

GROUND WATER QUALITY DATA BY PARAMETER (USEE200) FOR SITE GRJ01, GRAND JUNCTION
REPORT DATE: 9/22/98 8:37:28

PARAMETER	UNITS	LOCATION ID	SAMPLE:		ZONE COMPL.	FLOW REL.	RESULT	QUALIFIERS:			DETECTION LIMIT	UN-CERTAINTY
			DATE	ID				LAB	DATA	QA		
Chloride	mg/L	0713	01/27/98	0001	NR	U	347.000			#	-	-
	mg/L	0713	06/24/98	0001	NR	U	338.000			#	-	-
	mg/L	0715	01/27/98	0001	NR	U	280.000			#	-	-
	mg/L	0715	06/24/98	0001	NR	U	144.000			#	-	-
	mg/L	0745	01/26/98	0001	AL	U	591.000			#	-	-
	mg/L	0745	06/17/98	0001	AL	U	520.000		J	#	-	-
	mg/L	0746	01/26/98	0001	AL	U	801.000			#	-	-
	mg/L	0746	06/17/98	0001	AL	U	813.000		J	#	-	-
	mg/L	1020	01/26/98	0001	AL		991.000			#	-	-
	mg/L	1020	06/22/98	0001	AL		899.000			#	-	-
	mg/L	1021	01/26/98	0001	AL		746.000		L	#	-	-
	mg/L	1021	06/23/98	0001	AL		352.000		L	#	-	-
	mg/L	1023	01/22/98	0001	AL		253.000			#	-	-
	mg/L	1023	06/18/98	0001	AL		253.000			#	-	-
	mg/L	1025	01/22/98	0001	AL		307.000			#	-	-
	mg/L	1025	01/22/98	0002	AL		306.000			#	-	-
	mg/L	1025	06/18/98	0001	AL		301.000			#	-	-
Iron	mg/L	0713	01/27/98	0001	NR	U	0.0040	U		#	0.004	-
	mg/L	0713	06/24/98	0001	NR	U	0.0030	U		#	0.003	-
	mg/L	0715	01/27/98	0001	NR	U	0.0040	U		#	0.004	-
	mg/L	0715	06/24/98	0001	NR	U	0.0030	U		#	0.003	-
	mg/L	0745	01/26/98	0001	AL	U	1.170			#	-	-
	mg/L	0745	06/17/98	0001	AL	U	1.100			#	-	-
	mg/L	0746	01/26/98	0001	AL	U	0.0040	U		#	0.004	-
	mg/L	0746	06/17/98	0001	AL	U	0.0030	U		#	0.003	-
	mg/L	1020	01/26/98	0001	AL		3.130			#	-	-
	mg/L	1020	06/22/98	[illegible]	AL		1.800			#	-	-

$\bar{X} = 496$

$\bar{X} = .507$

GROUND WATER QUALITY DATA BY PARAMETER (USEE200) FOR SITE GRJ01, GRAND JUNCTION
REPORT DATE: 9/22/98 8:37:29

PARAMETER	UNITS	LOCATION ID	SAMPLE: DATE	ID	ZONE COMPL.	FLOW REL.	RESULT	QUALIFIERS: LAB	DATA	QA	DETECTION LIMIT	UN-CERTAINTY
Iron	mg/L	1021	01/26/98	0001	AL		0.0183	B	UL	#	-	-
	mg/L	1021	06/23/98	0001	AL		0.0069	B	UL	#	-	-
	mg/L	1023	01/22/98	0001	AL		0.0042	B	U	#	-	-
	mg/L	1023	06/18/98	0001	AL		0.0030	U		#	0.003	-
	mg/L	1025	01/22/98	0001	AL		0.552			#	-	-
	mg/L	1025	01/22/98	0002	AL		0.533			#	-	-
	mg/L	1025	06/18/98	0001	AL		0.321			#	-	-
Manganese	mg/L	0713	01/27/98	0001	NR	U	1.780			#	-	-
	mg/L	0713	06/24/98	0001	NR	U	2.220			#	-	-
	mg/L	0715	01/27/98	0001	NR	U	0.233			#	-	-
	mg/L	0715	06/24/98	0001	NR	U	2.080			#	-	-
	mg/L	0745	01/26/98	0001	AL	U	1.700			#	-	-
	mg/L	0745	06/17/98	0001	AL	U	1.670			#	-	-
	mg/L	0746	01/26/98	0001	AL	U	1.630			#	-	-
	mg/L	0746	06/17/98	0001	AL	U	1.840			#	-	-
	mg/L	1020	01/26/98	0001	AL		1.080			#	-	-
	mg/L	1020	06/22/98	0001	AL		0.972			#	-	-
	mg/L	1021	01/26/98	0001	AL		0.436		L	#	-	-
	mg/L	1021	06/23/98	0001	AL		0.514		L	#	-	-
	mg/L	1023	01/22/98	0001	AL		1.730			#	-	-
	mg/L	1023	06/18/98	0001	AL		1.760			#	-	-
	mg/L	1025	01/22/98	0001	AL		1.940			#	-	-
	mg/L	1025	01/22/98	0002	AL		1.940			#	-	-
	mg/L	1025	06/18/98	0001	AL		1.950			#	-	-
Selenium	mg/L	0713	01/27/98	0001	NR	U	0.0480			#	-	-
	mg/L	0713	06/24/98	0001	NR	U	0.0490			#	-	-

$\bar{X} = 1.47$

GROUND WATER QUALITY DATA BY PARAMETER (USEE200) FOR SITE GRJ01, GRAND JUNCTION
REPORT DATE: 9/22/98 8:37:31

PARAMETER	UNITS	LOCATION ID	SAMPLE: DATE	ID	ZONE COMPL.	FLOW REL.	RESULT	QUALIFIERS: LAB	DATA	QA	DETECTION LIMIT	UN-CERTAINTY
Selenium	mg/L	0715	01/27/98	0001	NR	U	0.0318			#	-	-
	mg/L	0715	06/24/98	0001	NR	U	0.0404			#	-	-
	mg/L	0745	01/26/98	0001	AL	U	0.0010	U		#	0.001	-
	mg/L	0745	06/17/98	0001	AL	U	0.0010	U		#	0.001	-
	mg/L	0746	01/26/98	0001	AL	U	0.111			#	-	-
	mg/L	0746	06/17/98	0001	AL	U	0.100			#	-	-
	mg/L	1020	01/26/98	0001	AL		0.0010	U		#	0.001	-
	mg/L	1020	06/22/98	0001	AL		0.0010	U		#	0.001	-
	mg/L	1021	01/26/98	0001	AL		0.0010	U	L	#	0.001	-
	mg/L	1021	06/23/98	0001	AL		0.0010	U	L	#	0.001	-
	mg/L	1023	01/22/98	0001	AL		0.137			#	-	-
	mg/L	1023	06/18/98	0001	AL		0.116			#	-	-
	mg/L	1025	01/22/98	0001	AL		0.0624			#	-	-
	mg/L	1025	01/22/98	0002	AL		0.0546			#	-	-
	mg/L	1025	06/18/98	0001	AL		0.0518			#	-	-
Sulfate	mg/L	0713	01/27/98	0001	NR	U	3060.000			#	-	-
	mg/L	0713	06/24/98	0001	NR	U	3140.000			#	-	-
	mg/L	0715	01/27/98	0001	NR	U	3720.000			#	-	-
	mg/L	0715	06/24/98	0001	NR	U	1840.000			#	-	-
	mg/L	0745	01/26/98	0001	AL	U	2680.000			#	-	-
	mg/L	0745	06/17/98	0001	AL	U	2480.000		J	#	-	-
	mg/L	0746	01/26/98	0001	AL	U	3560.000			#	-	-
	mg/L	0746	06/17/98	0001	AL	U	3550.000		J	#	-	-
	mg/L	1020	01/26/98	0001	AL		2940.000			#	-	-
	mg/L	1020	06/22/98	0001	AL		2730.000			#	-	-
	mg/L	1021	01/26/98	0001	AL		614.000		L	#	-	-
	mg/L	1021	06/23/98	0001	AL		416.000		L	#	-	-

$\bar{X} = 2767$

GROUND WATER QUALITY DATA BY PARAMETER (USEE200) FOR SITE GRJ01, GRAND JUNCTION
REPORT DATE: 9/22/98 8:37:32

		LOCATION	SAMPLE:		ZONE	FLOW		QUALIFIERS:			DETECTION	UN-
PARAMETER	UNITS	ID	DATE	ID	COMPL.	REL.	RESULT	LAB	DATA	QA	LIMIT	CERTAINTY
Sulfate	mg/L	1023	01/22/98	0001	AL		3720.000			#	-	-
	mg/L	1023	06/18/98	0001	AL		3700.000			#	-	-
	mg/L	1025	01/22/98	0001	AL		3100.000			#	-	-
	mg/L	1025	01/22/98	0002	AL		3100.000			#	-	-
	mg/L	1025	06/18/98	0001	AL		3020.000			#	-	-
Uranium	mg/L	0713	01/27/98	0001	NR	U	0.0652			#	-	-
	mg/L	0713	06/24/98	0001	NR	U	0.0662			#	-	-
	mg/L	0715	01/27/98	0001	NR	U	0.0602			#	-	-
	mg/L	0715	06/24/98	0001	NR	U	0.0535			#	-	-
	mg/L	0745	01/26/98	0001	AL	U	0.0381			#	-	-
	mg/L	0745	06/17/98	0001	AL	U	0.0380			#	-	-
	mg/L	0746	01/26/98	0001	AL	U	0.0624			#	-	-
	mg/L	0746	06/17/98	0001	AL	U	0.0637			#	-	-
	mg/L	1020	01/26/98	0001	AL		0.0566			#	-	-
	mg/L	1020	06/22/98	0001	AL		0.0573			#	-	-
	mg/L	1021	01/26/98	0001	AL		0.0305		L	#	-	-
	mg/L	1021	06/23/98	0001	AL		0.0228		L	#	-	-
	mg/L	1023	01/22/98	0001	AL		0.0468			#	-	-
	mg/L	1023	06/18/98	0001	AL		0.0452			#	-	-
	mg/L	1025	01/22/98	0001	AL		0.0435			#	-	-
	mg/L	1025	01/22/98	0002	AL		0.0436			#	-	-
	mg/L	1025	06/18/98	0001	AL		0.0437			#	-	-

GROUND WATER QUALITY DATA BY PARAMETER (USEE200) FOR SITE GRJ01, GRAND JUNCTION
REPORT DATE: 9/22/98 8:37:34

		LOCATION	SAMPLE:		ZONE	FLOW		QUALIFIERS:			DETECTION	UN-
PARAMETER	UNITS	ID	DATE	ID	COMPL.	REL.	RESULT	LAB	DATA	QA	LIMIT	CERTAINTY

RECORDS: SELECTED FROM USEE200 WHERE site_code='GRJ01' AND location_code in('0713','0715','0745','0746','1020','1021','1023','1025') AND quality_assurance = TRUE AND (NOT (data_validation_qualifiers LIKE "R" OR data_validation_qualifiers LIKE "X") OR IsNull(data_validation_qualifiers)) AND cas in('CHLORIDE ','07439-89-6 ','07439-96-5 ','07782-49-2 ','SULFATE ','07440-61-1 ') AND DATE_SAMPLED between #1/1/98# and #12/30/98#

SAMPLE ID CODES: 000X = Filtered sample (0.45 μm). N00X = Unfiltered sample. X = replicate number.

LAB QUALIFIERS:

*	Replicate analysis not within control limits.
+	Correlation coefficient for MSA < 0.995.
A	TIC is a suspected aldol-condensation product.
B	Inorganic: Result is between the IDL and CRDL. Organic: Analyte also found in method blank.
E	Inorganic: Estimate value because of interference, see case narrative. Organic: Analyte exceeded calibration range of the GC-MS.
Z	Laboratory defined (USEPA CLP organic) qualifier, see case narrative.
H	Holding time expired, value suspect.
I	Increased detection limit due to required dilution.
C	Pesticide result confirmed by GC-MS.
M	GFAA duplicate injection precision not met.
N	Inorganic or radiochemical: Spike sample recovery not within control limits. Organic: Tentatively identified compund (TIC).
S	Result determined by method of standard addition (MSA).
U	Analytical result below detection limit.
W	Post-digestion spike outside control limits while sample absorbance < 50% of analytical spike absorbance.
D	Analyte determined in diluted sample.
P	> 25% difference in detected pesticide or Arochlor concentrations between 2 columns.
X	Laboratory defined (USEPA CLP organic) qualifier, see case narrative.
Y	Laboratory defined (USEPA CLP organic) qualifier, see case narrative.
>	Result above upper detection limit.

DATA QUALIFIERS:

J	Estimated value.	F	Low flow sampling method used.	G	Possible grout contamination, pH > 9.
L	Less than 3 bore volumes purged prior to sampling.	R	Unusable result.	X	Location is undefined.
U	Parameter analyzed for but was not detected.				

QA QUALIFIER: # = validated according to Quality Assurance guidelines.

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Appendix I

Risk Assessment Data

```
        MgHCO3+           1.879e-04   1.457e-04    -3.726    -3.837    -0.110
        NaHCO3            1.052e-04   1.080e-04    -3.978    -3.967     0.011
        CaCO3             1.499e-05   1.538e-05    -4.824    -4.813     0.011
        CO3-2             1.004e-05   3.752e-06    -4.998    -5.426    -0.427
        MgCO3             7.327e-06   7.517e-06    -5.135    -5.124     0.011
        NaCO3-            2.916e-06   2.262e-06    -5.535    -5.646    -0.110
Ca                 1.107e-02
        Ca+2              6.430e-03   2.439e-03    -2.192    -2.613    -0.421
        CaSO4             4.391e-03   4.506e-03    -2.357    -2.346     0.011
        CaHCO3+           2.361e-04   1.846e-04    -3.627    -3.734    -0.107
        CaCO3             1.499e-05   1.538e-05    -4.824    -4.813     0.011
        CaOH+             7.028e-09   5.450e-09    -8.153    -8.264    -0.110
        CaHSO4+           2.523e-09   1.957e-09    -8.598    -8.708    -0.110
Cl                 1.604e-02
        Cl-               1.604e-02   1.213e-02    -1.795    -1.916    -0.121
H(0)               2.089e-17
        H2                1.044e-17   1.072e-17   -16.981   -16.970     0.011
K                  1.454e-03
        K+                1.367e-03   1.034e-03    -2.864    -2.985    -0.121
        KSO4-             8.676e-05   6.728e-05    -4.062    -4.172    -0.110
        KOH               4.706e-11   4.828e-11   -10.327   -10.316     0.011
Mg                 9.934e-03
        Mg+2              5.298e-03   2.099e-03    -2.276    -2.678    -0.402
        MgSO4             4.441e-03   4.556e-03    -2.353    -2.341     0.011
        MgHCO3+           1.879e-04   1.457e-04    -3.726    -3.837    -0.110
        MgCO3             7.327e-06   7.517e-06    -5.135    -5.124     0.011
        MgOH+             1.323e-07   1.026e-07    -6.878    -6.989    -0.110
N(-3)              3.983e-03
        NH4+              3.561e-03   2.619e-03    -2.448    -2.582    -0.133
        NH4SO4-           4.027e-04   3.123e-04    -3.395    -3.505    -0.110
        NH3               1.962e-05   2.013e-05    -4.707    -4.696     0.011
N(5)               1.964e-06
        NO3-              1.964e-06   1.463e-06    -5.707    -5.835    -0.128
Na                 4.373e-02
        Na+               4.169e-02   3.237e-02    -1.380    -1.490    -0.110
        NaSO4-            1.937e-03   1.502e-03    -2.713    -2.823    -0.110
        NaHCO3            1.052e-04   1.080e-04    -3.978    -3.967     0.011
        NaCO3-            2.916e-06   2.262e-06    -5.535    -5.646    -0.110
        NaOH              2.806e-09   2.879e-09    -8.552    -8.541     0.011
O(0)               0.000e+00
        O2                0.000e+00   0.000e+00   -58.453   -58.442     0.011
S(6)               3.698e-02
        SO4-2             2.572e-02   9.257e-03    -1.590    -2.034    -0.444
        MgSO4             4.441e-03   4.556e-03    -2.353    -2.341     0.011
        CaSO4             4.391e-03   4.506e-03    -2.357    -2.346     0.011
        NaSO4-            1.937e-03   1.502e-03    -2.713    -2.823    -0.110
        NH4SO4-           4.027e-04   3.123e-04    -3.395    -3.505    -0.110
        KSO4-             8.676e-05   6.728e-05    -4.062    -4.172    -0.110
        HSO4-             8.604e-08   6.672e-08    -7.065    -7.176    -0.110
        CaHSO4+           2.523e-09   1.957e-09    -8.598    -8.708    -0.110

------------------------------Saturation indices-------------------------------

        Phase               SI log IAP  log KT

        Anhydrite        -0.29   -4.65   -4.36  CaSO4
        Aragonite         0.30   -8.04   -8.34  CaCO3
        Calcite           0.44   -8.04   -8.48  CaCO3
        CO2(g)           -1.54  -19.68  -18.15  CO2
        Dolomite          0.95  -16.14  -17.09  CaMg(CO3)2
        Gypsum           -0.07   -4.65   -4.58  CaSO4:2H2O
        H2(g)           -13.82  -13.82    0.00  H2
        NH3(g)           -6.47    4.55   11.01  NH3
        O2(g)           -55.48   27.64   83.12  O2

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End of simulation.
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Reading input data for simulation 2.
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End of run.
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```

Soil and Sediment Data

Loc Id	Date	Sample From	Sample To	Sample Id	As mg/kg	Cd mg/kg	Co mg/kg	Cu mg/kg	Fe mg/kg	Fluoride mg/kg	Kd-As mL/g	Kd-Cd mL/g	Kd-Mo mL/g	Kd-U mL/g
Upgradient														
0315	10/22/97	0	0	0002	--	--	--	--	--	--	--	--	--	--
0323	10/22/97	0	0	0002	--	--	--	--	--	--	--	--	--	--
0324	10/22/97	0	0	0002	--	--	--	--	--	--	--	--	--	--
0325	10/22/97	0	0	0002	--	--	--	--	--	--	--	--	--	--
	11/07/97	0		0002	.48	.77	1B	6.6E	1890	38.7	--	--	--	--
0330	10/22/97	0	0	0002	--	--	--	--	--	--	--	--	--	--
	11/07/97	0		0002	1.5B	.42	2.2	9.2E	3240	58.6	--	--	--	--
0335	10/22/97	0	0	0002	--	--	--	--	--	--	--	--	--	--
0337	10/22/97	0	0	0002	--	--	--	--	--	--	--	--	--	--
0338	10/22/97	0	0	0002	--	--	--	--	--	--	--	--	--	--
0339	10/22/97	0	0	0002	--	--	--	--	--	--	--	--	--	--
0342	10/22/97	0	0	0002	--	--	--	--	--	--	--	--	--	--
	11/06/97	0		0002	1.5B	.44	1.9B	6.1E	2400	79.5	--	--	--	--
0349	10/22/97	0	0	0002	--	--	--	--	--	--	--	--	--	--
	11/06/97	0		0002	.86	.38	1.1B	2.9E	1780	55.1	--	--	--	--
0350	10/22/97	0	0	0002	--	--	--	--	--	--	--	--	--	--
	11/06/97	0		0002	1.4B	.5	2.1	7.9E	2580	83	--	--	--	--
1020	02/08/98	5	7	0001	1.2	.4B	--	--	--	--	--	--	--	--
	02/11/98	10	12	0001	--	--	--	--	--	--	83.83	182.23	.1	2.414
1021	02/08/98	5	7	0001	.9B	.32B	--	--	--	--	--	--	--	--
	02/11/98	5	7	0001	--	--	--	--	--	--	358.1	356.76	.7216	3.636
1023	02/08/98	5	7	0001	1	.42B	--	--	--	--	--	--	--	--
	02/08/98	10	12	0001	.92B	.25B	--	--	--	--	--	--	--	--
	02/11/98	5	7	0001	--	--	--	--	--	--	8241	248.64	1.2698	1.788
	02/11/98	10	12	0001	--	--	--	--	--	--	75.24	48.788	.1	.968
	02/11/98	10	12	0M01	--	--	--	--	--	--	--	--	--	1.703
	02/11/98	10	12	0M02	--	--	--	--	--	--	--	--	--	1.381
	02/11/98	10	12	0M03	--	--	--	--	--	--	--	--	--	.969
	02/11/98	10	12	0M04	--	--	--	--	--	--	--	--	--	1.083
	02/11/98	10	12	0M05	--	--	--	--	--	--	--	--	--	.912
	02/11/98	10	12	0M06	--	--	--	--	--	--	--	--	--	1.572
	02/11/98	10	12	0M07	--	--	--	--	--	--	--	--	--	.871
	02/11/98	10	12	0M08	--	--	--	--	--	--	--	--	--	.693
	02/11/98	15	15.4	0001	--	--	--	--	--	--	137	64.074	.5102	1.081
	02/11/98	15	15.4	0M09	--	--	--	--	--	--	--	--	--	1.91
	02/11/98	15	15.4	0M10	--	--	--	--	--	--	--	--	--	1.711
	02/11/98	15	15.4	0M11	--	--	--	--	--	--	--	--	--	1.09
	02/11/98	15	15.4	0M12	--	--	--	--	--	--	--	--	--	1.115
	02/11/98	15	15.4	0M13	--	--	--	--	--	--	--	--	--	1.16
1024	02/11/98	5	7	0001	--	--	--	--	--	--	356.2	133.9	.7216	3.353
1025	02/11/98	5	7	0001	--	--	--	--	--	--	635.2	279.67	1.2698	2.286
	02/11/98	10	12	0001	--	--	--	--	--	--	1168	278.68	1.4973	2.674
	02/11/98	15	17	0001	--	--	--	--	--	--	228.4	64.074	.303	1.429
1028	02/11/98	5	7	0001	--	--	--	--	--	--	208.9	181.33	.4061	1.91

Soil and Sediment Data

Loc Id	Date	Sample From	Sample To	Sample Id	Mn mg/kg	Mo mg/kg	Ni mg/kg	NO3 mg/kg	Ra-226 pCi/g	Se mg/kg	SO4 mg/kg	U mg/kg	V mg/kg	Zn mg/kg
Upgradient														
0315	10/22/97	0	0	0002	--	--	--	--	--	--	--	1.8	--	--
0323	10/22/97	0	0	0002	--	--	--	--	--	--	--	1.88	--	--
0324	10/22/97	0	0	0002	--	--	--	--	--	--	--	1.08	--	--
0325	10/22/97	0	0	0002	--	--	--	--	--	--	--	2.6	--	--
	11/07/97	0		0002	149	.09B	2.7	10.2B	--	.11B	342	2.5	6.7	51.2
0330	10/22/97	0	0	0002	--	--	--	--	--	--	--	1.2	--	--
	11/07/97	0		0002	117	.12B	5.3	6.5B	--	.04U	686	.73	6.1	24.8
0335	10/22/97	0	0	0002	--	--	--	--	--	--	--	1.08	--	--
0337	10/22/97	0	0	0002	--	--	--	--	--	--	--	1.08	--	--
0338	10/22/97	0	0	0002	--	--	--	--	--	--	--	1	--	--
0339	10/22/97	0	0	0002	--	--	--	--	--	--	--	1.6	--	--
0342	10/22/97	0	0	0002	--	--	--	--	--	--	--	1.2	--	--
	11/06/97	0		0002	278	.1B	3.1	5.9B	--	.04U	701	.72	4.8	15.8
0349	10/22/97	0	0	0002	--	--	--	--	--	--	--	1.08	--	--
	11/06/97	0		0002	237	.05B	1.4B	7.4B	--	.04U	226	.42	3.1	37.1
0350	10/22/97	0	0	0002	--	--	--	--	--	--	--	1.36	--	--
	11/06/97	0		0002	267	.08B	3.6	6.6B	--	.04U	469	.7	4.9	25.9
1020	02/08/98	5	7	0001	--	.3B	--	--	.646	--	--	.78	--	--
	02/11/98	10	12	0001	--	--	--	--	--	--	--	--	--	--
1021	02/08/98	5	7	0001	--	.33B	--	--	.472	--	--	1.1	--	--
	02/11/98	5	7	0001	--	--	--	--	--	--	--	--	--	--
1023	02/08/98	5	7	0001	--	.14B	--	--	.611	--	--	.74	--	--
	02/08/98	10	12	0001	--	.21B	--	--	.24	--	--	.44B	--	--
	02/11/98	5	7	0001	--	--	--	--	--	--	--	--	--	--
	02/11/98	10	12	0001	--	--	--	--	--	--	--	--	--	--
	02/11/98	10	12	0M01	--	--	--	--	--	--	--	--	--	--
	02/11/98	10	12	0M02	--	--	--	--	--	--	--	--	--	--
	02/11/98	10	12	0M03	--	--	--	--	--	--	--	--	--	--
	02/11/98	10	12	0M04	--	--	--	--	--	--	--	--	--	--
	02/11/98	10	12	0M05	--	--	--	--	--	--	--	--	--	--
	02/11/98	10	12	0M06	--	--	--	--	--	--	--	--	--	--
	02/11/98	10	12	0M07	--	--	--	--	--	--	--	--	--	--
	02/11/98	10	12	0M08	--	--	--	--	--	--	--	--	--	--
	02/11/98	15	15.4	0001	--	--	--	--	--	--	--	--	--	--
	02/11/98	15	15.4	0M09	--	--	--	--	--	--	--	--	--	--
	02/11/98	15	15.4	0M10	--	--	--	--	--	--	--	--	--	--
	02/11/98	15	15.4	0M11	--	--	--	--	--	--	--	--	--	--
	02/11/98	15	15.4	0M12	--	--	--	--	--	--	--	--	--	--
	02/11/98	15	15.4	0M13	--	--	--	--	--	--	--	--	--	--
1024	02/11/98	5	7	0001	--	--	--	--	--	--	--	--	--	--
1025	02/11/98	5	7	0001	--	--	--	--	--	--	--	--	--	--
	02/11/98	10	12	0001	--	--	--	--	--	--	--	--	--	--
	02/11/98	15	17	0001	--	--	--	--	--	--	--	--	--	--
1028	02/11/98	5	7	0001	--	--	--	--	--	--	--	--	--	--

GROUND WATER QUALITY DATA BY PARAMETER (USEE200) FOR SITE GRJ01, GRAND JUNCTION
REPORT DATE: 1/7/99 11:03:28

PARAMETER	UNITS	LOCATION ID	SAMPLE: DATE	ID	ZONE COMPL	FLOW REL.	RESULT	QUALIFIERS: LAB	DATA	QA	DETECTION LIMIT	UN-CERTAINTY

RECORDS: SELECTED FROM USEE200 WHERE site_code='GRJ01' AND location_code in('1017') AND quality_assurance = TRUE AND (NOT (data_validation_qualifiers LIKE "*R*" OR data_validation_qualifiers LIKE "*X*") OR IsNull(data_validation_qualifiers)) AND DATE_SAMPLED between #5/1/98# and #1/1/99#

SAMPLE ID CODES: 000X = Filtered sample (0.45 µm). N00X = Unfiltered sample. X = replicate number.

LAB QUALIFIERS:

*	Replicate analysis not within control limits.
+	Correlation coefficient for MSA < 0.995.
A	TIC is a suspected aldol-condensation product.
B	Inorganic: Result is between the IDL and CRDL. Organic: Analyte also found in method blank.
E	Inorganic: Estimate value because of interference, see case narrative. Organic: Analyte exceeded calibration range of the GC-MS.
Z	Laboratory defined (USEPA CLP organic) qualifier, see case narrative.
H	Holding time expired, value suspect.
I	Increased detection limit due to required dilution.
C	Pesticide result confirmed by GC-MS.
M	GFAA duplicate injection precision not met.
N	Inorganic or radiochemical: Spike sample recovery not within control limits. Organic: Tentatively identified compund (TIC).
S	Result determined by method of standard addition (MSA).
U	Analytical result below detection limit.
W	Post-digestion spike outside control limits while sample absorbance < 50% of analytical spike absorbance.
D	Analyte determined in diluted sample.
P	> 25% difference in detected pesticide or Arochlor concentrations between 2 columns.
X	Laboratory defined (USEPA CLP organic) qualifier, see case narrative.
Y	Laboratory defined (USEPA CLP organic) qualifier, see case narrative.
>	Result above upper detection limit.

DATA QUALIFIERS:

J	Estimated value.
L	Less than 3 bore volumes purged prior to sampling.
U	Parameter analyzed for but was not detected.
F	Low flow sampling method used.
R	Unusable result.
G	Possible grout contamination, pH > 9.
X	Location is undefined.

QA QUALIFIER: # = validated according to Quality Assurance guidelines.

```
------------------
Reading data base.
------------------

        SOLUTION_MASTER_SPECIES
        SOLUTION_SPECIES
        PHASES
        EXCHANGE_MASTER_SPECIES
        EXCHANGE_SPECIES
        SURFACE_MASTER_SPECIES
        SURFACE_SPECIES
        END
------------------------------------
Reading input data for simulation 1.
------------------------------------

        TITLE Ammonia at GJ
        SOLUTION 1
                units   mg/L
                pH              7.13
                pE              -0.22
                density         1.0
                Alkalinity      408.0
                Ca              441.0
                Cl              565.0
                Mg              240.0
                K               56.5
                Na              999.0
                S(6)            3530.0  as SO4
                N(5)            0.121 as NO3
                N(-3)           71.4 as NH4
        END
-----
TITLE
-----

 Ammonia at GJ

-------------------------------------------
Beginning of initial solution calculations.
-------------------------------------------

Initial solution 1.

-----------------------------Solution composition------------------------------

        Elements           Molality       Moles

        Alkalinity        8.204e-03   8.204e-03
        Ca                1.107e-02   1.107e-02
        Cl                1.604e-02   1.604e-02
        K                 1.454e-03   1.454e-03
        Mg                9.934e-03   9.934e-03
        N(-3)             3.983e-03   3.983e-03
        N(5)              1.964e-06   1.964e-06
        Na                4.373e-02   4.373e-02
        S(6)              3.698e-02   3.698e-02

----------------------------Description of solution----------------------------

                                       pH  =   7.130
                                       pe  =  -0.220
                        Activity of water  =   0.998
                           Ionic strength  =   1.115e-01
                       Mass of water (kg)  =   1.000e+00
                    Total carbon (mol/kg)  =   9.115e-03
                       Total CO2 (mol/kg)  =   9.115e-03
                      Temperature (deg C)  =  25.000
                  Electrical balance (eq)  =  -7.022e-03
                               Iterations  =   8
                                  Total H  = 1.110365e+02
                                  Total O  = 5.568052e+01

---------------------------------Redox couples---------------------------------

        Redox couple             pe  Eh (volts)

        N(-3)/N(5)           5.5658      0.3293

----------------------------Distribution of species----------------------------

                                                    Log       Log         Log
        Species            Molality    Activity  Molality  Activity     Gamma

        OH-               1.788e-07   1.348e-07    -6.748    -6.870    -0.123
        H+                9.028e-08   7.413e-08    -7.044    -7.130    -0.086
        H2O               5.551e+01   9.980e-01    -0.001    -0.001     0.000
C(4)          9.115e-03
        HCO3-             7.585e-03   5.931e-03    -2.120    -2.227    -0.107
        CO2               9.655e-04   9.906e-04    -3.015    -3.004     0.011
        CaHCO3+           2.361e-04   1.846e-04    -3.627    -3.734    -0.107
```

GROUND WATER QUALITY DATA BY PARAMETER (USEE200) FOR SITE GRJ01, GRAND JUNCTION
REPORT DATE: 1/7/99 11:03:27

PARAMETER	UNITS	LOCATION ID	SAMPLE: DATE	SAMPLE: ID	ZONE COMPL	FLOW REL.	RESULT	QUALIFIERS: LAB	QUALIFIERS: DATA	QUALIFIERS: QA	DETECTION LIMIT	UN-CERTAINTY
Alkalinity as CaCO3	mg/L	1017	06/22/98	0001	AL	O	408			#	-	-
	mg/L	1017	06/22/98	N001	AL	O	402			#	-	-
Ammonia as NH4	mg/L	1017	06/22/98	0001	AL	O	233.000			#	-	-
Arsenic	mg/L	1017	06/22/98	0001	AL	O	0.0010	U		#	0.001	-
Cadmium	mg/L	1017	06/22/98	0001	AL	O	0.0010	U		#	0.001	-
Calcium	mg/L	1017	06/22/98	0001	AL	O	441.000			#	-	-
Chloride	mg/L	1017	06/22/98	0001	AL	O	565.000			#	-	-
Cobalt	mg/L	1017	06/22/98	0001	AL	O	0.0060	U		#	0.006	-
Copper	mg/L	1017	06/22/98	0001	AL	O	0.0050	U		#	0.005	-
Fluoride	mg/L	1017	06/22/98	0001	AL	O	1.910			#	-	-
Gross Alpha	pCi/L	1017	06/22/98	0001	AL	O	66.49	U	J	#	66.49	± 37.4
Gross Beta	pCi/L	1017	06/22/98	0001	AL	O	67.71	U		#	67.71	± 39.7
Iron	mg/L	1017	06/22/98	0001	AL	O	0.718			#	-	-
Magnesium	mg/L	1017	06/22/98	0001	AL	O	240.000			#	-	-
Manganese	mg/L	1017	06/22/98	0001	AL	O	4.140			#	-	-
Molybdenum	mg/L	1017	06/22/98	0001	AL	O	0.0894			#	-	-
Nickel	mg/L	1017	06/22/98	0001	AL	O	0.0828			#	-	-
Nitrate	mg/L	1017	06/22/98	0001	AL	O	0.121	B		#	-	-
pH	s.u.	1017	06/22/98	N001	AL	O	7.13			#	-	-
Potassium	mg/L	1017	06/22/98	0001	AL	O	56.500			#	-	-
Radium-226	pCi/L	1017	06/22/98	0001	AL	O	0.14	U		#	0.14	± 0.07
Radium-228	pCi/L	1017	06/22/98	0001	AL	O	0.65			#	0.56	± 0.34

$pE = \frac{-13}{54} = -0.22$

GROUND WATER QUALITY DATA BY PARAMETER (USEE200) FOR SITE GRJ01, GRAND JUNCTION
REPORT DATE: 1/7/99 11:03:28

PARAMETER	UNITS	LOCATION ID	SAMPLE: DATE	SAMPLE: ID	ZONE COMPL	FLOW REL.	RESULT	QUALIFIERS: LAB	QUALIFIERS: DATA	QUALIFIERS: QA	DETECTION LIMIT	UN-CERTAINTY
Redox Potential	mV	1017	06/22/98	N001	AL	O	-13			#	-	-
Selenium	mg/L	1017	06/22/98	0001	AL	O	0.0010	U		#	0.001	-
Sodium	mg/L	1017	06/22/98	0001	AL	O	999.000			#	-	-
Specific Conductance	umhos/	1017	06/22/98	N001	AL	O	7700			#	-	-
Strontium	mg/L	1017	06/22/98	0001	AL	O	7.040			#	-	-
Sulfate	mg/L	1017	06/22/98	0001	AL	O	3530.000			#	-	-
Temperature	C	1017	06/22/98	N001	AL	O	14.7			#	-	-
Total Dissolved Solids	mg/L	1017	06/22/98	0001	AL	O	6070			#	-	-
Turbidity	NTU	1017	06/22/98	N001	AL	O	9.57			#	-	-
Uranium	mg/L	1017	06/22/98	0001	AL	O	0.0255			#	-	-
Vanadium	mg/L	1017	06/22/98	0001	AL	O	0.0021	B	U	#	-	-
Zinc	mg/L	1017	06/22/98	0001	AL	O	0.0050	U		#	0.005	-

Ecological Risk Assessment

Ecological Risk Assessment

1.0 Introduction

Ecological risk assessment (ERA) is a process that evaluates the likelihood that adverse ecological effects are occurring or may occur as a result of exposure to one or more stressors (EPA 1992). A stressor is any physical, chemical, or biological entity that can induce an adverse ecological response.

1.1 Purpose

The purpose of this risk assessment is to identify and characterize adverse effects, if any, on the ecosystem at the Grand Junction site. For ecological risks to occur at the Grand Junction site, pathways must exist for exposure of biological receptors to biotic and abiotic media contaminated by ground water. Screening-level assessments of ecological risks at the site evaluated COPCs, potential pathways, receptors, and adverse effects (DOE 1995).

This ERA is based on relevant components of the EPA guidance provided in the *Guidelines for Ecological Risk Assessment* (EPA 1998) and the *Framework for Ecological Risk Assessment* (EPA 1992).

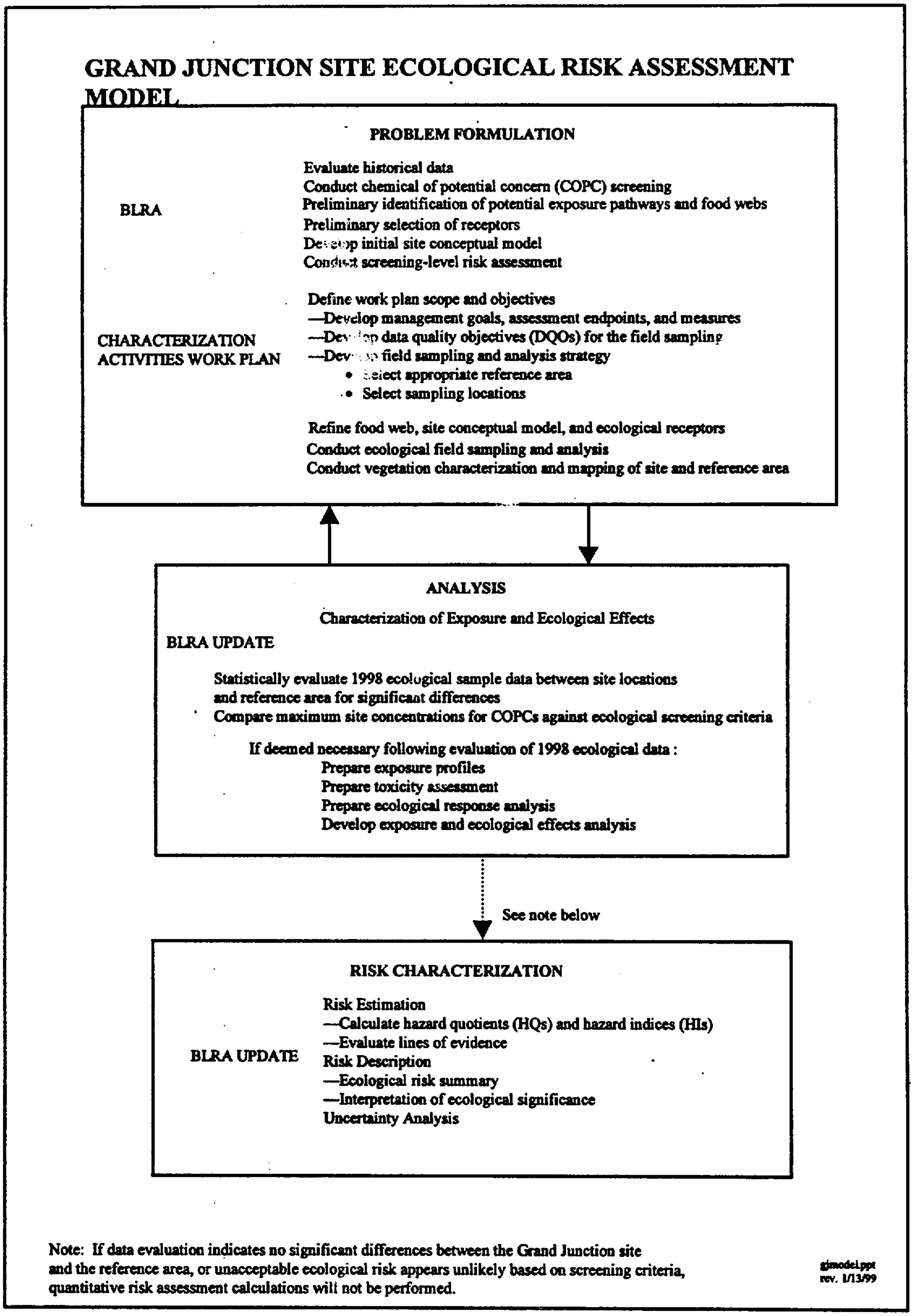
1.2 Risk Assessment Methodology

The ERA contains three main components: (1) problem formulation, (2) analysis, and (3) risk characterization. A tiered approach to the risk assessment process was followed by performing the screening-level BLRA, collecting additional samples, and evaluating recent 1998 data, with the possibility of proceeding to a quantitative risk assessment pending the outcome of the data review. The problem formulation component is discussed in detail in the following sections. A risk assessment model for the Grand Junction site is shown in Figure I–1. Following the evaluation of the 1998 ecological data, the risk assessment process may or may not conclude with the analysis phase. Depending on the outcome of the analysis phase, risk characterization may not be necessary for this screening-level assessment.

2.0 Problem Formulation

In the problem formulation phase, the need for a risk assessment is identified, and the scope of the problem is defined. Evaluation of available data helps to develop site conceptual models, food webs, risk hypotheses, endpoints and measures. The principal product from these activities is the analysis plan, which may include activities for new data collection as well as how the existing data will be used to complete the risk assessment. The problem formulation phase typically requires the greatest amount of effort, and the success of the risk assessment depends on a thorough and technically defensible planning process.

The problem formulation phase in the risk assessment process was represented in part by the BLRA (DOE 1995), which was a screening-level risk assessment. The primary input to this phase is the integration of available information. Historical analytical data for the Grand Junction site were reviewed to determine if concentrations of analytes in ground water, surface water, and sediment might pose an ecological risk. Other inputs included information gathered on the



GRAND JUNCTION SITE ECOLOGICAL RISK ASSESSMENT MODEL

PROBLEM FORMULATION

BLRA

Evaluate historical data
Conduct chemical of potential concern (COPC) screening
Preliminary identification of potential exposure pathways and food webs
Preliminary selection of receptors
Develop initial site conceptual model
Conduct screening-level risk assessment

CHARACTERIZATION ACTIVITIES WORK PLAN

Define work plan scope and objectives
—Develop management goals, assessment endpoints, and measures
—Develop data quality objectives (DQOs) for the field sampling
—Develop field sampling and analysis strategy
- Select appropriate reference area
- Select sampling locations

Refine food web, site conceptual model, and ecological receptors
Conduct ecological field sampling and analysis
Conduct vegetation characterization and mapping of site and reference area

ANALYSIS

Characterization of Exposure and Ecological Effects

BLRA UPDATE

Statistically evaluate 1998 ecological sample data between site locations and reference area for significant differences
Compare maximum site concentrations for COPCs against ecological screening criteria

If deemed necessary following evaluation of 1998 ecological data :
Prepare exposure profiles
Prepare toxicity assessment
Prepare ecological response analysis
Develop exposure and ecological effects analysis

See note below

RISK CHARACTERIZATION

BLRA UPDATE

Risk Estimation
—Calculate hazard quotients (HQs) and hazard indices (HIs)
—Evaluate lines of evidence
Risk Description
—Ecological risk summary
—Interpretation of ecological significance
Uncertainty Analysis

Note: If data evaluation indicates no significant differences between the Grand Junction site and the reference area, or unacceptable ecological risk appears unlikely based on screening criteria, quantitative risk assessment calculations will not be performed.

gjmodel.ppt
rev. 1/13/99

Figure I–1. Grand Junction Site Ecological Risk Assessment Model

Grand Junction geologic setting, ground water hydrology, geochemistry, and ecological habitat. Principal products of this phase included COPC screening and the preparation of a characterization work plan (DOE 1997). Since the BLRA, additional abiotic and biotic samples have been collected at Grand Junction and an upstream reference area, and these data were incorporated into the risk assessment process.

2.1 Ecological Chemicals of potential Concern

Ecological COPCs were defined in the screening-level risk assessment as those constituents that exceeded background concentrations (Table I–1). The water quality of upgradient wells was considered to be representative of background conditions (DOE 1995). Two categories of surface water were defined: Colorado River water and water in ponds constructed as part of a wetlands mitigation project. Colorado River COPCs were those constituents with higher concentrations downstream of the millsite than upstream. COPCs in the wetlands mitigation ponds were determined by comparing concentrations in the ponds and in the upgradient ground water wells (DOE 1996d). Sediment COPCs were determined by comparing data from Colorado River sediment sampled upstream, downstream, and adjacent to the site (DOE 1995).

Table I–1. Summary of Ecological Chemicals of Potential Concern in Ground Water, Surface Water, and Sediments

Constituents Above Background in Ground Water	COPC in Ground Water	Ecological COPC in Colorado River Surface Water	Ecological COPC in Water in Wetlands Mitigation Ponds	Ecological COPC in Colorado River Sediment
Ammonium		X		
Arsenic	X		X	
Cadmium	X		X	
Cobalt	X		X	
Copper		X		
Fluoride	X		X	
Iron	X	X	X	
Manganese	X		X	
Molybdenum	X		X	X
Nickel	X		X	
^{226}Ra	X	X	X	
Selenium				X
Strontium	X			X
Sulfate	X		X	X
Uranium	X	X	X	X
Vanadium	X	X	X	
Zinc	X		X	

2.2 Ecological Conceptual Site Model

Conceptual models for ecological risk assessments are developed from information about stressors, potential exposure, and predicted effects on an ecological entity (the assessment endpoint). Conceptual models consist of two principal components (EPA 1998):

- A set of risk hypotheses that describe predicted relationships among stressor, exposure, and assessment endpoint response, along with the rationale for their selection.
- A diagram that illustrates the relationships presented in the risk hypotheses.

The following is the risk hypothesis proposed for the Grand Junction site:

Risk hypothesis: Milling operations at the Grand Junction site have resulted in low levels of ground water contamination. Hydrogeologic information regarding plume migration suggests that contamination might be present in the Colorado River adjacent to and downgradient of the Grand Junction site. This could result in contaminant exposure directly or indirectly to wildlife and plant receptors that use or inhabit the site.

Because the stressors are chemical contaminants, the Grand Junction risk hypothesis is considered a "stressor-initiated" risk hypothesis; however, no apparent ecological effects have been observed that would provide a cause-and-effect relationship.

As part of the initial problem formulation in the BLRA, a generalized conceptual site model was developed for the Grand Junction site. That model has since been revised to address current and potential exposure pathways based on all of the available data (Figure I–2).

An exposure pathway is the mechanism by which a contaminant in an environmental medium (i.e., the source) contacts an ecological receptor. A complete exposure pathway includes:

- Contaminant source
- Release mechanism that allows contaminants to become mobile or accessible
- Transport mechanism that moves contaminants away from the release
- Ecological receptor
- Route of exposure (e.g., dermal or direct contact, inhalation, or ingestion).

Ecological receptors that could potentially be exposed to COPCs were identified in the BLRA (DOE 1995) and included mammalian and avian species. A food web for the Grand Junction site (Figure I–3) illustrates the significant dietary interactions between the terrestrial and aquatic receptors.

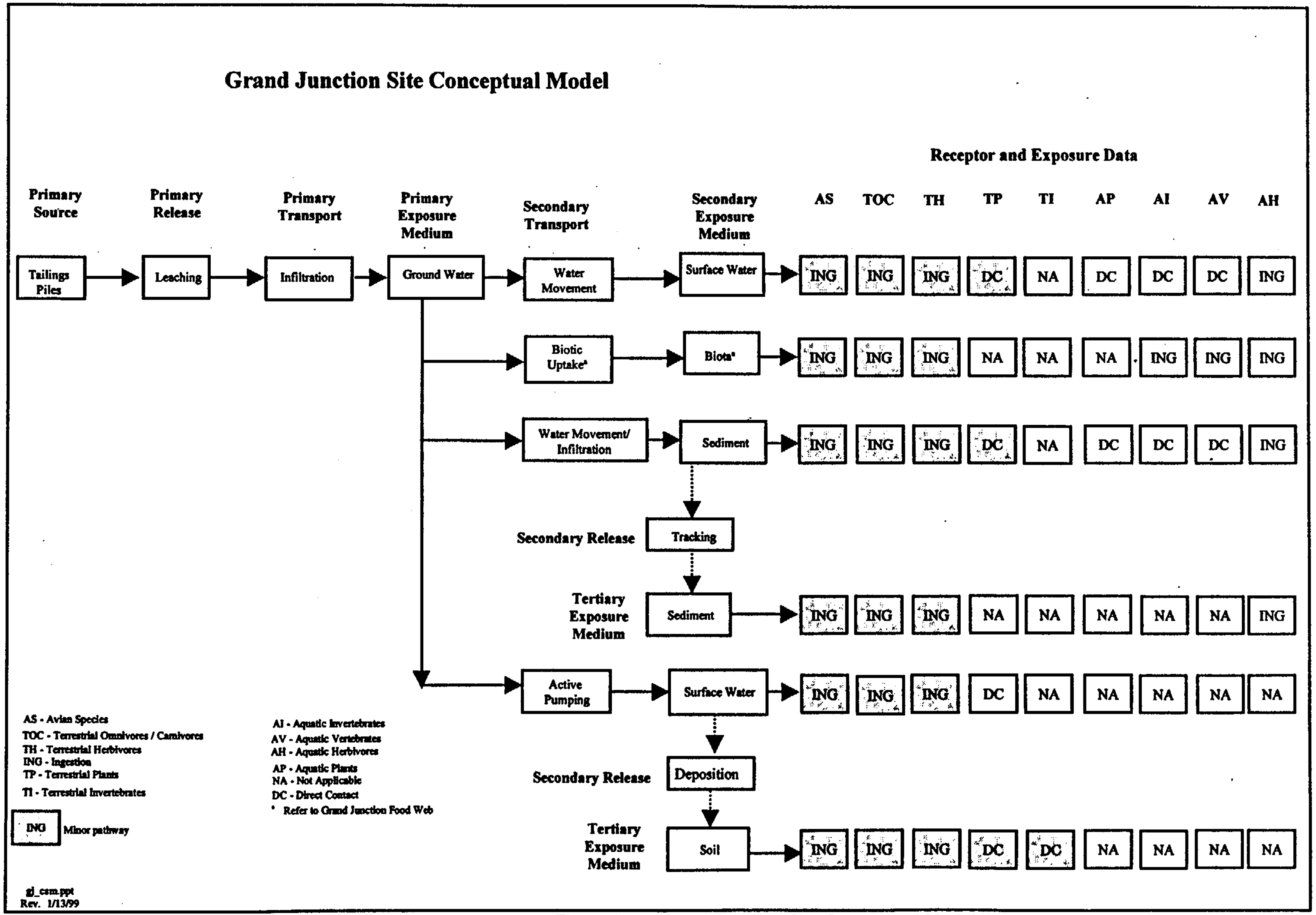
The food web also depicts the major trophic-level interactions and describes nutrient flow and transfer of matter and energy through these levels. It was developed from the species lists and consideration of the exposure pathways. The food web diagram was used to portray potential routes of COPCs from the ground water to biotic species at various trophic levels, with receptor species being components of this food web.

The terrestrial receptor categories include:

- Omnivores, carnivores—include fox, coyote, raccoon
- Herbivores—include mule deer, cottontail, some mice and vole species,
- Vegetation—includes phreatophytes such as black greasewood and other plant species
- Terrestrial invertebrates—include soil fauna

The aquatic receptor categories include:

- Avian species—include great blue heron, geese, ducks, some passerine birds
- Herbivores—include beaver, muskrat
- Vertebrates—include amphibians, reptiles, fish



	AS	TOC	TH	TP	TI	AP	AI	AV	AH
Surface Water	ING	ING	ING	DC	NA	DC	DC	DC	ING
Biota*	ING	ING	ING	NA	NA	NA	ING	ING	ING
Sediment	ING	ING	ING	DC	NA	DC	DC	DC	ING
Sediment	ING	ING	ING	NA	NA	NA	NA	NA	ING
Surface Water	ING	ING	ING	DC	NA	NA	NA	NA	NA
Soil	ING	ING	ING	DC	DC	NA	NA	NA	NA

AS - Avian Species
TOC - Terrestrial Omnivores / Carnivores
TH - Terrestrial Herbivores
ING - Ingestion
TP - Terrestrial Plants
TI - Terrestrial Invertebrates

AI - Aquatic Invertebrates
AV - Aquatic Vertebrates
AH - Aquatic Herbivores
AP - Aquatic Plants
NA - Not Applicable
DC - Direct Contact
* Refer to Grand Junction Food Web

ING Minor pathway

Figure I–2. Grand Junction Site Conceptual Model

Plants—include phreatophytes such as cattail, bulrush, willow, reed canarygrass, tamarisk, common reed

- Invertebrates—include benthic invertebrates

Only complete exposure pathways are quantitatively and qualitatively evaluated in an ERA. In order to be conservative, the following potential exposure pathways were considered for evaluation:

- Surface water—ingestion, direct contact
- Soil—ingestion, direct contact
- Sediment—ingestion, direct contact
- Dietary—ingestion of forage or prey, as appropriate, by receptor

The pathways that are subsequently addressed in further detail were divided into current and future hypothetical exposure scenarios.

2.3 Current Exposure Scenario

The terrestrial ecological habitat at the Grand Junction site is limited because the area is flat, has no significant tree cover, and has been overgrown with weedy species. Some patches of crested wheatgrass (*Agropyron cristatum*) exist as remnants of the revegetation efforts. Although the depth to ground water is relatively shallow at the millsite, the predominant vegetation includes wheatgrasses and weedy species, which are not likely to have root systems capable of reaching the aquifer. The northern boundary of the site is primarily industrial, and large expanses of the ground in the vicinity are covered with gravel, pavement, and rock. The eastern and western boundaries are adjacent to commercial properties and private residences. Remedial actions included placing a 6-inch layer of soil over the excavated tailings area and revegetating.

The area is not used for livestock grazing and is fenced to deter larger wildlife entry; however, wildlife can enter the site through the river corridor or adjacent properties. Since the contaminated tailings have been removed, ingestion of or direct contact with contaminated soils does not represent a complete exposure pathway. The only surface water associated with the terrestrial habitat at the site is a storm-water discharge canal on the western property boundary. Consequently, surface water ingestion was not evaluated for the terrestrial habitat.

The riparian and aquatic habitats associated with the Colorado River at the Grand Junction site represent the areas of significant potential exposure. Contaminated ground water associated with the former milling operations discharges into the Colorado River where COPCs may be deposited in sediment or may be present in the surface water as well as downstream of the site. Phreatophytes rooted in sediment may uptake contaminants through their root systems. Such species include sandbar willow (*Salix exigua*), cattail (*Typha sp.*), cottonwood (*Populus fremontii*), common reed (*Phragmites communis*), bulrushes, tamarisk (*Tamarix ramosissima*), and reed canarygrass (*Phalaris arundinaceae*). As mentioned in the characterization work plan (DOE 1997), elevated concentrations of some constituents were present in the wetlands mitigation ponds. Although the prominent boundaries of these ponds no longer exist, remnants of these ponds may still contain some elevated concentrations of COPCs. In addition, the sediments may act as sinks for COPCs in ground water discharging into the area, and thus represent potential sources of contamination.

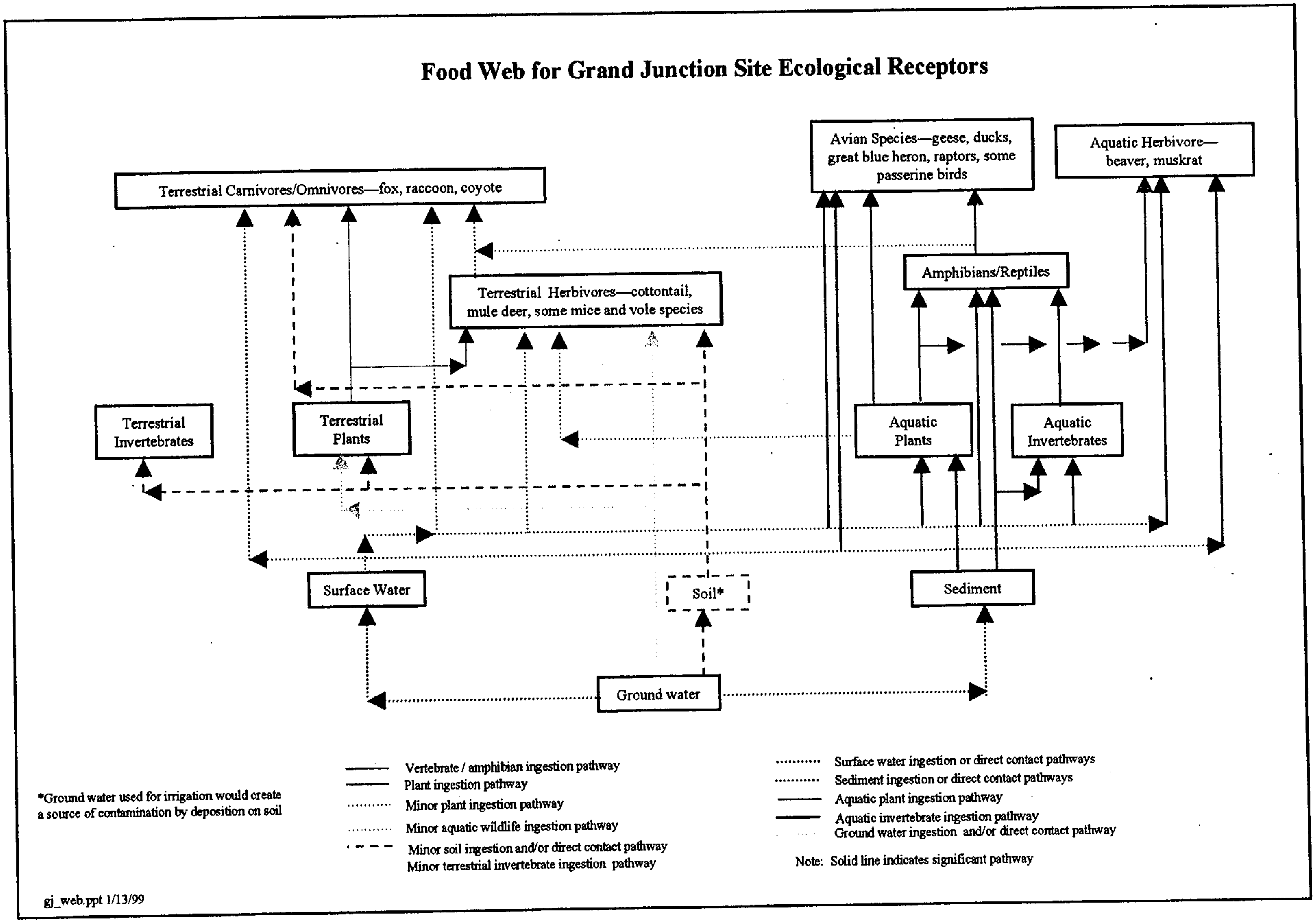


Figure I-3. Food Web for Grand Junction Site Ecological Receptors

Terrestrial receptors such as foxes, coyotes, skunks, raccoons, deer, and rodents likely use the riparian corridor for food items and as a drinking water source. Consequently, they are also exposed to potentially contaminated sediments. These terrestrial receptors typically do not spend most of their time in the riparian or aquatic areas.

Aquatic receptors living in the riparian and aquatic habitats adjacent to and downstream from the millsite have the potential to ingest contaminated sediment, surface water, and vegetation. These species have the potential for the greatest exposures. Larger herbivores prefer to browse on leafy material; smaller mammals and birds seek plant seeds and roots. Field observations in the reference area found evidence of wildlife browsing on cattails. Beaver (an herbivore) and muskrat (an omnivore that feeds chiefly on aquatic plants) forage on the types of vegetation found along the river banks. Higher trophic receptors such as coyotes, eagles, and hawks may in turn feed on small mammals or birds that have ingested contaminated food items. Aquatic avian species such as the great blue heron, ducks, geese, and killdeer frequent the Colorado River and represent ecological receptors with significant exposure potential. Aquatic invertebrates, amphibians, reptiles, and fish are also in direct contact with potentially contaminated sediment, surface water, and aquatic vegetation. These receptors can also serve as prey for eagles, herons and other wildlife.

2.4 Future Hypothetical Exposure Scenario

Because no significant habitat changes from the present scenario are expected, the future exposure scenario includes all of the current exposure scenarios associated with the riparian and aquatic habitats on the Colorado River. Localized flooding will likely continue to erode the vestiges of the wetlands mitigation ponds and reshape the river banks.

Without institutional controls, ground water could possibly be pumped and used for irrigation and livestock watering or other industrial uses. This would create a source for ground water and surface water ingestion, direct contact with terrestrial vegetation, and deposition of ground water and surface water on the soil. The soil would then represent an additional source medium for ingestion and direct contact. At present, both of these secondary exposure routes are considered incomplete since ground water is not currently used for these purposes, nor is ground water likely to be pumped in the future. Large-scale irrigation with ground water is not considered a likely future pathway because surface water is the main source of irrigation water in the Grand Junction area. As long as there is the possibility of pumping ground water for agricultural purposes, it is assumed that the potential exists for these two hypothetical exposure pathways.

The land use plans for the Grand Junction site have not been made final. One possible use is the construction of a recreation area, which would likely include the planting of various tree species. Since the potential exists for phreatophytes (e.g., cottonwood, willow, and greasewood) to inhabit the terrestrial portion of the site, contaminants in ground water could be taken up by those plants through extensive root systems. Contaminants could possibly bioaccumulate in various plant parts and exert a range of influences, depending on the specific COPC. Plant uptake rates and toxicities vary greatly among species and are affected by factors such as soil characteristics (e.g., pH, redox potential, organic matter), plant sensitivity, input-output balance, and cumulative effects. Foraging wildlife could be indirectly exposed to contaminants in ground water by ingesting plants that have bioaccumulated certain contaminants.

3.0 Analysis Phase

The analysis phase consists of two principal components: (1) the characterization of exposure, and (2) the characterization of effects, the principal products of which are summary profiles that describe exposure and the stressor-response relationships. The objective in the analysis phase is to quantify contaminant exposure (i.e., from one or more stressors) and potential ecological effects. This involves evaluating receptor attributes, toxicity, and exposure profiles.

The analysis phase for this BLRA update, which is a part of the ERA process, includes an evaluation of the current data and site ecology to determine the need for a quantitative risk assessment. As part of the BLRA update, effects on the COPC list are also discussed.

Evaluation of the 1998 analytical data and field observations are the main activities associated with the analysis phase in this screening-level assessment. If the statistical evaluations for the Grand Junction site data show no significant differences, that is, if COPC concentrations are not elevated compared to those of the reference area, or if an elevated concentration does not represent a likely ecological risk, then quantitative risk estimates will not be calculated. The risk assessment will conclude with a summary of results and conclusions based on the current data. If the data evaluation and interpretation indicate a potential for unacceptable ecological risk, then the remaining four activities under the analysis phase will be performed (i.e., preparation of exposure profiles, toxicity assessment, ecological response analysis, and development of exposure and ecological effects analysis [Figure I–1]).

3.1 Data Evaluation

This BLRA update focuses on the results of the 1998 ecological sampling, which was performed to address data gaps in the BLRA. Although the BLRA and characterization work plan presented a list of ecological COPCs, it is necessary to evaluate the newly collected data to update the COPC list. The following data evaluation serves as a subsequent rescreening of the data for COPCs in surface water, sediment, and vegetation based strictly on the 1998 ecological sampling. Where appropriate, maximum concentrations were compared to ecological screening criteria.

The 1995 BLRA (DOE 1995) used earlier ecological screening criteria. To be conservative, this ERA incorporates more current screening criteria where possible. In most cases, the criteria are based on 1996 versions of the Ecotox thresholds, Ambient Water Quality Criteria, SQC, and other screening benchmarks in the Oak Ridge National Laboratory database BENCH (ORNL 1996). Due to the limited number of media-specific (e.g., surface water, sediment, and biota) ecological screening benchmarks or regulatory standards, an UMTRA MCL may also be provided for comparison.

This data evaluation and screening process was used to determine whether site concentrations of inorganics exceeded the reference area concentrations or might pose an unacceptable ecological risk. A conservative screening approach was taken; no assumptions regarding bioavailability, persistence, or mobility were made. Inorganic analytes that are considered macronutrients (i.e., calcium, magnesium, potassium, and sodium) were removed from further evaluation in this BLRA update since toxicity is not expected.

To achieve a sufficient number of data points for statistical evaluation, the data sets were separated into two populations by matrix and vegetation type (where applicable). Locations 1216 through 1225 were categorized as reference area samples, whereas locations 1226 through 1235 were considered Grand Junction site data regardless of whether they were adjacent to or downstream of the site. In addition, no distinction was made among sampling points located on a pond, depression, or areas of open flowing water. This was done in order to achieve the necessary number of samples for statistical evaluation and to pool data from areas that potentially had the highest contaminant levels.

For each data set, on an analyte-by-analyte basis, duplicate data were incorporated by averaging the concentration in the original sample with that of its field duplicate, if available. Nondetect samples were incorporated by assigning one-half the detection limit for each nondetect. A new field, 'ecoval', was calculated for each data record that represented either the result or one-half the result (for a nondetect). No rejected data were included in the calculation of the 'ecoval' field. All statistical testing was performed on the 'ecovals' for each analyte in a data set.

Summary statistics (minimum, maximum, mean, standard deviation, number of samples, number of detects, detection frequency, and the 95 percent upper confidence limit on the arithmetic mean) for the Grand Junction site and reference area data set are included as Attachment 1

3.2 Statistical Evaluation

To evaluate the means of the analyte populations for the various matrices, a minimum of three samples was required. A sufficient number of samples was available for all the sediment and surface water data sets and for most of the vegetation species. To run a normality test using the Shapiro-Wilk W test, a minimum of five data points is required. If the data set exhibited low detection frequency (typically less than 30 percent or did not have at least three detects), no statistical testing was performed.

The Shapiro-Wilk W test was performed on both the Grand Junction site and reference area data sets; if the data were not normal, they were log-transformed and again tested for normality. If either the reference area data or the Grand Junction site data did not exhibit normality, the nonparametric Kruskal-Wallis (KW) test was used for those analytes to determine if the means of the Grand Junction site and reference area data sets were significantly different. If both data sets were normal or lognormal, a Bartlett test was performed to test for homogeneity of variance.

If both the reference area and the Grand Junction site data sets were homogeneous, a Student's t-test was performed to determine if the mean values from the reference area and Grand Junction site were significantly different. If they were not homogeneous, the KW test was applied to determine statistical difference in the means.

The KW test makes no assumptions concerning the underlying nature of the sample data. If the null hypothesis (H_o) is not rejected (i.e., it is accepted), then the site analyte data set was assumed to have the same mean as the reference area data set, and the analyte was not considered a COPC. If the alternative hypothesis (H_a) is not rejected (i.e., it is accepted), then the site analyte data set was assumed to *not* have the same mean as the reference area data set, and the analyte was considered a COPC. The null and alternative hypotheses for the KW test are provided below:

H_o: reference area mean = Grand Junction site mean (on an analyte-by-analyte basis)
H_a: reference area mean ≠ Grand Junction site mean (on an analyte-by-analyte basis)

The W test is considered effective for testing data sets with sample sizes less than 50 (Gilbert 1987). The W test is also applicable to lognormal distributions. For the W test, the null hypothesis, H_o, assumes the population follows a normal (or lognormal) distribution, and the alternative hypothesis, H_a, assumes that the population does not follow a normal (or lognormal) distribution. The null and alternative hypotheses for the W test are provided below:

H_o: The Grand Junction site (or reference area) data set (on an analyte-by-analyte basis) is drawn from an underlying normal (or lognormal) population.

H_a: The Grand Junction site (or reference area) data set (on an analyte-by-analyte basis) is not drawn from an underlying normal (or lognormal) population.

The Bartlett test was chosen as a test for homogeneity of variance since it was easily translated into a spreadsheet format. The Bartlett test is an analysis of variance test that evaluates the hypothesis that the data sets come from populations with similar variances. The test assumes that each sample set was randomly and independently drawn from a normal (or lognormal) population. The null hypothesis (H_o) assumes that the variances for the two data sets are equal. The alternative hypothesis (H_a) assumes that the variances are not equal. The null and alternative hypotheses for the Bartlett test are provided below:

H_o: reference area variance = Grand Junction site variance (on an analyte-by-analyte basis)

$$s^2_{\text{reference area}} = s^2_{\text{site}}$$

H_a: reference area variance ≠ Grand Junction site variance (on an analyte-by-analyte basis)

$$s^2_{\text{reference area}} \neq s^2_{\text{site}}$$

If the null hypothesis was not rejected (i.e., it was accepted), then the reference area data set was not homogeneous with respect to the Grand Junction site data set. The non-homogeneous site data sets were further evaluated using the nonparametric KW test to evaluate population means in a manner analogous to the parametric Student's t-test.

The Student's t-test assumes that the data sets are drawn from populations with an asymptotically normal (or lognormal) distribution, as determined by the W and Bartlett tests, and the means of the data set are then compared. The null hypothesis, H_o, assumes that the means of the reference area and Grand Junction site data sets are the same. The alternative hypothesis, H_a, assumes that the means of the reference area and site data sets are not the same. The null and alternative hypotheses for the Student's t-test are provided below:

H_o: reference area mean = Grand Junction site mean (on an analyte-by-analyte basis)

H_a: reference area mean ≠ Grand Junction site mean (on an analyte-by-analyte basis)

If the null hypothesis (H_o) was not rejected (i.e., it was accepted), then the analyte data set was assumed to have the same mean as the reference area data set, and the analyte was not considered a COPC. If the alternative hypothesis (H_a) was not rejected (i.e., it was accepted), then the Grand Junction site analyte data set was assumed not to have the same mean as the reference area data set, and the analyte was retained as COPC.

A detailed summary of the statistical evaluations for each analyte and matrix for the ecological data is provided in Appendix I.

4.0 Results

4.1 Sediment

For all analytes in sediment, with the exceptions of molybdenum, ^{228}Ra, and selenium, no significant differences existed in the population means between the Grand Junction site and reference area. Although a sufficient number of data points were available for both data sets, these analytes had such low detection frequencies in one or both data sets as to prevent statistical testing. Subsequent to external data validation, with the exception of location 1234 (1.4 mg/kg), all Grand Junction site locations for molybdenum were subsequently flagged as nondetects. Molybdenum was detected at 9 of 10 reference area locations. The only radium-228 detect (0.76 pCi/g) at the Grand Junction site was for location 1226 (300-series location 326). Radium-228 was detected in 5 out of 10 samples at the reference area with a maximum value of 0.83 pCi/g. Selenium was detected only once (Grand Junction site location 1234 [300-series location 328] [see Figure 4–15]). Summary statistics for analytes in sediment at the reference area and Grand Junction site are presented in Attachment 1.

4.2 Surface Water

Both filtered and unfiltered surface water data were available for the ecological sampling locations. However, at some locations the number of analytes differed slightly because the analyte list for the 300-series filtered surface water locations was not exactly the same as the analyte list for the ecological sampling locations. Table I–2 presents a summary of the analytes in surface water for which statistical testing was not performed because of low detection frequency or the population means showed significant differences. Although the test results for uranium in filtered and unfiltered surface water did not show a significant difference between data sets, the maximum detected concentrations (0.258 mg/L for the filtered samples and 0.263 mg/L for the unfiltered samples) occurred at Grand Junction site location 1228. Both values exceed the UMTRA MCL. For some KW and Student's t-tests (i.e., ammonia [as NH_4], and uranium), the robustness of the test was in question since inclusion or exclusion of elevated values did not change the test result. In these cases, the calculated test statistic was marginally valid. For the unfiltered surface water, this apparent anomaly may be due in part to the fact that only six values were available for ammonia at the reference area (four sample locations were missing ammonia, sulfate, and fluoride results). For those data sets with sufficient detection frequency, only ammonia and strontium mean concentrations at the Grand Junction site were elevated with respect to the reference area. Summary statistics for analytes in surface water at the reference area and Grand Junction site are presented in Attachment 1.

4.3 Ground Water

Concentrations of some COPCs are elevated with respect to background wells; however, since ecological receptors are not in direct contact with this medium, no further evaluation of ground water was conducted for the ERA. The ERA focuses on the media that are potentially contaminated as a result of contact with the contaminated ground water.

Table I–2. Summary of Analytes of Concern in Grand Junction Site Surface Water for Which Statistical Testing Was Not Performed or Population Means Showed Significant Differences

Analyte	Filtered /Unfiltered?	Test	Test Result	N	Result	Comment
Ammonia as NH_4	Filtered	Kruskal-Wallis (KW)	Reference area and Grand Junction site analyte means are significantly different.	10 (reference area) vs. 9 (Grand Junction site) –not including high value of 89.2 mg/L (Location 1228)	Filtered results do not agree with unfiltered results.	The results were same with or without high value (Location 1228); 100 % detection frequency (DF) at Grand Junction site locations; 60% DF at reference area locations.
Fluoride	Filtered	KW	Reference area and Grand Junction site analyte means are not significantly different.	10 each at reference area and Grand Junction site	Test statistic was somewhat marginal.	DF at reference area (90%) > DF at Grand Junction site (50%) but Grand Junction site values are higher than reference area values; highest Grand Junction site detect (2.06 mg/L) was for Location 1228.
Nitrate	Filtered	None	Not applicable (NA)	5 (reference area) vs. 4 (Grand Junction site)	Grand Junction site locations showed no detects while DF at reference area was 100%; data set suspect.	Nitrate was not identified as an ecological COPC but the data were available for evaluation.
Nickel	Filtered	None	NA	10 each at reference area and Grand Junction site	No detects at reference area; Grand Junction site DF=20%	Highest detect was 0.0227 mg/L at Location 1228; other value was 0.0096 mg/L at Location 1226 (326).
Radium-226	Filtered	None	NA	10 each at reference area and Grand Junction site	Only 1 detect at all locations–Grand Junction site Location 1226 (326)	Detect is a low value (0.17 pCi/L).
Selenium	Filtered	None	NA	10 each at reference area and Grand Junction site	Only 1 detect at all locations–reference area Location 1220	Grand Junction site DF=0%.
Uranium	Filtered	KW	Reference area and Grand Junction site analyte means are not significantly different.	10 each at reference area and Grand Junction site	Includes one high Grand Junction site–Location 1228 (0.258 mg/L)	Calculated test statistic (2.52) not far below Chi-square value (3.84) which is somewhat marginal.

Analyte	Filtered /Unfiltered?	Test	Test Result	N	Result	Comment
Vanadium	Filtered	None	NA	10 each at reference area and Grand Junction site	Only 1 detect (0.136 mg/L) at all locations– Grand Junction site Location 1228	Low Grand Junction site DF (10%).
Ammonia as NH_4	Unfiltered	KW and Student's t	Reference area and Grand Junction site analyte means are same	10 each at reference area and Grand Junction site	KW test statistic suspect	Results are same with or without 1, 2 or 3 highest Grand Junction site values; changing to significance level of 99% yields same results.
Arsenic	Unfiltered	Student's t	Reference area and Grand Junction site analyte means are significantly different.	10 each at reference area and Grand Junction site	Reference area mean > Grand Junction site mean	Grand Junction site concentrations less than reference area.
Molybdenum	Unfiltered	None	NA	10 each at reference area and Grand Junction site	Grand Junction site DF=100%; reference area DF=20% Based on revised data qualifiers, test results for filtered and unfiltered do not agree.	
Nickel	Unfiltered	None	NA	10 each at reference area and Grand Junction site	1 Grand Junction site detect; no detects at reference area	Low Grand Junction site DF (10%).
Radium-226	Unfiltered	None	NA	10 each at reference area and Grand Junction site	Only 1 detect (0.16 pCi/L) at all locations– Grand Junction site Location 1228	Low Grand Junction site DF (10%).
Strontium	Unfiltered	KW	Reference area and Grand Junction site analyte means are significantly different.	10 each at reference area and Grand Junction site	Grand Junction site mean > reference area mean	Reference mean > Grand Junction site mean by removal of two elevated values for Grand Junction site Locations 1226 and 1228.

Analyte	Filtered /Unfiltered?	Test	Test Result	N	Result	Comment
Uranium	Unfiltered	KW	Reference area and Grand Junction site analyte means are not significantly different.	10 each at reference area and Grand Junction site	Includes one high Grand Junction site Location 1228–0.263 mg/L.	Calculated test statistic (3.16) just below Chi-square value (3.84) which is marginal.
Vanadium	Unfiltered	None	NA	10 each at reference area and Grand Junction site	Grand Junction detect (0.15 mg/L–Location 1228) vs. reference area maximum detect–0.11 mg/L; reference area DF=20%	Low Grand Junction site DF (10%).
Zinc	Unfiltered	None	NA	10 each at reference area and Grand Junction site	Only Grand Junction site detect–Location 1228 (0.0082 mg/L); no detects at reference area.	Low Grand Junction site DF (10%).

COPC–contaminant of potential concern
N–number of samples
mg/L–milligrams per liter
pCi/L–picocuries per liter

4.4 Vegetation

Because of the varying distribution of suitable phreatophytic vegetation at the ecological sampling locations, an optimum number of samples for each vegetation type could not always be obtained. This restricted the extent of statistical evaluations, since normality testing cannot be performed on analyte distributions with less than five data points. Because willow could only be collected at two sampling locations at the reference area and Grand Junction site, no statistical evaluations could be performed. The maximum values for this matrix have the highest degree of uncertainty. All root data have a higher degree of uncertainty compared to stem data because the plant roots were in direct contact with sediment and were more difficult to clean. As expected, the plant tissue data generally varied more than the abiotic data. To discern strong differences or trends in biological data, a much larger number of sampling locations is required. An optimum number of biological samples is usually limited to budget, schedule, and vegetation availability. No order-of-magnitude differences between Grand Junction site and reference area results were observed. Such a difference in values based on the number of samples for each data set might indicate a significant discrepancy. The results differed at most by a factor of 5, but more often the factors ranged between 2 and 3. Most biota analyses were nondetects, or the population means showed no significant differences, or the reference area maximum concentration exceeded the Grand Junction site maximum. Summary statistics for the vegetation samples by analyte, matrix, and submatrix are provided in Attachment 1. Table I–3 provides a summary of analytes in vegetation for which statistical testing was not performed due to low detection frequency, or the population means showed significant differences.

5.0 Risk Assessment Discussion

The results of the ecological sampling indicate generally low levels of a few COPCs in sediment, surface water, and plant tissues. The occurrences of significant elevated concentrations coincide with sampling locations that are known to be either remnants of the wetlands mitigation ponds or ponded areas that receive little or no regular surface water flushing.

Based on sample size and variability, the strongest line-of-evidence factors for basing risk conclusions are the surface water and sediment results. In spite of the smaller sample sizes, the biota data serve as an additional but significant line-of-evidence. The tissue results show that for the majority of the analytes, Grand Junction site concentrations are the same as or less than the reference area concentrations.

The majority of the data indicate no significant differences between Grand Junction site and reference area mean analyte concentrations in both abiotic and biotic media. To maintain a conservative approach, the following constituents were retained as COPCs even though their occurrences appear to be isolated. In most cases, the occurrences coincide with Grand Junction site location 1228. On the basis of the 1998 ecological sampling, it is recommended that the following COPCs be retained:

- Ammonia in surface water
- Nickel in surface water
- Uranium in surface water
- Vanadium in surface water
- Arsenic in reed canarygrass stems
- Vanadium in reed canarygrass stems

Table I–3. Summary of Analytes of Concern in Grand Junction Site Vegetation for Which Statistical Testing Was Not Performed or Population Means Showed Significant Differences

Analyte	Vegetation	Test	Test Result	N	Result	Comment
Arsenic	Reed canarygrass stems	None	Not applicable (NA)	3 (reference area) vs. 5 (Grand Junction site)	Only detect at Grand Junction Site (1.55 mg/kg–Location 1228); 3 detects at reference area are less than single Grand Junction Site detect	Single detect suggests analyte is not a Grand Junction site-wide contaminant.
Molybdenum	Reed canarygrass stems	None	NA	3 (reference area) vs. 5 (Grand Junction site)	Only Grand Junction site detect is same as reference area detect	Comparable values for reference area and Grand Junction site suggest analyte is not elevated with respect to background.
Nickel	Reed canarygrass stems	None	NA	3 (reference area) vs. 5 (Grand Junction site)	Only one detect–Grand Junction site Location 1228	Single detect suggests analyte is not a Grand Junction site-wide contaminant.
Uranium	Reed canarygrass stems	None	NA	3 (reference area) vs. 5 (Grand Junction site)	Grand Junction site–2 detects/5 samples; only a single reference area detect	Maximum detect–Grand Junction site Location 1228 (0.195 mg/kg) vs. reference area detect (0.17 mg/kg); difference is within a reasonable margin of variability for biological data.
Vanadium	Reed canarygrass stems	None	NA	3 (reference area) vs. 5 (Grand Junction site)	Grand Junction site–3 detects/5 samples; reference area–1 detect/3 samples	Maximum detect–Grand Junction site Location 1228 (4.6 mg/kg) vs. reference area detect (0.92 mg/kg); removal of Location 1228 value, next highest Grand Junction site value is 1.0 mg/kg–difference between these two values is within a reasonable margin of variability for biological data.
Zinc	Reed canarygrass roots	None	NA	3 (reference area) vs. 5 (Grand Junction site)	Grand Junction site maximum value (163 mg/kg) vs. reference area maximum value (159 mg/kg)	Difference between Grand Junction site and reference area maximum values is within a reasonable margin of variability for biological data.
Manganese	Cattail stems	Kruskal-Wallis (KW)	Reference area and Grand Junction site analyte means are different	5 (reference area) vs. 3 (Grand Junction site)	Grand Junction site maximum (Location 1226 (326) –914 mg/kg)) vs. reference area maximum value (452 mg/kg)	N=3 is the minimum number of samples for calculating summary statistics and is not statistically robust; all three Grand Junction site values are significantly elevated over reference area values.

Analyte	Vegetation	Test	Test Result	N	Result	Comment
Molybdenum	Cattail stems	KW	Reference area and Grand Junction site analyte means are different	5 (reference area) vs. 3 (Grand Junction site	Grand Junction site maximum (Location 1226 (326)–6.4 mg/kg)) vs. reference area maximum (1.4 mg/kg)	N=3 is the minimum number of samples for calculating summary statistics and is not statistically robust; remaining two highest Grand Junction site values are approx. 2.5-3.5 times higher than reference area values.
Molybdenum	Cattail roots	KW	Reference area and Grand Junction site analyte means are different	5 (reference area) vs. 3 (Grand Junction site	Grand Junction site maximum (Location 1235–3.7 mg/kg) vs. reference area maximum (0.98 mg/kg)	N=3 is the minimum number of samples for calculating summary statistics and is not statistically robust; remaining highest Grand Junction site values are approx. 2.5-5 times higher than reference area values.
Ra-226	Cattail roots	None	NA	5 (reference area) vs. 3 (Grand Junction site	Grand Junction site single detect = reference area maximum detect	2 detects in 5 samples at reference area.
Arsenic	Willow roots	None	NA	2 (reference area) vs. 2 (Grand Junction site	3.2 mg/kg (Grand Junction site maximum) vs. 2 mg/kg (reference area maximum)	N=2–results not conclusive; however, the difference between these values is within a reasonable distribution of natural variability for biological data.
Cadmium	Willow roots	None	NA	2 (reference area) vs. 2 (Grand Junction site	1.5 mg/kg (Grand Junction maximum) vs. 0.8 mg/kg (reference area maximum)	N=2–results not conclusive; however, the difference between these values is within a reasonable distribution of natural variability for biological data.
Cobalt	Willow roots	None	NA	2 (reference area) vs. 2 (Grand Junction site	Only 1 Grand Junction site detect–1.3 mg/kg (Location 1232)	N=2–results not conclusive; single detect suggests analyte is not a Grand Junction site-wide contaminant.
Copper	Willow roots	None	NA	2 (reference area) vs. 2 (Grand Junction site	Maximum Grand Junction site detect was 7.1 mg/kg; no reference area detects.	N=2–results not conclusive; however, based on 100/%DF, analyte may represent a contaminant.
Iron	Willow roots	None	NA	2 (reference area) vs. 2 (Grand Junction site	1,800 mg/kg (Grand Junction site maximum) vs. 1,480 mg/kg (reference area maximum)	N=2–results not conclusive; however, the difference between these values is within a reasonable distribution of natural variability for biological data.
Manganese	Willow roots	None	NA	2 (reference area) vs. 2 (Grand Junction site	116 mg/kg (Grand Junction site maximum) vs. 57 mg/kg (reference area maximum)	N=2–results not conclusive; however, the difference between these values is within a reasonable distribution of natural variability for biological data.

Analyte	Vegetation	Test	Test Result	N	Result	Comment
Molybdenum	Willow roots	None	NA	2 (reference area) vs. 2 (Grand Junction site	Only detect 0.87 mg/kg–Grand Junction site Location 1232; no reference area detects	N=2–results not conclusive; single detect suggests analyte is not a Grand Junction site-wide contaminant.
Strontium	Willow roots	None	NA	2 (reference area) vs. 2 (Grand Junction site	67.8 mg/kg (Grand Junction site maximum) vs. 58.2 mg/kg (reference area maximum)	N=2–results not conclusive although these values are essentially equivalent
Cadmium	Willow stems	None	NA	2 (reference area) vs. 2 (Grand Junction site	2.3 mg/kg (Grand Junction site maximum) vs. 1.0 mg/kg (reference area maximum)	N=2–results not conclusive; however, the difference between these values is within a reasonable distribution of natural variability for biological data.
Uranium	Willow stems	None	NA	2 (reference area) vs. 2 (Grand Junction site	1 detect in 2 samples at Grand Junction site (0.13 mg/kg); no detects at reference area;	N=2–results not conclusive; single detect suggests analyte is not a Grand Junction site-wide contaminant.

- Manganese in cattail stems
- Molybdenum in cattail stems
- Molybdenum in cattail roots

Table I–4 provides additional information about the screening criteria and the potential ecological risk posed by elevated COPC concentrations. The ecological COPCs presented above are identified in bold type in the table.

One of the objectives of the characterization work plan (DOE 1997) was to collect data from areas that might have the highest contaminant levels. The highest values were obtained from ponded areas (locations 1226, 1228, and 1235, see Figure 4–15) where the Colorado River provides little or no natural flushing.

Because the occurrences are localized, elevated concentrations of ammonia and some metals in surface water and vegetation at these locations probably do not present an unacceptable ecological risk. Although unlikely, the possibility remains that an isolated effect or mortality could be associated with these locations; however, no negative ecological effects have been observed.

Location 1226 (Figure 4–15) is located at the Botanical Gardens pond. This pond is small, fenced, and provides no significant ecological habitat. The ecological sampling for surface water at this location did not include all parameters listed on the state of Colorado agricultural standards (Colorado Department of Health, Water Quality Control Commission, *The Basic Standards for Ground Waters* (Section 3.11.0, amended 4/1996). For those analytes that were included on this list, only the pH value of 9.07 was elevated over the recommended maximum value of 8.5. Based strictly on the surface water results for the ecological sampling event, there is no indication that this pond cannot be used to irrigate the plants in the arboretum.

The other ponded areas (Figure 4–15, locations 1228 and 1235) are very small and are located on a braided portion of the river. Their small size (estimated to be no more than 1,000 square feet each) restricts the numbers and types of ecological receptors that rely solely on them for surface water, forage, or prey species. In addition, wildlife receptors typically utilize a variety of prey or forage items.

Manganese concentrations in cattail stems averaged 860 mg/kg at the Grand Junction site and 300 mg/kg at the reference area. Before the bioaccumulation factors (BAFs) for manganese were calculated, the plant tissue concentrations were plotted against the sediment concentrations to detect a linear correlation. A correlation coefficient of 0.77 was obtained for the manganese data, and an r^2 of 0.6 was calculated for the linear regression trend line. BAFs were obtained by dividing the maximum co-located tissue concentration by the minimum co-located sediment concentration. The bioaccumulation factors (BAFs) calculated for manganese were approximately equal for the Grand Junction site and reference area (4.5 and 3.9, respectively). The manganese sediment concentrations for the Grand Junction site and reference area locations did not differ significantly and were all between 200 and 300 mg/kg. The screening benchmark for terrestrial plant phytotoxicity is given as 500 mg/kg in soil (ORNL 1996). A mature leaf tissue manganese concentration range of 200 to 1,000 mg/kg (dry weight) was cited as toxic in the BLRA (Kabata-Pendias and Pendias 1992, cited in DOE 1995). Manganese appears to bioaccumulate in cattail stems to a significant level at both the millsite locations and the reference area.

Table I–4. Summary of Analytes of Concern by Medium, Screening Criteria, and Interpretation of Ecological Risk

Analyte	Medium	Grand Junction Site Concentration of Concern	Screening Criterion	Data Summary	Comment	Risk Interpretation
Fluoride	Sediment	7.7 mg/kg	No SQC available	Maximum Grand Junction site detect (7.7 mg/kg) was at Location 1233; highest reference area detect was 3.2 mg/kg; 100% DF at Grand Junction site; 90% DF at reference area;	Test statistic was marginal; graphical inspection of data suggests that Grand Junction site data may be slightly elevated with respect to the reference area; next highest Grand Junction site detect was 4.9 mg/kg (Location 1235).	Based strictly on statistical testing, fluoride is not retained as a Grand Junction site COPC.
Molybdenum	Sediment	1.4 mg/kg	2.0 mg/kg–soil–terrestrial plant benchmark (Bench 1996); no SQC available	Only Grand Junction detect (1.4 mg/kg) vs. highest reference area detect (0.91 mg/kg) 10% DF at Grand Junction site; 90% DF at reference area;	Single Grand Junction site detect is at Location 1234. The difference between these values is within a reasonable distribution of natural variability for environmental data.	Low Grand Junction site DF suggests that analyte is not a COPC. Concentration is below screening benchmark for terrestrial plant phytotoxicity based on soil concentration; this benchmark is primarily for information purposes and somewhat relevant.
Radium-228	Sediment	0.76 pCi/g	For Ra-226 in sediment including daugh[illegible]L 1998): 2.82E04 pCi/g–small fish 3.32E04 pCi/g–large fish	Reference area DF (50%) >DF Grand Junction site (10%) Grand Junction site detect > maximum reference area detect	Single Grand Junction site detect is at Location 1226 (326); concentration likely elevated due to evaporation at this location as no regular flushing occurs (i.e., stagnant pond).	Low Grand Junction site DF suggests that analyte is not a COPC. Grand Junction site concentration is well below both screening criteria; benchmarks are the dry weight concentrations that produce a dose rate of 1 rad/day.
Selenium	Sediment	0.43 mg/kg	1.0 mg/kg–soil–terrestrial plant benchmark (Bench 1996); no SQC available	No detects at reference area; only 1 detect at Grand Junction site (Location 1234).	Low DF would indicate analyte is not a significant problem.	Concentration is below the screening benchmark for terrestrial plant phytotoxicity based on a soil concentration; this benchmark is primarily for information purposes and somewhat relevant

Analyte	Medium	Grand Junction Site Concentration of Concern	Screening Criterion	Data Summary	Comment	Risk Interpretation
Ammonia as NH_4	Filtered surface water	89.2 mg/L	0.0017 mg/L as ammonia –LCV for all organisms (Bench 1996) 2.4 mg/L as ammonia– LCV for aquatic plants (Bench 1996)	Detects at all Grand Junction site locations; detects at 6/10 reference area locations; 89.2 mg/L (Grand Junction site maximum–Location 1228); all but 2 Grand Junction site values < 0.1 mg/L	Means are significantly different even with removal of one high value (Location 1228); the robustness of the test is suspect for these data sets.	All but one reference area value (including non-detects at the detection limit) exceed this benchmark which suggests that it may be overly conservative. This high value may represent a localized ecological risk.
Fluoride	Filtered surface water	2.0 mg/L	None available.	KW results suggest that means are not significantly different even though reference area DF (90%) > Grand Junction site DF (50%).	Statistical test may not be sufficiently robust for these data sets. Graphical evaluation of data indicates means are similar if Locations 1226 and 1228 are not included.	Based strictly on statistical testing, analyte is not retained as a Grand Junction site COPC.
Nitrate	Filtered surface water	none	not applicable	All non-detects at Grand Junction site and all detects at reference area.	Results are suspect.	None–nitrate is not an ecological COPC.
Nickel	Filtered surface water	0.0227 mg/L	Chronic AWQC–0.160 mg/L (Ecotox 1996) < 0.005 mg/L–LCV for all organisms (Bench 1996)	Highest detect–0.0227 mg/L occurred at Grand Junction site Location 1228.	Concentration likely elevated due to evaporation at this location as no regular flushing occurs (i.e., stagnant remnant of mitigation wetland pond).	Highest value is well below AWQC but both Grand Junction site detects (Locations 1226 and 1228) exceed LCV aquatic benchmark. These high values may represent localized ecological risks.

Analyte	Medium	Grand Junction Site Concentration of Concern	Screening Criterion	Data Summary	Comment	Risk Interpretation
Ra-226	Filtered surface water	0.17 pCi/L	160 pCi/L–small fish (water) (ORNL 1998) 160 pCi/L–large fish (water) (includes short-lived progeny) (ORNL 1998) 5 pCi/L–Colorado surface water standard	Only detect (0.17 pCi/L) occurred at Grand Junction site Location 1226 (326).	Concentration likely elevated due to evaporation at this location as no regular flushing occurs (i.e., stagnant pond).	Only detect is well below screening benchmarks; ORNL benchmarks are the concentrations in water that produce a dose rate of 1 rad/day.
Uranium	Filtered surface water	0.258 mg/L	0.142 mg/L–estimated LCV for all organisms (Bench 1996) UMTRA MCL–0.044 mg/L	Highest detect (0.258 mg/L) was at Grand Junction Location 1228. All other detects were below 0.005 mg/L.	Location is stagnant remnant of mitigation wetland pond; concentration likely elevated due to evaporation at this location as no regular flushing occurs.	Concentration exceeds both criteria. The site data did not differ significantly from the reference area data even including this elevated value; the test statistic was marginal. This high value may represent a localized ecological risk.
Vanadium	Filtered surface water	0.136 mg/L	0.08 mg/L–estimated LCV for all organisms (Bench 1996) 1.9 mg/L–estimated LCV for daphnids (Bench 1996) 0.1 mg/L–Colorado agricultural standard	Only Grand Junction site detect was at Location 1228.	Location is stagnant remnant of mitigation wetland pond; concentration likely elevated due to evaporation at this location as no regular flushing occurs.	Concentration exceeds 2 of 3 criteria. This high value may represent a localized ecological risk.

Analyte	Medium	Grand Junction Site Concentration of Concern	Screening Criterion	Data Summary	Comment	Risk Interpretation
Ammonia as NH_4	Unfiltered surface water	91.7 mg/L	0.0017 mg/L as ammonia–aquatic invertebrate screening benchmark (Bench 1996) 2.4 mg/L as ammonia– LCV for aquatic plants (Bench 1996)	Detects at all Grand Junction site locations and all 6 reference area locations; Grand Junction site maximum (Location 1228–91.7 mg/L) Statistical testing indicates no significant difference in population means.	Means are not significantly different even with removal of one high value (Location 1228); the robustness of the statistical test is suspect for these data sets; graphical inspection of data reveals slightly different populations; in addition to K-W test, t-test without Location 1228 indicates means are same; this apparent anomaly may be due to N=6 for reference area for unfiltered data	Location is stagnant remnant of mitigation wetland pond; concentration likely elevated due to evaporation at this location as no regular flushing occurs. This high value may represent a localized ecological risk.
Arsenic	Unfiltered surface water	0.0088 mg/L	Chronic AWQC–0.19 mg/L (Ecotox 1996; Bench 1996) 0.914 mg/L–LCV for all organisms (Bench 1996)	Maximum value was at Grand Junction site (0.0088 mg/L–Location 1228).	Location is stagnant remnant of mitigation wetland pond; concentration likely elevated due to evaporation at this location as no regular flushing occurs.	All detects at all locations well below AWQC and aquatic benchmark.
Molybdenum	Unfiltered surface water	0.10 mg/L	0.24 mg/L–Tier II (Ecotox 1996; Bench 1996) 0.88 mg/L–LCV for all organisms (Bench 1996)	Maximum value was at Grand Junction site (0.1 mg/L–Location 1228).	Location is stagnant remnant of mitigation wetland pond; concentration likely elevated due to evaporation at this location as no regular flushing occurs.	All detects at all locations well below Tier II value and aquatic benchmark.
Nickel	Unfiltered surface water	0.0271 mg/L	Chronic AWQC–0.16 mg/L (Bench 1996) < 0.005 mg/L–LCV for all organisms (Bench 1996)	Only detect (0.0271 mg/L) was at Grand Junction site Location 1228.	Location is stagnant remnant of mitigation wetland pond; concentration likely elevated due to evaporation at this location as no regular flushing occurs.	Only detect is below AWQC but exceeds LCV for all aquatic organisms; detection limit (0.0189 mg/L) exceeds LCV benchmark. This elevated value may represent a localized ecological risk.
Ra-226	Unfiltered surface water	0.16 pCi/L	160 pCi/L–small fish (water) (ORNL 1998) 160 pCi/L–large fish (water) (includes short-lived progeny) (ORNL 1998)	Only detect was at (0.16 pCi/L–Grand Junction site Location 1228).	Concentration likely elevated due to evaporation at this location as no regular flushing occurs; location is stagnant remnant of mitigation wetland pond.	Only detect is well below screening benchmarks; benchmarks are the concentrations in water that produce a dose rate of 1 rad/day.

Analyte	Medium	Grand Junction Site Concentration of Concern	Screening Criterion	Data Summary	Comment	Risk Interpretation
Strontium	Unfiltered surface water	3.18 mg/L 5.03 mg/L	42 mg/L–LCV for all organisms (Bench 1996)	Maximum values occurred at Grand Junction site Locations 1226 and 1228.	Concentration likely elevated due to evaporation at these locations as no regular flushing occurs (stagnant ponded areas).	All detects are well below screening benchmark.
Uranium	Unfiltered surface water	0.263 mg/L	0.142 mg/L–estimated LCV for all organisms (Bench 1996) UMTRA MCL–0.044 mg/L	Highest detect (0.263 mg/L) was at Grand Junction site Location 1228. All other detects were below 0.005 mg/L.	Location is stagnant remnant of mitigation wetland pond; concentration likely elevated due to evaporation at this location as no regular flushing occurs.	Concentration exceeds both the screening criteria and MCL. The site data did not differ significantly from the reference area data even including this elevated value; the test statistic was somewhat marginal. This high value may represent a localized ecological risk.
Vanadium	Unfiltered surface water	0.155 mg/L	0.019 mg/L–Tier II (Ecotox 1996). 0.08 mg/L–LCV for all organisms (Bench 1996)	Only Grand Junction site detect (0.155 mg/L) was at Location 1228. Two reference area detects are below both criteria.	Concentration likely elevated due to evaporation at this location as no regular flushing occurs; location is stagnant remnant of mitigation wetland pond.	Concentration exceeds both screening benchmarks. This high value may represent a localized ecological risk.
Zinc	Unfiltered surface water	0.0082 mg/L.	0.10 mg/L–Chronic AWQC (Bench 1996; Ecotox 1996) 0.12 mg/L–Acute AWQC (Bench 1996)	Only detect (0.0082 mg/L) was at Grand Junction site Location [illegible]	Concentration likely elevated due to evaporation at this location as no regular flushing occurs; location is stagnant remnant of mitigation wetland pond.	Only detect is well below both AWQCs.
Arsenic	Reed canarygrass stems	1.55 mg/kg	0.621 mg/kg as arsenite–concentration in food item necessary to produce a NOAEL of 0.019 mg/kg for white-tailed deer (Bench 1996).	Maximum Grand Junction site value–1.55 mg/kg (Location 1228).	Inorganic arsenic is not generally considered a significant bioaccumulator. A BAF could not be calculated since linear correlation did not exist between sediment and tissue concentrations. Excluding one high value, all other Grand Junction site values are comparable to reference area values	Concentration exceeds screening benchmark. Consumption of single food item is unlikely, and consideration of an AUF would diminish potential exposure. This high value may represent a localized ecological risk.

Analyte	Medium	Grand Junction Site Concentration of Concern	Screening Criterion	Data Summary	Comment	Risk Interpretation
Nickel	Reed canarygrass stems	1.425 mg/kg	149 mg/kg as nickel sulfate hexahydrate–concentration in food item necessary to produce a NOAEL of 29.4 mg/kg for cottontail rabbit (Bench 1996). 364.3 mg/kg–as nickel sulfate hexahydrate–concentration in food item necessary to produce a NOAEL of 11.22 mg/kg for white-tailed deer (Bench 1996).	Only detect (1.425 mg/kg) at any location (Grand Junction site Location 1228).	Low DF (10%) would indicate analyte is not a problem.	Concentration is well below screening benchmarks.
Uranium	Reed canarygrass stems	0.195 mg/kg	14.87 mg/kg as uranyl acetate–concentration in food item necessary to produce a NOAEL of 0.458 mg/kg for white-tailed deer (Bench 1996).	Maximum Grand Junction site detect (Location 1228–0.195 mg/kg) vs. only reference area detect (0.17 mg/kg); maximum sediment value for reference area was 3.1 mg/kg; maximum sediment value for Grand Junction site was 3.0 mg/kg	Reference area–1 detect/3 samples; Grand Junction site–2 detects/5 samples These detects are essentially equivalent.	Consumption of a single food item is unlikely; consideration of an area use factor (AUF) would reduce potential exposure. Elevated concentration is below screening benchmark.

Analyte	Medium	Grand Junction Site Concentration of Concern	Screening Criterion	Data Summary	Comment	Risk Interpretation
Vanadium	Reed canarygrass stems	4.6 mg/kg	0.725 mg/kg as sodium metavanadate–concentration in food item necessary to produce a NOAEL of 0.143 mg/kg for cottontail rabbit (Bench 1996). 1.78 mg/kg as sodium metavanadate–concentration in food item necessary to produce a NOAEL of 0.055 mg/kg for white-tailed deer (Bench 1996).	Maximum Grand Junction site detect (4.6 mg/kg–Location 1228)	Removing maximum Grand Junction site detect (Location 1228–4.6 mg/kg), next highest value is 1.3 mg/kg (Grand Junction site Location 1230) vs. 0.92 mg/kg (reference area); the difference between these lesser values is within a reasonable distribution of natural variability for biological data.	Concentrations of Grand Junction two highest detects and single reference area detect are greater than lowest screening benchmark. This suggests that criterion may be overly conservative. Consumption of single food item unlikely; consideration of an AUF would reduce potential exposure. This high value may represent a localized ecological risk.
Zinc	Reed canarygrass roots	163 mg/kg	595 mg/kg as zinc oxide–concentration in food item necessary to produce a NOAEL of 118 mg/kg for cottontail rabbit (Bench 1996). 1,457 mg/kg as zinc oxide–concentration in food item necessary to produce a NOAEL of 44.9 mg/kg for white-tailed deer (Bench 1996).	Maximum value (163 mg/kg-Grand Junction site) vs. maximum value (159 mg/kg–reference area)	The difference in these values is within a reasonable distribution of natural variability for biological data.	These values are essentially equivalent. Maximum value is well below screening benchmarks.

Analyte	Medium	Grand Junction Site Concentration of Concern	Screening Criterion	Data Summary	Comment	Risk Interpretation
Manganese	Cattail stems	914 mg/kg	802 mg/kg as Mn_3O_4–concentration in food item necessary to produce a NOAEL of 25.1 mg/kg for white-tailed deer (Bench 1996).	Maximum value (914 mg/kg–Location 1226 (326) The means for the data sets differed significantly; however, there were only 3 data points for the Grand Junction site.	Calculated BAFs for Grand Junction site (4.5) and for reference area (3.9); removing Location 1226 value, replacing with next highest value, and recalculating Grand Junction site BAF results in a Grand Junction site BAF = 4.1; this recalculated BAF and reference area BAF are essentially equivalent.	Concentration exceeds screening benchmark. Consumption of single food item unlikely; consideration of an AUF would reduce potential exposure. All three Grand Junction site values may represent localized ecological risks.
Molybdenum	Cattail stems	6.4 mg/kg	1.28 mg/kg as MoO_4–concentration in food item necessary to produce a NOAEL of 0.04 mg/kg for white-tailed deer (Bench 1996). 0.52 mg/kg as MoO_4–concentration in food item necessary to produce a NOAEL of 0.10 mg/kg for cottontail rabbit (Bench 1996).	6.4 mg/kg (Grand Junction site maximum–Location 1235) vs. reference area maximum 1.4 mg/kg	BAF could not be calculated since a linear correlation did not exist between sediment and tissue concentrations.	Concentration exceeds screening benchmarks. Consumption of single food item unlikely; consideration of an AUF would reduce potential exposure. This high value may represent a localized ecological risk.

Analyte	Medium	Grand Junction Site Concentration of Concern	Screening Criterion	Data Summary	Comment	Risk Interpretation
Molybdenum	Cattail roots	3.7 mg/kg	1.28 mg/kg as MoO_4–concentration in food item necessary to produce a NOAEL of 0.04 mg/kg for white-tailed deer (Bench 1996). 0.52 mg/kg as MoO_4–concentration in food item necessary to produce a NOAEL of 0.10 mg/kg for cottontail rabbit (Bench 1996).	3.7 mg/kg (Grand Junction site maximum–Location 1235) vs. reference area maximum 0.98 mg/kg	BAF could not be calculated since a linear correlation did not exist between sediment and tissue concentrations; The difference in these values is within a reasonable distribution of natural variability for biological data.	Concentration exceeds screening benchmarks. Root data have higher degree of uncertainty due to difficulty in cleaning of tissue prior to analysis. Consumption of single food item unlikely; consideration of an AUF would reduce potential exposure. This high value may represent a localized ecological risk.
Arsenic	Willow roots	3.2 mg/kg	0.621 mg/kg as arsenite–concentration in food item necessary to produce a NOAEL of 0.019 mg/kg for white-tailed deer (Bench 1996).	3.2 mg/kg (Grand Junction site maximum–Location 1232) vs. 2 mg/kg (reference area maximum)	The difference between these values is within a reasonable natural variability for biological data. N=2 at Grand Junction site and reference area.	Both the Grand Junction and reference area concentrations exceed the screening benchmark which suggests that the criterion may be overly conservative. Root data have higher degree of uncertainty due to difficulty in cleaning of tissue prior to analysis.

Analyte	Medium	Grand Junction Site Concentration of Concern	Screening Criterion	Data Summary	Comment	Risk Interpretation
Cadmium	Willow roots	1.5 mg/kg	8.8 mg/kg as cadmium chloride–concentration in food item necessary to produce a NOAEL of 0.27 mg/kg for white-tailed deer (Bench 1996). 3.6 mg/kg as cadmium chloride–concentration in food item necessary to produce a NOAEL of 0.71 mg/kg for cottontail rabbit (Bench 1996).	1.5 mg/kg (Grand Junction site maximum–Location 1229) vs. 0.8 mg/kg (reference area maximum)	The difference between these values is within a reasonable distribution of natural variability for biological data. N=2 at Grand Junction site and reference area	Root data have higher degree of uncertainty due to difficulty in cleaning of tissue prior to analysis. Concentration is below both screening benchmarks.
Cobalt	Willow roots	1.3 mg/kg	No wildlife screening benchmark available.	1.3 mg/kg–single Grand Junction site detect–(Location 1232)	No detects at reference area N=2 at Grand Junction site and reference area	Root data have higher degree of uncertainty due to difficulty in cleaning of tissue prior to analysis. Consumption of single food item unlikely; consideration of an AUF would reduce potential exposure.
Copper	Willow roots	7.1 mg/kg	139 mg/kg as copper sulfate–concentration in food item necessary to produce a NOAEL of 3.4 mg/kg for white-tailed deer (Bench 1996). 56.6 mg/kg as copper sulfate–concentration in food item necessary to produce a NOAEL of 11.2 mg/kg for cottontail rabbit (Bench 1996).	7.1 mg/kg–single Grand Junction site detect occurred at Location 1232.	No detects at reference area N=2 at Grand Junction site and reference area	Root data have higher degree of uncertainty due to difficulty in cleaning of tissue prior to analysis. Elevated concentration is well below both screening benchmarks.

Analyte	Medium	Grand Junction Site Concentration of Concern	Screening Criterion	Data Summary	Comment	Risk Interpretation
Iron	Willow roots	1,800 mg/kg	No wildlife screening benchmark available.	1,800 mg/kg (Grand Junction site maximum) vs. 1,480 mg/kg (reference area maximum)	The difference between these values is within a reasonable distribution of natural variability for biological data N=2 at Grand Junction site and reference area	Root data have higher degree of uncertainty due to difficulty in cleaning of tissue prior to analysis.
Manganese	Willow roots	116 mg/kg	802 mg/kg as Mn_3O_4–concentration in food item necessary to produce a NOAEL of 25.1 mg/kg for white-tailed deer (Bench 1996).	116 mg/kg (Grand Junction site maximum) vs. 57 mg/kg (reference area maximum)	The difference between these values is within a reasonable distribution of natural variability for biological data. Calculated BAFs for Grand Junction site (0.49) and for reference area (0.26) –the difference in these values is within a reasonable degree of natural variability for environmental data; N=2 at Grand Junction site and reference area	Concentration is well below screening benchmark. Root data have higher degree of uncertainty due to difficulty in cleaning of tissue prior to analysis. Low BAFs suggest low likelihood of significant bioaccumulation in roots.
Molybdenum	Willow roots	0.87 mg/kg	1.28 mg/kg as MoO_4–concentration in food item necessary to produce a NOAEL of 0.04 mg/kg for white-tailed deer (Bench 1996)..	0.87 [illegible] single detect (Grand [illegible] site Location 1232)	No detects at reference area N=2 at Grand Junction site and reference area	Root data have higher degree of uncertainty due to difficulty in cleaning of tissue prior to analysis. Concentration is below screening benchmark.
Strontium	Willow roots	67.8 mg/kg	No wildlife screening benchmark available.	67.8 mg/kg (Grand Junction site maximum) vs. 58.2 mg/kg (reference area maximum)	The difference between these values is within a reasonable distribution of natural variability for biological data N=2 at Grand Junction site and reference area	Root data have a higher degree of uncertainty due to difficulty in cleaning of tissue prior to analysis.

Analyte	Medium	Grand Junction Site Concentration of Concern	Screening Criterion	Data Summary	Comment	Risk Interpretation
Uranium	Willow roots	0.72 mg/kg	14.87 mg/kg as uranyl acetate–concentration in food item necessary to produce a NOAEL of 0.458 mg/kg for white-tailed deer (Bench 1996).	0.72 mg/kg (Grand Junction site maximum) vs. 0.19 mg/kg (reference area maximum)	A BAF could not be calculated since a linear correlation did not exist between sediment and tissue concentrations. The difference between these values is likely within a reasonable distribution of natural variability for biological data. N=2 at Grand Junction site and reference area	Concentration is well below screening benchmark. Root data have higher degree of uncertainty due to difficulty in cleaning of tissue prior to analysis.
Vanadium	Willow roots	3.4 mg/kg	0.725 mg/kg as sodium metavanadate–concentration in food item necessary to produce a NOAEL of 0.143 mg/kg for cottontail rabbit (Bench 1996).	3.4 mg/kg (Grand Junction site maximum) vs. 1.5 mg/kg (reference area maximum)	A BAF could not be calculated since a linear correlation did not exist between sediment and tissue concentrations. The difference between these values is within a reasonable distribution of natural variability for biological data. N=2 at Grand Junction site and reference area	Root data have higher degree of uncertainty due to difficulty in cleaning of tissue prior to analysis Both Grand Junction site and reference area values exceed screening benchmark which suggests that criterion may be overly conservative.
Arsenic	Willow stems	0.96 mg/kg	0.621 mg/kg as arsenite–concentration in food item necessary to produce a NOAEL of 0.019 mg/kg for white-tailed deer (Bench 1996).	0.96 mg/kg (Grand Junction site maximum) vs. 0.48 mg/kg (reference area maximum)	The difference between these values is within a reasonable distribution of natural variability for biological data. N=2 at Grand Junction site and reference area	Maximum Grand Junction site value slightly exceeds screening benchmark. Root data have higher degree of uncertainty due to difficulty in cleaning of tissue prior to analysis.

Analyte	Medium	Grand Junction Site Concentration of Concern	Screening Criterion	Data Summary	Comment	Risk Interpretation
Cadmium	Willow stems	2.3 mg/kg	8.8 mg/kg as cadmium chloride–concentration in food item necessary to produce a NOAEL of 0.27 mg/kg for white-tailed deer (Bench 1996). 3.6 mg/kg as cadmium chloride–concentration in food item necessary to produce a NOAEL of 0.71 mg/kg for cottontail rabbit (Bench 1996).	2.3 mg/kg (Grand Junction site maximum) vs. 1.0 mg/kg (reference area maximum)	The difference between these values is within a reasonable distribution of natural variability for biological data. N=2 at Grand Junction site and reference area	Root data have higher degree of uncertainty due to difficulty in cleaning of tissue prior to analysis. Maximum value is below screening benchmarks.
Uranium	Willow stems	0.13 mg/kg	14.87 mg/kg as uranyl acetate-concentration in food item necessary to produce a NOAEL of 0.458 mg/kg for white-tailed deer (Bench 1996).	0.13 mg/kg– only Grand Junction site detect occurred at Location 1229.	No detects at reference area N=2 at Grand Junction site and reference area	Concentration is well below screening benchmark.

BAFs—bioaccumulation factors
COPCs—chemicals of potential concern
DF—detection frequency
KW—Kruskal-Wallis
pCi/L—picocuries per liter
pCi/g—picocuries per gram
mg/kg—milligrams per kilogram
mg/L—milligrams per liter
Tier II—Great Lakes Water Quality Initiative Tier II Methodology
LCV—lowest chronic value
AWQC—Ambient Water Quality Criteria
MCL—maximum concentration limit
NOAEL—no observed adverse effect level
SQC—Sediment Quality Criteria

ORNL—Radiological Benchmarks for Screening Contaminants of Potential Concern for Effects on Aquatic Biota at Oak Ridge National Laboratory, Oak Ridge Tennessee, BJC/0R-80, July 1998.Bench—Screening Benchmarks for Ecological Risk Assessment (Oak Ridge National Laboratory, version 1.6, 10/1996). Ecotox—Ecotox Thresholds, US EPA Office of Solid Waste and Emergency Response, January 1996, EPA 540/F-95/038.

As stated in Kabata-Pendias and Pendias 1992, "... Mn compounds are known for their rapid oxidation and reduction under variable soil environments, and thus oxidizing conditions may greatly reduce the availability of Mn and associated micronutrients, whereas reducing conditions may lead to the ready availability of these elements even up to the toxic range."

Therefore, it is possible that under stagnant conditions, manganese may become highly bioavailable to cattails, thereby producing such a high concentration as observed at Location 1226 (914 mg/kg wet-weight). Reducing conditions at the other two Grand Junction site locations (1231 and 1235) might also account for the elevated manganese concentrations in cattails. It is noteworthy that most elevated concentrations of metals in biota occurred at generally stagnant ponded areas that represent the remnants of the mitigation wetlands ponds, especially locations 1228 and 1235.

Since the data evaluation did not indicate an unacceptable ecological risk at the Grand Junction site, the ERA concludes with the analysis phase. Exposure estimates and stress-response profiles have not been calculated, and no risk characterization was performed.

Some residual milling-related constituents apparently persist at the Grand Junction site, as shown by the occasional elevated concentrations of metals and ammonia in surface water and biota. Based on a review of the analytical data and screening criteria, these isolated occurrences are not likely to present significant ecological risks.

Natural flushing is expected to diminish ground water COPC concentrations to negligible levels and prevent bioaccumulation of contaminants through phreatophytes growing in the terrestrial habitat. This situation depends on the future land use at the millsite.

Elevated concentrations of COPCs in surface water, sediment, and biota are expected to diminish over time as a result of natural ground water flushing. The sediment concentrations do not indicate site-related contamination, although elevated concentrations in some of the biota suggests that some degree of bioaccumulation is occurring. Constituent concentrations in sediment and biota are likely to persist for a longer period of time. Periodic flooding of the Colorado River adjacent to the site will tend to disperse these contaminants and remove the remaining boundaries of the mitigation wetlands ponds.

6.0 Ecological Risk Conclusion

Ecological risk assessments evaluate the likelihood that adverse ecological effects are occurring or might occur as a result of exposure to a physical, chemical, or biological entity. Section 6.2 describes the collection and evaluation of information from surface water, sediment, and vegetation to determine risks to the environment. Samples were collected from the plume area and from a reference area located in an ecologically similar environment about 3 miles east (upgradient) along the Colorado River.

Results of this sampling indicate generally low levels of a few COPCs in sediment, surface water, and plant tissues. Some residual levels of millsite-related constituents still remain in ponded areas along the Colorado River that receive little or no regular surface water flushing. Nearly all the data indicate no significant differences between the Grand Junction site and the reference area for concentrations of COPCs in biotic and abiotic media. To be conservative, it is recommended that ammonia, nickel, uranium and vanadium in surface water, arsenic and vanadium in reed canarygrass stems, manganese and molybdenum in cattail stems, and molybdenum in cattail roots be retained as COPCs. Because the data evaluation did not indicate an unacceptable ecological risk for the Grand Junction site, the ERA concludes with the analysis phase. Exposure estimates and stress-response profiles were not calculated and no risk characterization was performed.

7.0 References

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Attachment 1

Statistics for Ecological Risk Assessment Samples

Summary Statistics for the Reference Area—Inorganics in Sediment

Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Standard Deviation	UCL 95	Units
Ammonia as NH_4	10	10	100	1.60	11.50	4.47	3.59	6.55	mg/kg
Arsenic	10	10	100	4.10	6.00	5.13	0.52	5.43	mg/kg
Cadmium	10	10	100	0.17	0.67	0.28	0.14	0.36	mg/kg
Cobalt	10	10	100	2.50	4.30	3.50	0.59	3.84	mg/kg
Copper	10	10	100	5.50	14.50	9.45	2.67	10.99	mg/kg
Fluoride	10	10	100	1.10	3.20	2.07	0.69	2.47	mg/kg
Iron	10	10	100	9135	12800	11043	1124	11694	mg/kg
Manganese	10	10	100	152.0	252.0	208.7	40.72	232.3	mg/kg
Molybdenum	10	10	100	0.53	0.91	0.74	0.12	0.81	mg/kg
Nickel	10	10	100	5.90	14.20	9.48	2.32	10.82	mg/kg
Radium-226	10	10	100	0.61	1.17	0.82	0.17	0.92	pCi/g
Radium-228	5	10	50	0.16	0.83	0.47	0.27	0.62	pCi/g
Selenium	0	10	0	0.10	0.10	0.10	0.00	0.10	mg/kg
Strontium	10	10	100	62.10	110.0	82.20	16.49	91.76	mg/kg
Sulfate	10	10	100	46.10	853.0	197.3	244.7	339.1	mg/kg
Uranium	10	10	100	1.70	3.10	2.46	0.42	2.70	mg/kg
Vanadium	10	10	100	16.30	21.50	18.73	1.91	19.84	mg/kg
Zinc	10	10	100	33.75	85.40	53.83	13.92	61.89	mg/kg

UCL95—Upper 95% confidence limit.

mg/kg—milligrams per kilogram; pCi/g—picocuries per gram

Summary Statistics for the Grand Junction Site—Inorganics in Sediment

Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Standard Deviation	UCL 95	Units
Ammonia as NH_4	10	10	100	0.56	81.20	19.11	30.14	36.58	mg/kg
Arsenic	10	10	100	4.10	6.70	4.97	0.77	5.42	mg/kg
Cadmium	10	10	100	0.19	0.57	0.30	0.11	0.36	mg/kg
Cobalt	10	10	100	2.70	4.70	3.65	0.66	4.03	mg/kg
Copper	10	10	100	5.10	12.30	8.47	2.47	9.90	mg/kg
Fluoride	10	10	100	1.20	7.70	3.32	1.87	4.41	mg/kg
Iron	10	10	100	7610	14600	10808	2345	12167	mg/kg
Manganese	10	10	100	204.0	296.0	233.4	27.39	249.3	mg/kg
Molybdenum	10	10	100	0.59	1.40	0.88	0.23	1.01	mg/kg
Nickel	10	10	100	6.30	13.40	8.62	2.44	10.03	mg/kg
Radium-226	10	10	100	0.50	1.28	0.74	0.22	0.87	pCi/g
Radium-228	1	10	10	0.11	0.76	0.29	0.18	0.39	pCi/g
Selenium	1	10	10	0.10	0.43	0.13	0.10	0.19	mg/kg
Strontium	10	10	100	69.70	105.0	82.10	11.66	88.85	mg/kg
Sulfate	10	10	100	34.20	6150	1228	2019	2398	mg/kg
Uranium	10	10	100	1.80	3.00	2.35	0.35	2.55	mg/kg
Vanadium	10	10	100	14.40	28.80	21.46	5.78	24.81	mg/kg
Zinc	10	10	100	35.80	64.60	49.32	8.32	54.14	mg/kg

UCL95—Upper 95% confidence limit.

mg/kg—milligrams per kilogram; pCi/g—picocuries per gram

Summary Statistics for the Reference Area—Inorganics in Filtered Surface Water

Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Standard Deviation	UCL 95	Units
Alkalinity as CaCO3 *	5	5	100	92.0	135.0	110.8	15.51	126	mg/L
Ammonia as NH_4	6	10	60	0.001	0.097	0.032	0.032	0.051	mg/L
Arsenic	8	10	80	0.001	0.005	0.003	0.002	0.004	mg/L
Cadmium	0	10	0	0.001	0.001	0.001	0	NA	mg/L
Calcium *	5	5	100	37.00	58.40	43.38	8.54	51.5	mg/L
Calcium Carbonate *	5	5	100	111.0	160.5	129.1	23.41	151	mg/L
Chloride *	5	5	100	39.60	87.60	49.86	21.14	70.0	mg/L
Cobalt	0	10	0	0.003	0.006	0.004	0.0013	NA	mg/L
Copper	0	10	0	0.003	0.003	0.003	0	NA	mg/L
Fluoride	9	10	90	0.082	0.29	0.19	0.051	0.22	mg/L
Gross Alpha *	1	5	20	1.62	8.46	3.02	3.04	5.92	pCi/L
Gross Beta *	2	5	40	1.69	6.45	3.64	2.08	5.62	pCi/L
Hardness *	5	5	100	162.0	272.5	204.7	52.17	254	mg/L
Iron	5	10	50	0.002	0.118	0.033	0.035	0.053	mg/L
Magnesium*	5	5	100	11.40	30.90	15.560	8.58	23.74	mg/L
Manganese	10	10	100	0.002	0.043	0.019	0.016	0.028	mg/L
Molybdenum	10	10	100	0.003	0.013	0.005	0.003	0.007	mg/L
Nickel	0	10	0	0.004	0.009	0.006	0.003	NA	mg/L
Nitrate *	5	5	100	0.022	0.094	0.050	0.029	0.078	mg/L
Radium-226	0	10	0	0.065	0.130	0.087	0.021	NA	pCi/L
Radium-228	0	10	0	0.090	0.335	0.241	0.0721	NA	pCi/L
Selenium	1	10	10	0.001	0.001	0.001	0.0003	0.001	mg/L
Strontium	10	10	100	0.35	0.79	0.46	0.14	0.54	mg/L
Sulfate	10	10	100	68.50	223.0	112.5	55.59	144.7	mg/L
Uranium	10	10	100	0.002	0.005	0.002	0.001	0.003	mg/L
Vanadium	0	10	0	0.001	0.004	0.002	0.001	NA	mg/L
Zinc	2	10	20	0.003	0.018	0.005	0.005	0.007	mg/L

UCL95—Upper 95% confidence limit.

*—Not an ecological chemical of potential concern or parameter.

mg/L—milligrams per liter; pCi/L—picocuries per liter

Summary Statistics for the Grand Junction Site—Inorganics in Filtered Surface Water

Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Standard Deviation	UCL 95	Units
Alkalinity as $CaCO_3$ *	4	4	100	54.00	109.0	88.00	24.26	116.5	mg/L
Ammonia as NH_4	10	10	100	0.03	89.20	9.00	28.18	25.3	mg/L
Arsenic	7	10	70	0.001	0.008	0.003	0.002	0.005	mg/L
Calcium *	4	4	100	37.00	204.0	78.85	83.43	177	mg/L
Calcium Carbonate *	6	6	100	102.0	1180	284.3	438.8	645.3	mg/L
Cadmium	0	10	0	0.001	0.001	0.001	0	NA	mg/L
Chloride *	4	4	100	38.50	678.0	198.6	319.6	574.6	mg/L
Cobalt	0	10	0	0.003	0.006	0.005	0.001	NA	mg/L
Copper	0	10	0	0.003	0.003	0.003	0	NA	mg/L
Fluoride	7	10	70	0.08	2.06	0.40	0.62	0.76	mg/L
Gross Alpha *	0	4	0	1.49	15.34	4.97	6.91	NA	pCi/L
Gross Beta *	0	4	0	1.69	16.85	5.48	7.58	NA	pCi/L
Hardness *	6	6	100	143.0	2390	524.0	914.2	1276	mg/L
Iron	6	10	60	0.00	0.08	0.02	0.02	0.04	mg/L
Magnesium *	4	4	100	9.37	137.0	41.45	63.70	116.4	mg/L
Manganese	10	10	100	0.00	0.84	0.09	0.26	0.24	mg/L
Molybdenum	10	10	100	0.00	0.11	0.02	0.03	0.04	mg/L
Nickel	2	10	20	0.00	0.02	0.01	0.01	0.01	mg/L
Nitrate *	0	4	0	0.01	0.01	0.01	0	NA	mg/L
Potassium *	4	4	100	1.51	18.20	5.72	8.32	15.51	mg/L
Radium-226	1	10	10	0.01	0.17	0.06	0.05	0.089	pCi/L
Radium-228	0	10	0	0.04	0.44	0.22	0.13	0.293	pCi/L
Selenium	0	10	0	0.001	0.001	0.001	0	NA	mg/L
Sodium *	4	4	100	30.20	614.0	176.6	291.6	519.7	mg/L
Strontium	10	10	100	0.31	4.87	1.10	1.64	2.05	mg/L
Sulfate	10	10	100	57.2	2910	488.5	956	1042	mg/L
Total Dissolved Solids *	4	4	100	292.0	3310	1051	1506	2823	mg/L
Uranium	10	10	100	0.001	0.26	0.03	0.08	0.07	mg/L
Vanadium	1	10	10	0.001	0.14	0.02	0.04	0.04	mg/L
Zinc	1	10	10	0.003	0.01	0.003	0.002	0.004	mg/L

UCL95—Upper 95% confidence limit.

*—Not an ecological chemical of potential concern or parameter.

mg/L—milligrams per liter; pCi/L—picocuries per liter

Summary Statistics for the Reference Area—Inorganics in Unfiltered Surface Water

Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Standard Deviation	UCL 95	Units
Alkalinity as $CaCO_3$ *	5	5	100	88.00	130.0	106.6	15.16	121.1	mg/L
Ammonia as NH_4	6	6	100	0.03	0.09	0.06	0.02	0.08	mg/L
Arsenic	10	10	100	0.00	0.01	0.01	0.00	0.01	mg/L
Cadmium	0	10	0	0.00	0.00	0.00	0.00	NA	mg/L
Calcium Carbonate *	10	10	100	80.60	165.5	126.8	27.08	142.5	mg/L
Cobalt	0	10	0	0.01	0.01	0.01	0.00	NA	mg/L
Copper	0	10	0	0.00	0.00	0.00	0.00	NA	mg/L
Fluoride	6	6	100	0.17	0.42	0.23	0.09	0.31	mg/L
Hardness *	10	10	100	135.0	302.0	205.1	57.29	238.3	mg/L
Iron	10	10	100	0.06	1.74	0.81	0.48	1.09	mg/L
Manganese	10	10	100	0.00	0.06	0.04	0.02	0.05	mg/L
Molybdenum	10	10	100	0.00	0.01	0.01	0.00	0.01	mg/L
Nickel	0	10	0	0.01	0.01	0.01	0.00	NA	mg/L
Selenium	0	10	0	0.00	0.00	0.00	0.00	NA	mg/L
Strontium	10	10	100	0.35	0.72	0.46	0.13	0.53	mg/L
pH *	6	6	100	7.52	8.07	7.82	0.23	8.01	none
Radium-226	0	10	0	0.01	0.07	0.04	0.02	NA	pCi/L
Radium-228	0	10	0	0.10	0.23	0.16	0.05	NA	pCi/L
Redox Potential *	6	6	100	-196.0	178.0	78.50	147.0	199.4	mV
Specific Conductance *	6	6	100	467.0	925.0	560.5	179.0	707.8	µmhos/cm
Sulfate	6	6	100	71.50	226.0	125.1	63.84	177.6	mg/L
Uranium	10	10	100	0.00	0.00	0.00	0.00	0.003	mg/L
Vanadium	2	10	20	0.00	0.01	0.01	0.00	0.01	mg/L
Zinc	0	10	0	0.00	0.00	0.00	0.00	NA	mg/L

UCL95—Upper 95% confidence limit.
*—Not an ecological chemical of potential concern or parameter.
mg/L—milligrams per liter; pCi/L—picocuries per liter; mV—millivolt; µmhos/cm—micromhos per centimeter

Summary Statistics for the Grand Junction Site—Inorganics in Unfiltered Surface Water

Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Standard Deviation	UCL 95	Units
Alkalinity as $CaCO_3$ *	4	4	100	46.0	110	90.25	30.05	125.6	mg/L
Ammonia as NH_4	10	10	100	0.033	91.7	9.27	28.96	26.06	mg/L
Arsenic	10	10	100	0.0025	0.0088	0.0053	0.0019	0.0064	mg/L
Cadmium	1	10	10	0.00055	0.00355	0.0009	0.0009	0.0014	mg/L
Calcium Carbonate *	10	10	100	109.0	1210	263.9	358.7	471.8	mg/L
Cobalt	0	10	0	0.0061	0.0061	0.0061	0.000	0.0061	mg/L
Copper	0	10	0	0.0028	0.0028	0.0028	0.000	0.0028	mg/L
Fluoride	10	10	100	0.163	2.13	0.4445	0.620	0.804	mg/L
Hardness *	10	10	100	155.0	2460	486.7	757.5	925.7	mg/L
Iron	10	10	100	0.105	1.15	0.6254	0.292	0.795	mg/L
Manganese	10	10	100	0.019	1.39	0.1691	0.429	0.418	mg/L
Molybdenum	10	10	100	0.0028	0.101	0.0167	0.0321	0.035	mg/L
Nickel	1	10	10	0.0095	0.0271	0.0112	0.0056	0.014	mg/L
pH *	4	4	100	8.36	9.07	8.64	0.302	9.00	none
Radium-226	1	10	10	0.005	0.16	0.02875	0.048	0.06	pCi/L
Radium-228	0	10	0	0.020	0.215	0.13575	0.058	0.17	pCi/L
Redox Potential *	4	4	100	69	148	105.3	32.63	143.6	mV
Selenium	0	10	0	0.0011	0.0011	0.0011	0.000	0.001	mg/L
Specific Conductance *	4	4	100	425	4410	1431	1986	3768	µmhos/cm
Strontium	10	10	100	0.336	5.03	1.10	1.644	2.05	mg/L
Sulfate	10	10	100	63.2	3050	512.52	999.8	1092	mg/L
Temperature *	4	4	100	19.1	26.4	23.45	3.47	27.54	degrees C
Turbidity *	2	2	100	1.96	18.4	10.18	11.62	62.08	NTU
Uranium	9	10	90	0.00098	0.263	0.0278	0.083	0.076	mg/L
Vanadium	1	10	10	0.0039	0.155	0.0190	0.048	0.047	mg/L
Zinc	1	10	10	0.0034	0.0082	0.0038	0.0015	0.005	mg/L

UCL95—Upper 95% confidence limit.
*Not an ecological chemical of potential concem or parameter.
mg/L—milligrams per liter; pCi/L—picocuries/liter;
mV—millivolt; µmhos/cm—micromhos per centimeter;
C—Centigrade; NTU—normal turbidity unit

Summary Statistics for the Reference Area—Metals in Cattail Roots									
Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Std. Deviation	UCL 95	Units (wet-weight)
Arsenic	5	5	100	[illegible]	2.90	1.92	0.91	2.79	mg/kg
Cadmium	5	5	100	0.27	0.83	0.49	0.24	0.72	mg/kg
Cobalt	4	5	80	0.55	2.10	1.49	0.58	2.04	mg/kg
Copper	5	5	100	5.60	14.60	9.16	3.70	12.68	mg/kg
Iron	5	5	100	854.0	3060	2241	951.5	3148	mg/kg
Manganese	5	5	100	89.90	276.5	151.3	78.43	226.1	mg/kg
Molybdenum	5	5	100	0.51	0.99	0.74	0.18	0.91	mg/kg
Nickel	1	5	20	0.85	3.90	1.46	1.36	2.76	mg/kg
Radium-226	2	5	40	0.02	0.14	0.07	0.06	0.13	pCi/g
Radium-228	0	5	0	0.03	0.09	0.06	0.03	0.08	pCi/g
Selenium	4	5	80	0.10	0.85	0.47	0.27	0.73	mg/kg
Strontium	5	5	100	42.70	81.60	62.26	15.75	77.28	mg/kg
Uranium	5	5	100	0.13	0.72	0.39	0.23	0.60	mg/kg
Vanadium	5	5	100	0.80	10.20	3.84	3.71	7.37	mg/kg
Zinc	5	5	100	37.30	156.0	78.58	54.39	130.4	mg/kg
UCL95—Upper 95% confidence limit.									
mg/kg—milligrams per kilogram; pCi/g – picocuries per gram									

Summary Statistics for the Grand Junction Site—Metals in Cattail Roots									
Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Std. Deviation	UCL 95	Units (wet-weight)
Arsenic	3	3	100	1.70	9.60	5.63	3.95	12.29	mg/kg
Cadmium	3	3	100	0.51	1.20	0.77	0.37	1.40	mg/kg
Cobalt	3	3	100	1.30	1.70	1.50	0.20	1.84	mg/kg
Copper	3	3	100	10.10	18.40	12.97	4.71	20.90	mg/kg
Iron	3	3	100	2290	4730	3350	1251	5459	mg/kg
Manganese	3	3	100	224.0	418.0	347.0	106.9	527.3	mg/kg
Molybdenum	3	3	100	1.20	3.70	2.47	1.25	4.57	mg/kg
Nickel	1	3	33	0.85	1.70	1.13	0.49	1.96	mg/kg
Radium-226	1	3	33	0.04	0.14	0.07	0.06	0.17	pCi/g
Radium-228	0	3	0	0.02	0.25	0.16	0.12	0.36	pCi/g
Selenium	3	3	100	0.42	0.51	0.45	0.05	0.54	mg/kg
Strontium	3	3	100	60.80	92.10	81.47	17.90	111.6	mg/kg
Uranium	3	3	100	0.36	0.59	0.45	0.13	0.66	mg/kg
Vanadium	3	3	100	1.40	5.20	3.53	1.94	6.81	mg/kg
Zinc	3	3	100	86.50	114.0	98.57	14.06	122.3	mg/kg
UCL95—Upper 95% confidence limit.									
mg/kg—milligrams per kilogram; pCi/g—picocuries per gram									

Summary Statistics for the Reference Area—Metals in Cattail Stems

Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Std. Deviation	UCL 95	Units (wet-weight)
Arsenic	5	5	100	0.34	0.94	0.63	0.22	0.84	mg/kg
Cadmium	3	5	60	0.05	0.69	0.25	0.27	0.50	mg/kg
Cobalt	1	5	20	0.55	1.08	0.66	0.23	0.88	mg/kg
Copper	5	5	100	3.50	7.00	4.87	1.32	6.13	mg/kg
Iron	5	5	100	217.0	535.0	330.3	122.8	447.4	mg/kg
Manganese	5	5	100	107.0	591.0	303.5	214.5	508.0	mg/kg
Molybdenum	5	5	100	0.18	1.40	0.85	0.48	1.31	mg/kg
Nickel	0	5	0	0.85	0.85	0.85	0.00	NA	mg/kg
Radium-226	0	5	0	0.00	0.07	0.02	0.03	0.05	pCi/g
Radium-228	0	5	0	0.11	0.31	0.25	0.08	0.33	pCi/g
Selenium	4	5	80	0.10	1.40	0.58	0.49	1.04	mg/kg
Strontium	5	5	100	80.9	107.0	94.44	9.36	103.4	mg/kg
Uranium	1	5	20	0.05	0.23	0.09	0.08	0.16	mg/kg
Vanadium	1	5	20	0.35	1.00	0.48	0.29	0.76	mg/kg
Zinc	5	5	100	19.50	210.0	61.68	83.01	140.8	mg/kg

UCL95—Upper 95% confidence limit.
mg/kg—milligrams per kilogram; pCi/g—picocuries per gram

Summary Statistics for the Grand Junction Site—Metals in Cattail Stems

Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Std. Deviation	UCL 95	Units (wet-weight)
Arsenic	3	3	100	0.66	1.20	0.93	0.27	1.38	mg/kg
Cadmium	3	3	100	0.10	0.13	0.11	0.02	0.14	mg/kg
Cobalt	0	3	0	0.55	0.55	0.55	0.00	NA	mg/kg
Copper	3	3	100	3.00	4.20	3.43	0.67	4.56	mg/kg
Iron	3	3	100	249.0	480.0	361.0	115.7	556.0	mg/kg
Manganese	3	3	100	826.0	914.0	857.7	48.91	940.1	mg/kg
Molybdenum	3	3	100	3.50	6.40	4.70	1.51	7.25	mg/kg
Nickel	0	3	0	0.85	0.85	0.85	0.00	NA	mg/kg
Radium-226	0	3	0	0.01	0.04	0.02	0.02	0.04	pCi/g
Radium-228	0	3	0	0.06	0.26	0.19	0.11	0.38	pCi/g
Selenium	3	3	100	0.50	0.77	0.65	0.14	0.88	mg/kg
Strontium	3	3	100	103.0	128.0	111.3	14.43	135.7	mg/kg
Uranium	0	3	0	0.05	0.05	0.05	0.00	NA	mg/kg
Vanadium	0	3	0	0.35	0.35	0.35	0.00	0.35	mg/kg
Zinc	3	3	100	19.10	24.20	21.10	2.72	25.69	mg/kg

UCL95—Upper 95% confidence limit.
mg/kg—milligrams per kilogram; pCi/g—picocuries per gram

Summary Statistics for the Reference Area—Metals in Reed Canarygrass Roots

Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Std. Deviation	UCL 95	Units (wet-weight)
Arsenic	3	3	100	2.80	7.40	5.67	2.50	9.88	mg/kg
Cadmium	3	3	100	0.74	3.80	1.85	1.70	4.71	mg/kg
Cobalt	3	3	100	1.50	2.80	2.13	0.65	3.23	mg/kg
Copper	3	3	100	18.60	42.40	27.30	13.13	49.43	mg/kg
Iron	3	3	100	3490	8840	5543	2884	10405	mg/kg
Manganese	3	3	100	83.80	181.0	128.6	49.04	211.3	mg/kg
Molybdenum	3	3	100	0.91	3.70	1.87	1.59	4.54	mg/kg
Nickel	2	3	67	0.85	5.70	3.28	2.43	7.37	mg/kg
Radium-226	1	3	33	0.03	0.18	0.08	0.09	0.23	pCi/g
Radium-228	0	3	0	0.07	0.33	0.19	0.13	0.41	pCi/g
Selenium	3	3	100	0.48	3.00	1.37	1.41	3.75	mg/kg
Strontium	3	3	100	24.10	43.90	34.87	10.01	51.75	mg/kg
Uranium	3	3	100	0.45	2.60	1.19	1.22	3.25	mg/kg
Vanadium	3	3	100	5.60	13.70	8.37	4.62	16.16	mg/kg
Zinc	3	3	100	64.90	159.0	118.6	48.45	200.3	mg/kg

UCL95—Upper 95% confidence limit.
mg/kg—milligrams per kilogram; pCi/g—picocuries per gram

Summary Statistics for the Grand Junction Site—Metals in Reed Canarygrass Roots

Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Std. Deviation	UCL 95	Units (wet-weight)
Arsenic	5	5	100	1.00	6.35	3.07	2.22	5.19	mg/kg
Cadmium	5	5	100	0.82	2.50	1.50	0.66	2.14	mg/kg
Cobalt	4	5	80	0.55	2.20	1.45	0.64	2.06	mg/kg
Copper	5	5	100	10.15	37.50	23.55	10.07	33.15	mg/kg
Iron	5	5	100	572.0	4880	2282	1799	3997	mg/kg
Manganese	5	5	100	45.70	181.0	123.8	51.95	173.4	mg/kg
Molybdenum	5	5	100	0.35	1.00	0.69	0.25	0.93	mg/kg
Nickel	3	5	60	0.85	4.55	2.55	1.70	4.17	mg/kg
Radium-226	0	5	0	0.01	0.05	0.02	0.01	0.04	pCi/g
Radium-228	0	5	0	0.00	0.37	0.20	0.14	0.33	pCi/g
Selenium	5	5	100	0.29	0.94	0.66	0.26	0.91	mg/kg
Strontium	5	5	100	17.50	42.80	31.15	11.40	42.02	mg/kg
Uranium	5	5	100	0.40	1.20	0.70	0.32	1.00	mg/kg
Vanadium	5	5	100	1.30	6.80	3.56	2.25	5.70	mg/kg
Zinc	5	5	100	102.0	163.0	125.4	26.27	150.5	mg/kg

UCL95—Upper 95% confidence limit.
mg/kg—milligrams per kilogram; pCi/g—picocuries per gram

Summary Statistics for the Reference Area—Metals in Reed Canarygrass Stems

Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Std. Deviation	UCL 95	Units (wet-weight)
Arsenic	3	3	100	0.51	0.59	0.54	0.04	0.61	mg/kg
Cadmium	2	3	67	0.05	0.20	0.12	0.08	0.25	mg/kg
Cobalt	0	3	0	0.55	0.55	0.55	0.00	NA	mg/kg
Copper	3	3	100	3.30	7.40	4.90	2.19	8.60	mg/kg
Iron	3	3	100	237.0	486.0	382.7	129.8	601.5	mg/kg
Manganese	3	3	100	58.40	98.70	80.30	20.38	114.7	mg/kg
Molybdenum	3	3	100	0.25	0.67	0.41	0.23	0.79	mg/kg
Nickel	0	3	0	0.85	0.85	0.85	0.00	NA	mg/kg
Radium-226	0	3	0	0.00	0.01	0.01	0.01	0.02	pCi/g
Radium-228	0	3	0	0.22	0.27	0.25	0.03	0.30	pCi/g
Selenium	3	3	100	0.30	1.10	0.61	0.43	1.33	mg/kg
Strontium	3	3	100	15.10	48.70	27.30	18.59	58.65	mg/kg
Uranium	1	3	33	0.05	0.17	0.09	0.07	0.21	mg/kg
Vanadium	1	3	33	0.35	0.92	0.54	0.33	1.09	mg/kg
Zinc	3	3	100	28.70	69.80	45.13	21.75	81.80	mg/kg

UCL95—Upper 95% confidence limit.
mg/kg—milligrams per kilogram; pCi/g—picocuries per gram

Summary Statistics for Grand Junction Site—Metals in Reed Canarygrass Stems

Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Std. Deviation	UCL 95	Units (wet-weight)
Arsenic	5	7	71	0.68	1.55	0.93	0.35	1.19	mg/kg
Cadmium	5	7	71	0.11	0.25	0.17	0.06	0.22	mg/kg
Cobalt	0	7	0	0.55	0.55	0.55	0.00	0.55	mg/kg
Copper	5	5	100	2.80	6.80	4.77	1.65	6.34	mg/kg
Iron	5	5	100	307.0	2005	727.4	717.7	1411.7	mg/kg
Manganese	5	5	100	67.50	135.0	83.92	28.70	111.3	mg/kg
Molybdenum	5	5	100	0.40	0.84	0.65	0.16	0.80	mg/kg
Nickel	1	5	20	0.85	1.43	0.97	0.26	1.21	mg/kg
Radium-226	0	5	0	0.01	0.04	0.02	0.01	0.03	pCi/g
Radium-228	0	5	0	0.03	0.35	0.19	0.14	0.32	pCi/g
Selenium	5	5	100	0.23	0.70	0.49	0.17	0.66	mg/kg
Strontium	5	5	100	27.50	37.15	31.99	3.54	35.36	mg/kg
Uranium	1	4	25	0.05	0.12	0.07	0.04	0.11	mg/kg
Vanadium	3	5	60	0.35	4.60	1.52	1.77	3.21	mg/kg
Zinc	5	5	100	31.80	55.60	43.72	9.53	52.81	mg/kg

UCL95—Upper 95% confidence limit.
mg/kg—milligrams per kilogram; pCi/g—picocuries per gram

Summary Statistics for the Reference Area—Metals in Willow Roots

Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Std. Deviation	UCL 95	Units (wet-weight)
Arsenic	2	2	100	0.75	2.00	1.38	0.88	5.32	mg/kg
Cadmium	2	2	100	0.27	0.79	0.53	0.37	2.17	mg/kg
Cobalt	0	2	0	0.55	0.55	0.55	0.00	NA	mg/kg
Copper	2	2	100	4.60	7.10	5.85	1.77	13.74	mg/kg
Iron	2	2	100	454.0	1480	967.0	725.5	4206	mg/kg
Manganese	2	2	100	48.60	57.30	52.95	6.15	80.42	mg/kg
Molybdenum	2	2	100	0.40	0.41	0.41	0.01	0.44	mg/kg
Nickel	0	2	0	0.85	0.85	0.85	0.00	NA	mg/kg
Radium-226	0	2	0	0.01	0.05	0.03	0.03	0.15	pCi/g
Radium-228	0	2	0	0.07	0.24	0.16	0.12	0.69	pCi/g
Selenium	1	2	50	0.10	0.34	0.22	0.17	0.98	mg/kg
Strontium	2	2	100	37.00	58.20	47.60	14.99	114.5	mg/kg
Uranium	2	2	100	0.17	0.19	0.18	0.01	0.24	mg/kg
Vanadium	1	2	50	0.35	1.50	0.93	0.81	4.56	mg/kg
Zinc	2	2	100	53.50	95.80	74.65	29.91	208.2	mg/kg

UCL95—Upper 95% confidence limit.
mg/kg—milligrams per kilogram; pCi/g—picocuries per gram

Summary Statistics for Grand Junction Site—Metals in Willow Roots

Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Std. Deviation	UCL 95	Units (wet-weight)
Arsenic	2	2	100	1.20	3.20	2.20	1.41	8.51	mg/kg
Cadmium	2	2	100	0.44	1.50	0.97	0.75	4.32	mg/kg
Cobalt	1	2	50	0.55	1.30	0.93	0.53	3.29	mg/kg
Copper	2	2	100	5.40	7.10	6.25	1.20	11.62	mg/kg
Iron	2	2	100	374.0	1800	1087	1008	5589	mg/kg
Manganese	2	2	100	21.50	116.00	68.75	66.82	367.1	mg/kg
Molybdenum	2	2	100	0.59	0.87	0.73	0.20	1.61	mg/kg
Nickel	0	2	0	0.85	0.85	0.85	0.00	NA	mg/kg
Radium-226	0	2	0	0.02	0.03	0.02	0.01	0.05	pCi/g
Radium-228	0	2	0	0.29	0.35	0.32	0.05	0.52	pCi/g
Selenium	2	2	100	0.34	0.36	0.35	0.01	0.41	mg/kg
Strontium	2	2	100	53.00	67.80	60.40	10.47	107.1	mg/kg
Uranium	2	2	100	0.67	0.72	0.70	0.04	0.85	mg/kg
Vanadium	2	2	100	0.77	3.40	2.09	1.86	10.39	mg/kg
Zinc	2	2	100	50.90	84.40	67.65	23.69	173.4	mg/kg

UCL95—Upper 95% confidence limit.
mg/kg—milligrams per kilogram; pCi/g—picocuries per gram

Summary Statistics for the Reference Area—Metals in Willow Stems

Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Std. Deviation	UCL 95	Units (wet-weight)
Arsenic	2	2	100	0.35	0.48	0.42	0.09	0.83	mg/kg
Cadmium	2	2	100	0.69	1.00	0.85	0.22	1.82	mg/kg
Cobalt	0	2	0	0.55	0.55	0.55	0.00	NA	mg/kg
Copper	2	2	100	4.30	6.70	5.50	1.70	13.08	mg/kg
Iron	2	2	100	171.0	314.0	242.5	101.1	694.0	mg/kg
Manganese	2	2	100	44.20	117.0	80.60	51.48	310.4	mg/kg
Molybdenum	2	2	100	0.11	0.16	0.14	0.04	0.29	mg/kg
Nickel	0	2	0	0.85	0.85	0.85	0.00	NA	mg/kg
Radium-226	0	2	0	0.00	0.01	0.01	0.01	0.04	pCi/g
Radium-228	0	2	0	0.28	0.31	0.29	0.02	0.37	pCi/g
Selenium	2	2	100	0.34	0.86	0.60	0.37	2.24	mg/kg
Strontium	2	2	100	54.90	108.0	81.45	37.55	249.1	mg/kg
Uranium	0	2	0	0.05	0.05	0.05	0.00	NA	mg/kg
Vanadium	0	2	0	0.35	0.35	0.35	0.00	NA	mg/kg
Zinc	2	2	100	76.30	120.0	98.15	30.90	236.1	mg/kg

UCL95—Upper 95% confidence limit.
mg/kg—milligrams per kilogram; pCi/g—picocuries per gram

Summary Statistics for the Grand Junction Site—Metals in Willow Stems

Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Std. Deviation	UCL 95	Units (wet-weight)
Arsenic	2	2	100	0.74	0.96	0.85	0.16	1.54	mg/kg
Cadmium	2	2	100	0.33	2.30	1.32	1.39	7.53	mg/kg
Cobalt	0	2	0	0.55	0.55	0.55	0.00	NA	mg/kg
Copper	2	2	100	4.90	5.60	5.25	0.49	7.46	mg/kg
Iron	2	2	100	160.0	163.0	161.5	2.12	171.0	mg/kg
Manganese	2	2	100	43.40	82.30	62.85	27.51	185.7	mg/kg
Molybdenum	2	2	100	0.12	0.27	0.20	0.11	0.67	mg/kg
Nickel	0	2	0	0.85	0.85	0.85	0.00	NA	mg/kg
Radium-226	0	2	0	0.02	0.03	0.02	0.01	0.05	pCi/g
Radium-228	0	2	0	0.24	0.38	0.31	0.10	0.73	pCi/g
Selenium	2	2	100	0.23	0.31	0.27	0.06	0.52	mg/kg
Strontium	2	2	100	88.00	98.90	93.45	7.71	127.9	mg/kg
Uranium	1	2	50	0.05	0.13	0.09	0.06	0.34	mg/kg
Vanadium	0	2	0	0.35	0.35	0.35	0.00	NA	mg/kg
Zinc	2	2	100	36.10	114.0	75.05	55.08	321.0	mg/kg

UCL95—Upper 95% confidence limit.
mg/kg—milligrams per kilogram; pCi/g—picocuries per gram

Attachment 2

Raw Data for Ecological Risk Assessment by Water, Sediments, and Plants Tissue

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Ecological Sampling Data

Loc Id	Matrix	Date	Sample Id	As mg/kg	Cd mg/kg	Co mg/kg	Cu mg/kg	Fe mg/kg	Fluoride mg/kg	LOD %	Mn mg/kg	Mo mg/kg
Reference												
1216	Sediment	06/30/98	00S1	5.4	.26B	3.7B	11.1	12800	2.8N	--	181N	.6BN
	Bullrush Roots	06/23/98	00V4	1.2	.44B	1.8B	20.3	1590	--	84.7	303	.57B
	Bullrush Stems	06/23/98	00V3	.65B	.1U	1.1U	5.4	471	--	83.1	325	.84B
	Cattail Roots	06/23/98	00V2	1.5	.46B	2.1B	10	3040	--	85.8	111	.7B
	Cattail Stems	06/23/98	00V1	.94B	.1U	1.1U	4.8	535	--	82.7	107	1.4
1217	Sediment	06/30/98	00S1	5.3	.23B	4.3B	10.4	12100	3.2N	--	229N	.53BN
	Reed Canarygrass Roots	06/23/98	00V2	2.8	.74	1.5B	18.6	3490	--	63.8	121	.99B
	Reed Canarygrass Stems	06/23/98	00V1	.53B	.12B	1.1U	4	486	--	74.5	83.8	.3B
1218	Sediment	06/30/98	00S1	5.6	.27B	3.5B	14.5	11400	1.6BN	--	166N	.72BN
	Cattail Roots	06/23/98	00V2	2.9	.83	1.7B	9.8	3060	--	65.7	99.2	.83B
	Cattail Stems	06/23/98	00V1	.6B	.69	1.1U	7	343	--	69.9	107	.18B
1219	Sediment	06/30/98	00S1	4.8	.21B	3.1B	9.2	10300	2.4N	--	217N	.72BN
	Willow Roots	06/23/98	00V2	.75B	.27B	1.1U	7.1	454	--	79.6	48.6	.4B
	Willow Stems	06/23/98	00V1	.48B	.69	1.1U	6.7	314	--	80.3	117	.16B
1220	Sediment	06/30/98	00S1	4.1	.67	3.5B	7.5	10900	1.3BN	--	156N	.91BN
	Reed Canarygrass Roots	06/23/98	00V2	7.4	3.8	2.8B	42.4	8840	--	85.3	83.8	3.7
	Reed Canarygrass Stems	06/23/98	00V1	.59B	.2B	1.1U	7.4	425	--	81.8	58.4	.67B
1221	Sediment	07/01/98	00S1	4.7	.25B	2.8B	5.5	8720	1.9B	--	247	.94B
	Sediment	07/01/98	00S2	5.1	.27B	3.2B	6	9550	1.8B	--	254	.78B
	Cattail Roots	06/24/98	00V2	2	.27B	1.1U	5.6	1700	--	84	180	.67B
	Cattail Stems	06/24/98	00V1	.71B	.1U	1.1U	4.1	278	--	87.5	591	1.2
1222	Sediment	06/30/98	00S1	5.3	.3B	4B	10.6	11600	1.5BN	--	252N	.74BN
	Cattail Roots	06/23/98	00V2	3.3	.63	1.9B	15.4	3080	--	92.9	251	1.2
	Cattail Roots	06/23/98	00V4	1.9	.63	1.5B	13.8	2020	--	92.7	302	.77B
	Cattail Stems	06/23/98	00V1	.55B	.13B	1.1U	5.2	323	--	87.3	461	.91B
	Cattail Stems	06/23/98	00V3	.6B	.12B	1.6B	4.7	234	--	87.1	444	.82B
1223	Sediment	06/30/98	00S1	6	.19B	4.3B	10.3	11800	2.4N	--	248N	.86BN
	Reed Canarygrass Roots	06/23/98	00V2	6.8	1	2.1B	20.9	4300	--	84	181	.91B
	Reed Canarygrass Stems	06/23/98	00V1	.51B	.1U	1.1U	3.3	237	--	75.6	98.7	.25B
1224	Sediment	06/30/98	00S1	5	.17B	2.5B	5.5	9690	1.1BN	--	235N	.68BN
	Willow Roots	06/23/98	00V2	2	.79	1.1U	4.6	1480	--	65.4	57.3	.41B
	Willow Stems	06/23/98	00V1	.35B	1	1.1U	4.3	171	--	69.3	44.2	.11B
1225	Sediment	06/30/98	00S1	4.9	.21B	3.1B	9.6	10700	2.5N	--	152N	.8BN
	Cattail Roots	06/23/98	00V2	.61B	.27B	1.4B	5.8	854	--	82.7	89.9	.51B
	Cattail Stems	06/23/98	00V1	.34B	.31B	1.1U	3.5	217	--	88.3	260	.6B
Site												
1226	Sediment	07/01/98	00S1	5.1	.37B	3.3B	9.8	10500	2.7	--	261	.81B
	Cattail Roots	06/24/98	00V2	1.7	.61	1.3B	10.4	2290	--	88.9	224	1.2
	Cattail Stems	06/24/98	00V1	.66B	.1B	1.1U	3.1	480	--	85.1	914	3.5
1227	Sediment	07/01/98	00S1	4.1	.19B	3.2B	7.6	8680	1.7B	--	204	.64B
	Reed Canarygrass Roots	06/24/98	00V2	1.3	1.1	1.3B	37.5	927	--	89.8	160	.57B
	Reed Canarygrass Stems	06/24/98	00V1	.76B	.22B	1.1U	2.8	376	--	72.5	135	.4B

Ecological Sampling Data

Loc Id	Matrix	Date	Sample Id	NH4 mg/kg	Ni mg/kg	Ra-226 pCi/g	Ra-228 pCi/g	Se mg/kg	SO4 mg/kg	Sr mg/kg	U mg/kg	V mg/kg
Reference												
1216	Sediment	06/30/98	00S1	2.3	14.2	.9	.81	.2UN	71.5	67.1	3.1	20.4
	Bullrush Roots	06/23/98	00V4	--	1.9B	.09	-.69	.59	--	25	.34B	3.5B
	Bullrush Stems	06/23/98	00V3	--	1.7U	.03	-.85	1.2	--	77.3	.1U	1.3B
	Cattail Roots	06/23/98	00V2	--	3.9B	.13	-.1	.49B	--	61.9	.25B	10.2
	Cattail Stems	06/23/98	00V1	--	1.7U	-.04	-.62	.46B	--	80.9	.1U	1B
1217	Sediment	06/30/98	00S1	5.1	9.7	.81	.72	.2UN	305	78.5	2.4	17.9
	Reed Canarygrass Roots	06/23/98	00V2	--	3.3B	.07	-.65	.63	--	24.1	.45B	5.8
	Reed Canarygrass Stems	06/23/98	00V1	--	1.7U	.02	-.52	.42B	--	15.1	.1U	.7U
1218	Sediment	06/30/98	00S1	2.3	11.7	.99	.56	.2UN	92.2	65.8	2.9	17.4
	Cattail Roots	06/23/98	00V2	--	1.7U	.14	-.18	.56	--	73.4	.72	3.2B
	Cattail Stems	06/23/98	00V1	--	1.7U	-.01	-.53	.43B	--	107	.23B	.7U
1219	Sediment	06/30/98	00S1	9.9	9.2	.7	.55	.2UN	76.1	95.3	2.1	16.3
	Willow Roots	06/23/98	00V2	--	1.7U	.01	-.48	.34B	--	37	.17B	.7U
	Willow Stems	06/23/98	00V1	--	1.7U	0	-.61	.86	--	108	.1U	.7U
1220	Sediment	06/30/98	00S1	2	8.9	1.17	.71	.2UN	103	69.9	2.8	21.4
	Reed Canarygrass Roots	06/23/98	00V2	--	5.7	.18	.35	3	--	43.9	2.6	13.7
	Reed Canarygrass Stems	06/23/98	00V1	--	1.7U	.02	-.43	1.1	--	48.7	.17B	.92B
1221	Sediment	07/01/98	00S1	1.7	7.4	.64	.67	.2U	1090N	77.8	2.1	15
	Sediment	07/01/98	00S2	1.6	6.3	.63	.25	.2U	616N	81.4	2.2	17.6
	Cattail Roots	06/24/98	00V2	--	1.7U	-.09	-.16	.85*	--	42.7	.13B	.8B
	Cattail Stems	06/24/98	00V1	--	1.7U	-.14	.22	1.4*	--	94.2	.1U	.7U
1222	Sediment	06/30/98	00S1	2.6	9.7	.76	.83	.2UN	65.9	97.3	2.6	17.9
	Cattail Roots	06/23/98	00V2	--	1.7U	-.04	-.14	.53	--	83.2	.54	3.9B
	Cattail Roots	06/23/98	00V4	--	1.7U	-.04	.03	.21B	--	80	.41B	2.7B
	Cattail Stems	06/23/98	00V1	--	1.7U	-.02	-.49	.6	--	95.2	.1U	.7U
	Cattail Stems	06/23/98	00V3	--	1.7U	-.05	-.69	.39B	--	99	.1U	.7U
1223	Sediment	06/30/98	00S1	11.5	8.6	.87	.45	.2UN	124	110	2.5	21.5
	Reed Canarygrass Roots	06/23/98	00V2	--	1.7U	.05	.14	.48B	--	36.6	.53	5.6
	Reed Canarygrass Stems	06/23/98	00V1	--	1.7U	0	-.54	.3B	--	18.1	.1U	.7U
1224	Sediment	06/30/98	00S1	1.6	5.9	.61	.32	.2UN	46.1	96.4	1.7	19.3
	Willow Roots	06/23/98	00V2	--	1.7U	-.09	.14	.2U	--	58.2	.19B	1.5B
	Willow Stems	06/23/98	00V1	--	1.7U	-.02	-.56	.34B	--	54.9	.1U	.7U
1225	Sediment	06/30/98	00S1	5.7	10	.79	.54	.2UN	236	62.1	2.3	18.9
	Cattail Roots	06/23/98	00V2	--	1.7U	-.03	-.05	.2U	--	51.7	.36B	1.7B
	Cattail Stems	06/23/98	00V1	--	1.7U	0	-.58	.2U	--	93	.1U	.7U
Site												
1226	Sediment	07/01/98	00S1	.56	7.4	.82	.76	.2U	654N	69.7	2.4	26.5
	Cattail Roots	06/24/98	00V2	--	1.7U	-.08	.04	.51*	--	60.8	.39B	1.4B
	Cattail Stems	06/24/98	00V1	--	1.7U	-.07	.12	.67*	--	103	.1U	.7U
1227	Sediment	07/01/98	00S1	6.3	7	.71	.42	.2U	34.2N	84.5	2.2	14.4
	Reed Canarygrass Roots	06/24/98	00V2	--	1.7U	-.05	0	.87*	--	21.1	.66	2.2B
	Reed Canarygrass Stems	06/24/98	00V1	--	1.7U	-.08	-.05	.58*	--	31.6	.1U	.7U

Loc Id	Matrix	Date	Sample Id	Zn mg/kg
Reference				
1216	Sediment	06/30/98	00S1	58.8
	Bullrush Roots	06/23/98	00V4	46.5
	Bullrush Stems	06/23/98	00V3	14.2
	Cattail Roots	06/23/98	00V2	45.6
	Cattail Stems	06/23/98	00V1	22.4
1217	Sediment	06/30/98	00S1	55.2
	Reed Canarygrass Roots	06/23/98	00V2	64.9
	Reed Canarygrass Stems	06/23/98	00V1	36.9
1218	Sediment	06/30/98	00S1	55.3
	Cattail Roots	06/23/98	00V2	156
	Cattail Stems	06/23/98	00V1	210
1219	Sediment	06/30/98	00S1	43.7
	Willow Roots	06/23/98	00V2	53.5
	Willow Stems	06/23/98	00V1	120
1220	Sediment	06/30/98	00S1	85.4
	Reed Canarygrass Roots	06/23/98	00V2	159
	Reed Canarygrass Stems	06/23/98	00V1	69.8
1221	Sediment	07/01/98	00S1	33
	Sediment	07/01/98	00S2	34.5
	Cattail Roots	06/24/98	00V2	38
	Cattail Stems	06/24/98	00V1	19.5
1222	Sediment	06/30/98	00S1	62.5
	Cattail Roots	06/23/98	00V2	118
	Cattail Roots	06/23/98	00V4	114
	Cattail Stems	06/23/98	00V1	29.4
	Cattail Stems	06/23/98	00V3	30.6
1223	Sediment	06/30/98	00S1	49
	Reed Canarygrass Roots	06/23/98	00V2	132
	Reed Canarygrass Stems	06/23/98	00V1	28.7
1224	Sediment	06/30/98	00S1	43.5
	Willow Roots	06/23/98	00V2	95.8
	Willow Stems	06/23/98	00V1	76.3
1225	Sediment	06/30/98	00S1	51.1
	Cattail Roots	06/23/98	00V2	37.3
	Cattail Stems	06/23/98	00V1	26.5
Site				
1226	Sediment	07/01/98	00S1	55.7
	Cattail Roots	06/24/98	00V2	86.5
	Cattail Stems	06/24/98	00V1	20
1227	Sediment	07/01/98	00S1	35.8
	Reed Canarygrass Roots	06/24/98	00V2	102
	Reed Canarygrass Stems	06/24/98	00V1	37.1

Ecological Sampling Data

Loc Id	Matrix	Date	Sample Id	As mg/kg	Cd mg/kg	Co mg/kg	Cu mg/kg	Fe mg/kg	Fluoride mg/kg	LOD %	Mn mg/kg	Mo mg/kg
Site												
1228	Sediment	07/01/98	00S1	4.4	.29B	2.7B	5.1	7610	3.7	--	221	.98B
	Reed Canarygrass Roots	06/24/98	00V2	6.7	.84	2.3B	10.1	4710	--	86.9	132	1.1
	Reed Canarygrass Roots	06/25/98	00V4	6	.79	2.1B	10.2	5050	--	86.3	101	.9B
	Reed Canarygrass Stems	06/25/98	00V1	2	.12B	1.1U	5	2610	--	81.8	80.1	1
	Reed Canarygrass Stems	06/25/98	00V3	1.1	.11B	1.1U	4.3	1400	--	84.4	58.1	.67B
1229	Sediment	07/01/98	00S1	4.2	.26B	3B	5.3	9040	1.8B	--	228	.64B
	Sediment	07/01/98	00S2	4.8	.29B	3.4B	5.4	10100	2	--	248	.9B
	Willow Roots	06/25/98	00V2	1.2	1.5	1.1U	5.4	374	--	73.3	21.5	.59B
	Willow Stems	06/25/98	00V1	.74B	2.3	1.1U	5.6	163	--	70.4	43.4	.12B
1230	Sediment	07/01/98	00S1	5.1	.26B	4B	9.9	12800	3.2	--	230	.96B
	Reed Canarygrass Roots	06/26/98	00V2	4.2	2.5	1.9B	20.7	3330	--	88	181	.84B
	Reed Canarygrass Stems	06/26/98	00V1	.68B	.11B	1.1U	3.6	478	--	77.7	74.4	.63B
1231	Sediment	07/01/98	00S1	5.2	.25B	4.7B	11.8	14600	2.8	--	238	.59B
	Cattail Roots	06/26/98	00V2	5.6	.51	1.5B	10.1	3030	--	94.5	418	2.5
	Cattail Stems	06/26/98	00V1	.92B	.13B	1.1U	3	249	--	90.9	826	4.2
1232	Sediment	07/01/98	00S1	4.2	.36B	3.4B	6.7	8220	1.2B	--	296	.96B
	Willow Roots	06/25/98	00V2	3.2	.44B	1.3B	7.1	1800	--	80	116	.87B
	Willow Stems	06/25/98	00V1	.96B	.33B	1.1U	4.9	160	--	73.4	82.3	.27B
1233	Sediment	07/01/98	00S1	5.6	.19B	3.9B	8	11700	7.7	--	218	.73B
	Reed Canarygrass Roots	06/26/98	00V2	2.5	1.8	1.3B	27.9	1700	--	87.5	116	.69B
	Reed Canarygrass Stems	06/26/98	00V1	.79B	.16B	1.1U	6	307	--	82.6	73.6	.71B
1234	Sediment	07/01/98	00S1	6.7	.57	4.7B	12.3	13500	3.4	--	212	1.4
	Reed Canarygrass Roots	06/26/98	00V2	1	1.3	1.1U	[illegible].5	572	--	87.9	45.7	.35B
	Reed Canarygrass Stems	06/26/98	00V1	.88B	.25B	1.1U	6.8	471	--	80.1	67.5	.68B
1235	Sediment	07/01/98	00S1	4.8	.22B	3.4B	8.1	10900	4.9	--	216	.96B
	Cattail Roots	06/26/98	00V2	9.6	1.2	1.7B	18.4	4730	--	95	399	3.7
	Cattail Stems	06/26/98	00V1	1.2	.1B	1.1U	4.2	354	--	89.8	833	6.4

Ecological Sampling Data

Loc Id	Matrix	Date	Sample Id	NH4 mg/kg	Ni mg/kg	Ra-226 pCi/g	Ra-228 pCi/g	Se mg/kg	SO4 mg/kg	Sr mg/kg	U mg/kg	V mg/kg
Site												
1228	Sediment	07/01/98	00S1	69.7	6.3	.55	.21	.2U	758N	70.9	2.6	14.5
	Reed Canarygrass Roots	06/24/98	00V2	--	2.3B	.07	-.66	.22B	--	44.2	.46B	6.1
	Reed Canarygrass Roots	06/25/98	00V4	--	6.8	.11	.11	.36B*	--	37.1	.47B	7.5
	Reed Canarygrass Stems	06/25/98	00V1	--	2B	0	.13	.2U*	--	42.3	.25B	6.3
	Reed Canarygrass Stems	06/25/98	00V3	--	1.7U	-.05	.07	.36B*	--	32	.14B	2.9B
1229	Sediment	07/01/98	00S1	14.5	6.8	.55	.31	.2U	42N	75.4	1.9	16.8
	Sediment	07/01/98	00S2	6.3	6.5	.65	.49	.2U	88.5N	85.7	1.7	22.2
	Willow Roots	06/25/98	00V2	--	1.7U	-.03	-.7	.34B*	--	53	.72	.77B
	Willow Stems	06/25/98	00V1	--	1.7U	-.03	-.48	.23B*	--	98.9	.13B	.7U
1230	Sediment	07/01/98	00S1	1.5	10.8	.78	.67	.2U	3470N	78.7	2.7	28.2
	Reed Canarygrass Roots	06/26/98	00V2	--	2.6B	.05	-.37	.94*	--	42.8	1.2	4.9B
	Reed Canarygrass Stems	06/26/98	00V1	--	1.7U	-.03	-.45	.45B*	--	30.6	.12B	1.3B
1231	Sediment	07/01/98	00S1	14.2	11.2	1.28	.54	.2U	59.9N	105	2.2	26.8
	Cattail Roots	06/26/98	00V2	--	1.7U	.07	-.41	.42B*	--	92.1	.59	4B
	Cattail Stems	06/26/98	00V1	--	1.7U	-.01	-.52	.77*	--	103	.1U	.7U
1232	Sediment	07/01/98	00S1	2.4	7	.72	.6	.2U	101N	71	2	15
	Willow Roots	06/25/98	00V2	--	1.7U	.05	-.57	.36B*	--	67.8	.67	3.4B
	Willow Stems	06/25/98	00V1	--	1.7U	-.05	-.75	.31B*	--	88	.1U	.7U
1233	Sediment	07/01/98	00S1	81.2	7	.5	.58	.2U	935N	89.2	2.3	21.3
	Reed Canarygrass Roots	06/26/98	00V2	--	3.9B	.03	-.55	.52*	--	33.7	.76	2.6B
	Reed Canarygrass Stems	06/26/98	00V1	--	1.7U	.01	-.57	.51*	--	27.5	.1U	.7U
1234	Sediment	07/01/98	00S1	4.1	13.4	.8	.47	.43B	53.6N	95.7	3	28.8
	Reed Canarygrass Roots	06/26/98	00V2	--	1.7U	-.02	-.73	.69*	--	17.5	.4B	1.3B
	Reed Canarygrass Stems	06/26/98	00V1	--	1.7U	-.02	-.69	.7	--	33.1	.1U	1B
1235	Sediment	07/01/98	00S1	.75	9.4	.63	.35	.2U	6150N	75.7	2.3	19.6
	Cattail Roots	06/26/98	00V2	--	1.7B	.14	-.5	.42B	--	91.5	.36B	5.2
	Cattail Stems	06/26/98	00V1	--	1.7U	-.01	-.5	.5B	--	128	.1U	.7U

Ecological Sampling Data

Loc Id	Matrix	Date	Sample Id	Zn mg/kg
Site				
1228	Sediment	07/01/98	00S1	42.7
	Reed Canarygrass Roots	06/24/98	00V2	108
	Reed Canarygrass Roots	06/25/98	00V4	102
	Reed Canarygrass Stems	06/25/98	00V1	37.5
	Reed Canarygrass Stems	06/25/98	00V3	26.1
1229	Sediment	07/01/98	00S1	52.2
	Sediment	07/01/98	00S2	49.8
	Willow Roots	06/25/98	00V2	84.4
	Willow Stems	06/25/98	00V1	114
1230	Sediment	07/01/98	00S1	48.7
	Reed Canarygrass Roots	06/26/98	00V2	142
	Reed Canarygrass Stems	06/26/98	00V1	44.4
1231	Sediment	07/01/98	00S1	53.2
	Cattail Roots	06/26/98	00V2	114
	Cattail Stems	06/26/98	00V1	24.2
1232	Sediment	07/01/98	00S1	54.2
	Willow Roots	06/25/98	00V2	50.9
	Willow Stems	06/25/98	00V1	36.1
1233	Sediment	07/01/98	00S1	40.9
	Reed Canarygrass Roots	06/26/98	00V2	163
	Reed Canarygrass Stems	06/26/98	00V1	49.7
1234	Sediment	07/01/98	00S1	64.6
	Reed Canarygrass Roots	06/26/98	00V2	115
	Reed Canarygrass Stems	06/26/98	00V1	55.6
1235	Sediment	07/01/98	00S1	46.4
	Cattail Roots	06/26/98	00V2	95.2
	Cattail Stems	06/26/98	00V1	19.1

Ecological Surface Water Sampling Data

Loc Id	Date	Sample Id	As mg/L	CACO3 mg/L	Cd mg/L	Co mg/L	Cu mg/L	Fe mg/L	Fluoride mg/L	Hardness mg/L	Mn mg/L	Mo mg/L	NH4 mg/L
Reference													
1216	06/30/98	N001	.0108B	80.6	.0011U	.0122U	.0056U	.0626B	.199B	135	.0048B	.0042B	.0459
1217	06/30/98	N001	.0096B	119	.0011U	.0122U	.0056U	.919	.193B	184	.0635	.005B	.0871
1218	06/30/98	N001	.0087B	117	.0011U	.0122U	.0056U	1.09	.173B	178	.0559	.0044B	.0903
1219	06/30/98	N001	.0067B	116	.0011U	.0122U	.0056U	1.19	.18B	176	.0562	.0038B	.0333
1220	06/30/98	N001	.0062B	160	.0011U	.0122U	.0056U	.321	.415	302	.0266	.0136	.0523
1221	07/01/98	0001	.0054B	160	.001U	.011U	.005U	.106	.207	272	.0083B	.0061B	.0648
	07/01/98	0002	.0048B	161	.001U	.011U	.005U	.129	.201	273	.0199	.006B	.0712
	07/01/98	N001	.0091B	166	.0011U	.0122U	.0056U	.39	.213	282	.0242	.0069B	.0489
	07/01/98	N002	.0037B	165	.0011U	.0122U	.0056U	.296	.226	282	.0196	.0073B	.0616
1222	06/30/98	0001	.0044B	112	.001U	.011U	.005U	.0401B	.175B	163	.0068B	.0027B	.0586
	06/30/98	N001	.0066B	116	.0011U	.0122U	.0056U	.786	--	170	.026	.003B	--
1223	06/30/98	0001	.0041B	111	.001U	.011U	.005U	.0452B	.175B	162	.0074B	.0027B	.0966
	06/30/98	N001	.0051B	115	.0011U	.0122U	.0056U	.802	--	170	.0257	.003B	--
1224	06/30/98	0001	.0041B	148	.001U	.011U	.005U	.0536B	.207	249	.0096B	.0058B	.0174B
	06/30/98	N001	.0078B	162	.0011U	.0122U	.0056U	1.74	--	271	.063	.0059B	--
1225	06/30/98	0001	.0052B	114	.001U	.011U	.005U	.0332B	.196B	177	.0364	.0046B	.0174B
	06/30/98	N001	.0045B	117	.0011U	.0122U	.0056U	.805	--	183	.0577	.005B	--
Site													
1226	07/01/98	N001	.0072B	540	.0011U	.0122U	.0056U	.105B	.775B	1130	.077	.0419	.202
1227	07/01/98	0001	.005B	102	.001U	.011U	.005U	.0419B	.16B	143	.0038B	.0025B	.0267
	07/01/98	N001	.0039B	110	.0011U	.0122U	.0056U	.755	.163B	156	.0303	.0029B	.033
1228	07/01/98	0001	.0081B	1180	.001U	.011U	.005U	.0294B	2.06	2390	.837	.107	89.2
	07/01/98	N001	.0088B	1210	.0011U	.0122U	.0056U	.774	2.13	2460	1.39	.101	91.7
1229	07/01/98	N001	.005B	109	.0011U	.0122U	.0056U	.379	.262	157	.02	.0032B	.0394
	07/01/98	N002	.0062B	109	.003B	.0122U	.0056U	.452	.199B	156	.02	.003B	.0743
1230	07/01/98	N001	.0051B	111	.0011U	.0122U	.0056U	.795	.181B	159	.026	.0029B	.068
1231	07/01/98	0001	.0044B	103	.001U	.011U	.005U	.0318B	.178B	147	.0087B	.0027B	.0648
	07/01/98	N001	.007B	109	.0011U	.0122U	.0056U	.823	.174B	156	.0317	.0029B	.068
1232	07/01/98	0001	.0038B	104	.001U	.011U	.005U	.0172B	.173B	148	.0078B	.0026B	.0403
	07/01/98	N001	.0025B	110	.0011U	.0122U	.0056U	.489	.21	157	.0216	.0029B	.0489
1233	07/01/98	0001	.0024B	105	.001U	.011U	.005U	.0811B	.168B	150	.008B	.0025B	.0743
	07/01/98	N001	.0044B	114	.0011U	.0122U	.0056U	1.15	.175B	163	.0396	.0028B	.0807
1234	07/01/98	N001	.0039B	109	.0011U	.0122U	.0056U	.53	.223	155	.0191	.0028B	.033
1235	07/01/98	0001	.0048B	112	.001U	.011U	.005U	.0175B	.164B	166	.0215	.0031B	.392
	07/01/98	N001	.0046B	117	.0011U	.0122U	.0056U	.417	.183B	174	.0352	.0035B	.383

Ecological Surface Water Sampling Data

Loc Id	Date	Sample Id	Ni mg/L	Ra-226 pCi/L	Ra-228 pCi/L	Se mg/L	SO4 mg/L	Sr mg/L	U mg/L	V mg/L	Zn mg/L
Reference											
1216	06/30/98	N001	.0189U	-.14	-.46	.0022U	71.5	.354	.0015B	.0078U	.0067U
1217	06/30/98	N001	.0189U	-.1	-.32	.0022U	96.4	.397	.0021B	.0078U	.0067U
1218	06/30/98	N001	.0189U	-.07	-.21	.0022U	88.1	.389	.0018B	.0078U	.0067U
1219	06/30/98	N001	.0189U	-.08	-.24	.0022U	84.3	.383	.0018B	.0078U	.0067U
1220	06/30/98	N001	.0189U	-.02	-.2	.0022U	226	.718	.0047B	.0078U	.0067U
1221	07/01/98	0001	.017U	-.36	-.79	.002U	178*	.589	.003B	.007U	.006U
	07/01/98	0002	.017U	-.16	-.1	.002U	175*	.59	.0027B	.007U	.006U
	07/01/98	N001	.0189U	-.05	.32	.0023B	184*	.617	.0031B	.0078U	.0067U
	07/01/98	N002	.0189U	.01	.2	.0022U	184*	.609	.0032B	.0078U	.0067U
1222	06/30/98	0001	.017U	-.19	-.18	.002U	75.4	.354	.0017B	.007U	.006U
	06/30/98	N001	.0189U	-.07	-.45	.0022U	--	.365	.0016B	.0078U	.0067U
1223	06/30/98	0001	.017U	-.23	-.42	.002U	77	.349	.0016B	.007U	.006U
	06/30/98	N001	.0189U	-.1	-.34	.0022U	--	.371	.0017B	.0078U	.0067U
1224	06/30/98	0001	.017U	-.13	-.42	.002U	170	.533	.003B	.007U	.006U
	06/30/98	N001	.0189U	-.09	-.46	.0022U	--	.569	.0034B	.0092B	.0067U
1225	06/30/98	0001	.017U	-.17	-.37	.002U	97.4	.373	.002B	.007U	.006U
	06/30/98	N001	.0189U	-.07	-.31	.0022U	--	.397	.0021B	.0109B	.0067U
Site											
1226	07/01/98	N001	.0189U	.1	.43	.0022U	1510*	3.18	.0046B	.0078U	.0067U
1227	07/01/98	0001	.017U	-.15	-.42	.002U	57.2*	.314	.0011B	.007U	.006U
	07/01/98	N001	.0189U	.01	.36	.0022U	63.2*	.337	.0013B	.0078U	.0067U
1228	07/01/98	0001	.0227B	-.06	-.07	.002U	2910*	4.87	.258	.136	.006U
	07/01/98	N001	.0271B	.16	.28	.0022U	3050*	5.03	.263	.155	.0082B
1229	07/01/98	N001	.0189U	-.04	.22	.0022U	68.6*	.345	.0026B	.0078U	.0067U
	07/01/98	N002	.0189U	-.05	.21	.0022U	70.8*	.343	.0013B	.0078U	.0067U
1230	07/01/98	N001	.0189U	-.02	.21	.0022U	68.4*	.344	.0013B	.0078U	.0067U
1231	07/01/98	0001	.017U	-.13	-.37	.002U	61.4*	.324	.0013B	.007U	.006U
	07/01/98	N001	.0189U	-.04	.26	.0022U	66.7*	.336	.0013B	.0078U	.0067U
1232	07/01/98	0001	.017U	-.01	.28	.002U	60.5*	.327	.0012B	.007U	.006U
	07/01/98	N001	.0189U	-.01	.2	.0022U	67.8*	.343	.0013B	.0078U	.0067U
1233	07/01/98	0001	.017U	-.01	.17	.002U	61*	.33	.0013B	.007U	.006U
	07/01/98	N001	.0189U	.01	.41	.0022U	67.7*	.347	.0013B	.0078U	.0067U
1234	07/01/98	N001	.0189U	-.01	.04	.0022U	71.5*	.339	.0013B	.0078U	.0067U
1235	07/01/98	0001	.017U	-.05	.19	.002U	82.1*	.362	.0017B	.007U	.006U
	07/01/98	N001	.0189U	.01	.31	.0022U	90.2*	.374	.0017B	.0078U	.0067U

Surface Water Data

Loc Id	Date	Sample Id	Alkalinity mg/L	As mg/L	Ca mg/L	Cd mg/L	Chloride mg/L	Co mg/L	Cu mg/L	EC µmhos/cm	Eh mV	Fe mg/L	Fluoride mg/L
Upgradient													
0325	01/29/98	0001	--	.001U	68.9	.001U	100	.008U	--	--	--	.004U	.151
	01/29/98	N001	125	--	--	--	--	--	--	1117	136	--	--
	06/30/98	0001	135	.0014B	58.4	.001U	87.6	.006U	.005U	--	--	.003U	.292
	06/30/98	N001	130	--	--	--	--	--	--	925	111	--	--
0330	01/30/98	0001	--	.001U	25.5	.001U	41.9	.008U	--	--	--	.0051BU	.0971B
	01/30/98	N001	96	--	--	--	--	--	--	465	65	--	--
	06/30/98	0001	92	.0012B	37	.001U	42.7	.006U	.005U	--	--	.0183BU	.163U
	06/30/98	N001	88	--	--	--	--	--	--	467	-196	--	--
0342	01/30/98	0001	--	.001U	373	.001U	204	.008U	--	--	--	.0844	.196
	01/30/98	0002	--	.001U	377	.001U	204	.008U	--	--	--	.0829	.198
	01/30/98	N001	239	--	--	--	--	--	--	3680	167	--	--
	06/30/98	0001	106	.001U	40.7	.001U	39.7	.006U	.005U	--	--	.0152BU	.182
	06/30/98	N001	108	--	--	--	--	--	--	504	26	--	--
0349	01/29/98	0001	--	.001U	278	.001U	180	.008U	--	--	--	.0073BU	.188
	01/29/98	N001	279	--	--	--	--	--	--	3120	152	--	--
	06/30/98	0001	111	.001U	40	.001U	39.6	.006U	.005U	--	--	.0136BU	.175
	06/30/98	N001	105	--	--	--	--	--	--	484	178	--	--
0350	01/30/98	0001	--	.001U	294	.001U	186	.008U	--	--	--	.0192B	.185
	01/30/98	N001	242	--	--	--	--	--	--	3310	42	--	--
	06/30/98	0001	110	.0011B	40.8	.001U	39.7	.006U	.005U	--	--	.0229BU	.177
	06/30/98	N001	102	--	--	--	--	--	--	499	174	--	--
0423	12/18/96	N001	142	.00056B	83.6	.0011U	175	.0067U	--	1212	232	1.04	.308
	01/23/98	0001	--	.001U	69	.001U	145	.008U	--	--	--	.0099BU	.155
	01/23/98	N001	137	--	--	--	--	--	--	1103	119	--	--
	06/29/98	0001	101	.001U	37.2	.001U	37.3	.006U	.005U	--	--	.0161BU	.169U
	06/29/98	N001	95	--	--	--	--	--	--	416	186	--	--
On-Site													
0310	01/29/98	0001	--	.001U	540	.001U	886	.008U	--	--	--	.0135BU	1.21
	01/29/98	N001	507	--	--	--	--	--	--	6390	213	--	--
	07/01/98	0001	88	.001U	37.2	.001U	38.5	.006U	.005U	--	--	.0107BU	.165U
	07/01/98	N001	110	--	--	--	--	--	--	447	148	--	--
0312	01/29/98	0001	--	.001U	73.5	.001U	151	.008U	--	--	--	.0116BU	.177
	01/29/98	N001	133	--	--	--	--	--	--	1179	161	--	--
	06/30/98	0001	101	.001U	37.2	.001U	39.2	.006U	.005U	--	--	.0119BU	.17U
	06/30/98	N001	97	--	--	--	--	--	--	425	69	--	--
0328	01/29/98	0001	--	.001U	81.4	.001U	70.9	.008U	--	--	--	.0081BU	.119
	01/29/98	N001	45	--	--	--	--	--	--	1072	212	--	--
	06/30/98	0001	109	.001U	37	.001U	38.5	.006U	.005U	--	--	.0103BU	.196U
	06/30/98	N001	108	--	--	--	--	--	--	443	98	--	--
0344	01/30/98	0001	--	.001U	90	.001U	167	.008U	--	--	--	.0058BU	.188
	01/30/98	N001	306	--	--	--	--	--	--	1309	60	--	--
	06/30/98	0001	100	.001U	37.8	.001U	39.3	.006U	.005U	--	--	.0124BU	.176U

Surface Water Data

Loc Id	Date	Sample Id	GA pCi/L	GB pCi/L	K mg/L	Mg mg/L	Mn mg/L	Mo mg/L	Na mg/L	NH4 mg/L	Ni mg/L	NO3 mg/L	pH s.u.
Upgradient													
0325	01/29/98	0001	7.58	7.14	4.05	33.9	.001U	.0147	25.4	--	.016U	.0558B	--
	01/29/98	N001	--	--	--	--	--	--	--	--	--	--	8.18
	06/30/98	0001	8.46J	6.81U	3.82	30.9	.0019B	.0129	82.6	.0204BU	.007U	.0217B	--
	06/30/98	N001	--	--	--	--	--	--	--	--	--	--	8.07
0330	01/30/98	0001	2.2	3.75	3.43	9.64	.0046B	.0024B	39.1	--	.016U	.0633B	--
	01/30/98	N001	--	--	--	--	--	--	--	--	--	--	8.91
	06/30/98	0001	3.32UJ	3.39U	2.32	11.4	.0066B	.0032B	35	.0386B	.007U	.0341B	--
	06/30/98	N001	--	--	--	--	--	--	--	--	--	--	7.52
0342	01/30/98	0001	23.13U	30.02U	7.12	224	.894	.0149	290	--	.016U	6.28	--
	01/30/98	0002	23.09U	30.13U	7.15	226	.907	.0148	292	--	.016U	6.3	--
	01/30/98	N001	--	--	--	--	--	--	--	--	--	--	8.12
	06/30/98	0001	3.38U	6.45J	1.8	12.1	.0427	.0037B	37	.0143BU	.007U	.0942B	--
	06/30/98	N001	--	--	--	--	--	--	--	--	--	--	8
0349	01/29/98	0001	16.63U	21.24	5.98	165	.716	.013	237	--	.016U	3.02	--
	01/29/98	N001	--	--	--	--	--	--	--	--	--	--	8.39
	06/30/98	0001	3.3U	4.96J	1.68	11.5	.0367	.0032B	35	.0022BU	.007U	.0655B	--
	06/30/98	N001	--	--	--	--	--	--	--	--	--	--	7.66
0350	01/30/98	0001	29.86	20.46U	6.07	176	.757	.0125	248	--	.016U	3.26	--
	01/30/98	N001	--	--	--	--	--	--	--	--	--	--	7.88
	06/30/98	0001	3.23U	3.38UJ	1.77	11.9	.0322	.0036B	36.5	.0083BU	.007U	.0366B	--
	06/30/98	N001	--	--	--	--	--	--	--	--	--	--	8
0423	12/18/96	N001	8.01U	9.59U	4.08	23.4	.0413	.0087B	135	--	--	1.18	8.94
	01/23/98	0001	4.47UJ	4.44U	3.23	18.9	.0187	.0084B	110	--	.016U	.896B	--
	01/23/98	N001	--	--	--	--	--	--	--	--	--	--	8.61
	06/29/98	0001	3.37UJ	3.39U	1.5	9.27	.0175	.0024B	30.4	.0204BU	.007U	.121B	--
	06/29/98	N001	--	--	--	--	--	--	--	--	--	--	8.09
On-Site													
0310	01/29/98	0001	118.2	61.15U	38.2	296	.928	.0261	845	--	.0352B	7.07	--
	01/29/98	N001	--	--	--	--	--	--	--	--	--	--	7.78
	07/01/98	0001	3.08U	3.38UJ	1.51	9.37	[illegible]	.0027B	30.2	.0528B	.007U	.011U	--
	07/01/98	N001	--	--	--	--	--	--	--	--	--	--	8.36
0312	01/29/98	0001	7.04	[illegible].54	3.73	25.4	.066	.0093B	117	--	.016U	1.08	--
	01/29/98	N001	--	--	--	--	--	--	--	--	--	--	9.03
	06/30/98	0001	3.06U	3.38UJ	1.54	9.68	.0104	.0026B	31	.059B	.007U	.011U	--
	06/30/98	N001	--	--	--	--	--	--	--	--	--	--	8.57
0328	01/29/98	0001	6.89	8.08	3.48	22.1	.0192	.005B	77.9	--	.016U	1.43	--
	01/29/98	N001	--	--	--	--	--	--	--	--	--	--	9.08
	06/30/98	0001	2.97U	3.37UJ	1.62	9.74	.0076B	.0027B	31.1	.0528B	.007U	.011U	--
	06/30/98	N001	--	--	--	--	--	--	--	--	--	--	8.57
0344	01/30/98	0001	6.59	6.13U	4.11	35.5	.13	.0116	135	--	.016U	1.87	--
	01/30/98	N001	--	--	--	--	--	--	--	--	--	--	8.32
	06/30/98	0001	3.15U	3.38UJ	1.54	9.88	.0106	.0027B	31.8	.0435B	.007U	.011U	--

Surface Water Data

Loc Id	Date	Sample Id	Ra-226 pCi/L	Ra-228 pCi/L	Se mg/L	SO4 mg/L	Sr mg/L	TDS mg/L	Tmp C	Turbidity NTU	U mg/L	U-234 pCi/L	U-235 pCi/L
Upgradient													
0325	01/29/98	0001	.3	.6U	.0014B	237	--	688	--	--	.0054	2.6U	1U
	01/29/98	N001	--	--	--	--	--	--	5.4	20.5	--	--	--
	06/30/98	0001	.14U	.56U	.0012B	223	.792	652	--	--	.0047	--	--
	06/30/98	N001	--	--	--	--	--	--	22.8	22.6	--	--	--
0330	01/30/98	0001	.14	.4U	.001U	55.9	--	275	--	--	.0032	1.2	1U
	01/30/98	N001	--	--	--	--	--	--	5	--	--	--	--
	06/30/98	0001	.15U	.58U	.001U	68.5	.414	300	--	--	.0015	--	--
	06/30/98	N001	--	--	--	--	--	--	21.4	9.23	--	--	--
0342	01/30/98	0001	.14	.7U	.0112	1810	--	3280	--	--	.025	12.9	1U
	01/30/98	0002	.16	.9U	.0113	1810	--	3270	--	--	.0252	12.7	1U
	01/30/98	N001	--	--	--	--	--	--	5.1	20	--	--	--
	06/30/98	0001	.15U	.59U	.001U	82.4	.412	328	--	--	.0018	--	--
	06/30/98	N001	--	--	--	--	--	--	19.7	48.7	--	--	--
0349	01/29/98	0001	.19	.8U	.0065	1270	--	2480	--	--	.0157	8.5	1U
	01/29/98	N001	--	--	--	--	--	--	5.8	17	--	--	--
	06/30/98	0001	.15U	.59U	.001U	74.4	.396	323	--	--	.0016	--	--
	06/30/98	N001	--	--	--	--	--	--	18.5	86.7	--	--	--
0350	01/30/98	0001	.16	.8U	.0071	1390	--	2610	--	--	.0184	8.6	1U
	01/30/98	N001	--	--	--	--	--	--	4.3	16.8	--	--	--
	06/30/98	0001	.17U	.67U	.001U	80.3	.409	335	--	--	.0017	--	--
	06/30/98	N001	--	--	--	--	--	--	20.7	46.4	--	--	--
0423	12/18/96	N001	.44	.9U	.0012B	163	--	702	-.3	31.4	.0039	--	--
	01/23/98	0001	.18	.6U	.0013B	138	--	608	--	--	.0038	1.5*	1U
	01/23/98	N001	--	--	--	--	--	--	.3	8.55	--	--	--
	06/29/98	0001	.15U	.59U	.001U	56.5	.347	270	--	--	.0015	--	--
	06/29/98	N001	--	--	--	--	--	--	18.4	13.5	--	--	--
On-Site													
0310	01/29/98	0001	.11	.8U	.001U	2820	--	5860	--	--	.0948	31.2	1.5
	01/29/98	N001	--	--	--	--	--	--	10.1	--	--	--	--
	07/01/98	0001	.12U	.65U	.001U	66.6	.357	292	--	--	.0016	--	--
	07/01/98	N001	--	--	--	--	--	--	19.1	18.4	--	--	--
0312	01/29/98	0001	.22	.8U	.0016B	199	--	730	--	--	.0055	2U	1U
	01/29/98	N001	--	--	--	--	--	--	7.2	8.98	--	--	--
	06/30/98	0001	.12U	.65U	.001U	67.7	.375	295	--	--	.0016	--	--
	06/30/98	N001	--	--	--	--	--	--	22.2	--	--	--	--
0328	01/29/98	0001	.24	.4U	.001U	311	--	623	--	--	.0091	3.2U	1U
	01/29/98	N001	--	--	--	--	--	--	10.7	8.8	--	--	--
	06/30/98	0001	.21U	.87U	.001U	68.2	.365	307	--	--	.0016	--	--
	06/30/98	N001	--	--	--	--	--	--	26.1	--	--	--	--
0344	01/30/98	0001	.16	.4U	.0022B	278	--	822	--	--	.0072	3.7	1U
	01/30/98	N001	--	--	--	--	--	--	5.2	--	--	--	--
	06/30/98	0001	.12U	.69U	.001U	68.1	.363	285	--	--	.0016	--	--

Surface Water Data

Loc Id	Date	Sample Id	U-238 pCi/L	V mg/L	Zn mg/L
Upgradient					
0325	01/29/98	0001	1.8	.0022B	.004U
	01/29/98	N001	--	--	--
	06/30/98	0001	--	.0038BU	.005U
	06/30/98	N001	--	--	--
0330	01/30/98	0001	1.1	.0011BU	.004U
	01/30/98	N001	--	--	--
	06/30/98	0001	--	.003BU	.005U
	06/30/98	N001	--	--	--
0342	01/30/98	0001	8.3	.001U	.0041B
	01/30/98	0002	8.4	.001U	.0045B
	01/30/98	N001	--	--	--
	06/30/98	0001	--	.0026BU	.005U
	06/30/98	N001	--	--	--
0349	01/29/98	0001	5.2	.001U	.004U
	01/29/98	N001	--	--	--
	06/30/98	0001	--	.0027BU	.0177B
	06/30/98	N001	--	--	--
0350	01/30/98	0001	6.2	.001U	.004U
	01/30/98	N001	--	--	--
	06/30/98	0001	--	.0027BU	.0057B
	06/30/98	N001	--	--	--
0423	12/18/96	N001	--	.0067U	.011B
	01/23/98	0001	1.3	.0013B	.004U
	01/23/98	N001	--	--	--
	06/29/98	0001	--	.0022BU	.005U
	06/29/98	N001	--	--	--
On-Site					
0310	01/29/98	0001	31.6	.001U	.004U
	01/29/98	N001	--	--	--
	07/01/98	0001	--	.0031BU	.005U
	07/01/98	N001	--	--	--
0312	01/29/98	0001	1.8	.014	.004U
	01/29/98	N001	--	--	--
	06/30/98	0001	--	.0042BU	.005U
	06/30/98	N001	--	--	--
0328	01/29/98	0001	3.1	.0016BU	.004U
	01/29/98	N001	--	--	--
	06/30/98	0001	--	.0035BU	.0081B
	06/30/98	N001	--	--	--
0344	01/30/98	0001	2.4	.0403	.0057B
	01/30/98	N001	--	--	--
	06/30/98	0001	--	.0036BU	.005U

Surface Water Data

Loc Id	Date	Sample Id	Alkalinity mg/L	As mg/L	Ca mg/L	Cd mg/L	Chloride mg/L	Co mg/L	Cu mg/L	EC µmhos/cm	Eh mV	Fe mg/L	Fluoride mg/L
On-Site													
0344	06/30/98	N001	98	--	--	--	--	--	--	458	55	--	--
0346	01/30/98	0001	--	.0115	492	.0012	628	.008U	--	--	--	.0081BU	1.26
	01/30/98	N001	398	--	--	--	--	--	--	6610	92	--	--
	06/30/98	0001	96	.001U	37.3	.001U	38.1	.006U	.005U	--	--	.0125BU	.177
	06/30/98	N001	100	--	--	--	--	--	--	444	182	--	--
0424	12/18/96	N001	138	.0006B	98.8	.0011U	188	.0067U	--	1420	238	1.31	.336
	01/29/98	0001	--	.001U	69.8	.001U	150	.008U	--	--	--	.0139BU	.174
	01/29/98	N001	133	--	--	--	--	--	--	1062	45	--	--
	06/30/98	0001	103	.001U	37.7	.001U	38	.006U	.005U	--	--	.0163BU	.167
	06/30/98	N001	109	--	--	--	--	--	--	451	181	--	--
0425	01/29/98	0001	--	.001U	69.1	.001U	146	.008U	--	--	--	.0093BU	.158
	01/29/98	N001	152	--	--	--	--	--	--	1037	62	--	--
	06/30/98	0001	99	.001U	37.6	.001U	38.5	.006U	.005U	--	--	.0107BU	.163U
	06/30/98	N001	98	--	--	--	--	--	--	453	103	--	--
0432	12/19/96	N001	174	.00032B	86.6	.0011U	185	.0067U	--	1040	255	.347	.316
	12/19/96	N002	--	.00051B	88.4	.0011U	177	.0067U	--	--	--	.381	.306
Down Gradient													
0308	01/30/98	0001	--	.001U	69	.001U	142	.008U	--	--	--	.0093BU	.194
	01/30/98	N001	139	--	--	--	--	--	--	1047	105	--	--
	06/30/98	0001	99	.001U	37.6	.001U	37.8	.006U	.005U	--	--	.0128BU	.186
	06/30/98	0002	--	.001U	37.4	.001U	38.1	.006U	.005U	--	--	.0113BU	.201U
	06/30/98	N001	94	--	--	--	--	--	--	446	61	--	--
0326	01/30/98	0001	--	.001U	181	.001U	438	.008U	--	--	--	.0237BU	.132
	01/30/98	N001	199	--	--	--	--	--	--	3880	158	--	--
	07/01/98	0001	54	.002B	204	.001U	678	.006U	.005U	--	--	.003U	.794
	07/01/98	N001	46	--	--	--	--	--	--	4410	106	--	--
0360	07/01/98	0001	157	.0016B	382	.001U	1850	.006U	.005U	--	--	.0153BU	.486
	07/01/98	N001	166	--	--	--	--	--	--	11570	172	--	--
0427	12/19/96	N001	170	.00047B	89.2	.0011U	178	.0067U	--	1296	255	.45	.303
	01/30/98	0001	--	.001U	68.2	.001U	143	.008U	--	--	--	.0381	.159
	01/30/98	N001	144	--	--	--	--	--	--	1052	92	--	--
	06/30/98	0001	101	.001U	36.3	.001U	37.9	.006U	.005U	--	--	.0121BU	.167U
	06/30/98	N001	98	--	--	--	--	--	--	443	128	--	--

Surface Water Data

Loc Id	Date	Sample Id	GA pCi/L	GB pCi/L	K mg/L	Mg mg/L	Mn mg/L	Mo mg/L	Na mg/L	NH4 mg/L	Ni mg/L	NO3 mg/L	pH s.u.
On-Site													
0344	06/30/98	N001	--	--	--	--	--	--	--	--	--	--	8.29
0346	01/30/98	0001	92.39	54.51	22.2	390	3.03	.0887	669	--	.0422	26.4	--
	01/30/98	N001	--	--	--	--	--	--	--	--	--	--	7.45
	06/30/98	0001	3.17U	3.39UJ	1.56	9.61	.0058B	.0027B	31.3	.0022BU	.007U	.0998B	--
	06/30/98	N001	--	--	--	--	--	--	--	--	--	--	8.07
0424	12/18/96	N001	9.67U	11.57U	4.38	37.2	.118	.011B	155	--	--	1.45	9.45
	01/29/98	0001	5.02U	7.68	3.42	20.5	.0221	.0085B	114	--	.016U	.578B	--
	01/29/98	N001	--	--	--	--	--	--	--	--	--	--	8.66
	06/30/98	0001	3.04U	3.37UJ	1.54	9.71	.0134	.0027B	31.5	.0083BU	.007U	.197B	--
	06/30/98	N001	--	--	--	--	--	--	--	--	--	--	7.52
0425	01/29/98	0001	5.27	6.08U	3.44	20.3	.0233	.0088B	112	--	.016U	.587B	--
	01/29/98	N001	--	--	--	--	--	--	--	--	--	--	8.67
	06/30/98	0001	2.99U	3.37UJ	1.58	9.82	.0091B	.0026B	31	.0528B	.007U	.011U	--
	06/30/98	N001	--	--	--	--	--	--	--	--	--	--	8.32
0432	12/19/96	N001	9.06U	11.54U	3.76	24.3	.0415	.0075B	136	--	--	1.4	9.03
	12/19/96	N002	8.85U	11.48U	3.85	24.9	.0426	.0078B	140	--	--	1.36	--
Down Gradient													
0308	01/30/98	0001	4.95U	6.04U	3.32	19.7	.0234	.0084B	106	--	.016U	.575B	--
	01/30/98	N001	--	--	--	--	--	--	--	--	--	--	8.32
	06/30/98	0001	4.18U	101.2J	1.53	9.59	.0058B	.0026B	30.4	.0374B	.007U	.011U	--
	06/30/98	0002	3.08U	3.37UJ	1.52	9.5	.0057B	.0025B	30.1	.0497B	.007U	.011U	--
	06/30/98	N001	--	--	--	--	--	--	--	--	--	--	8.28
0326	01/30/98	0001	17.29U	20.23U	11.1	151	.0079B	.0085B	431	--	.016U	.113B	--
	01/30/98	N001	--	--	--	--	--	--	--	--	--	--	8.84
	07/01/98	0001	30.68U	33.7UJ	18.2	137	.0161	.0426	614	.0775B	.0096B	.011U	--
	07/01/98	N001	--	--	--	--	--	--	--	--	--	--	9.07
0360	07/01/98	0001	110.95U	134.24UJ	25.7	693	.104	.0564	1990	.133	.0133B	.011U	--
	07/01/98	N001	--	--	--	--	--	--	--	--	--	--	7.89
0427	12/19/96	N001	9.04U	11.49U	3.95	24.9	.0449	.0077B	140	--	--	1.33	8.48
	01/30/98	0001	4.94U	6.02U	3.35	19.6	.0291	.0084B	107	--	.0401	.577B	--
	01/30/98	N001	--	--	--	--	--	--	--	--	--	--	8.19
	06/30/98	0001	3U	3.37UJ	1.5	9.23	.0052B	.0026B	29.6	.0528B	.007U	.011U	--
	06/30/98	N001	--	--	--	--	--	--	--	--	--	--	8.29

Surface Water Data

Loc Id	Date	Sample Id	Ra-226 pCi/L	Ra-228 pCi/L	Se mg/L	SO4 mg/L	Sr mg/L	TDS mg/L	Tmp C	Turbidity NTU	U mg/L	U-234 pCi/L	U-235 pCi/L
On-Site													
0344	06/30/98	N001	--	--	--	--	--	--	18.9	--	--	--	--
0346	01/30/98	0001	.13	.5	.017	2990	--	5640	--	--	.0734	32.3	1.2
	01/30/98	N001	--	--	--	--	--	--	11.3	--	--	--	--
	06/30/98	0001	.12U	.5U	.001U	62.3	.359	293	--	--	.0015	--	--
	06/30/98	N001	--	--	--	--	--	--	24.9	7.74	--	--	--
0424	12/18/96	N001	.37U	.8U	.0021B	265	--	878	-.3	26.5	.0058	--	--
	01/29/98	0001	.27	.9U	.0013B	151	--	628	--	--	.0038	1.5	1U
	01/29/98	N001	--	--	--	--	--	--	3.1	--	--	--	--
	06/30/98	0001	.15U	.61U	.001U	62	.361	297	--	--	.0016	--	--
	06/30/98	N001	--	--	--	--	--	--	18.1	17.4	--	--	--
0425	01/29/98	0001	.16	.7U	.0015B	150	--	617	--	--	.0038	1.7	1U
	01/29/98	N001	--	--	--	--	--	--	3.9	--	--	--	--
	06/30/98	0001	.14U	.57U	.001U	67.7	.364	345	--	--	.0016	--	--
	06/30/98	N001	--	--	--	--	--	--	20.2	--	--	--	--
0432	12/19/96	N001	.26	.9U	.0013B	183	--	747	-.2	11	.0043	--	--
	12/19/96	N002	.21	.9U	.0013B	176	--	762	--	--	.0044	--	--
Down Gradient													
0308	01/30/98	0001	.19	.5U	.0013B	148	--	612	--	--	.0038	1.2	1U
	01/30/98	N001	--	--	--	--	--	--	2.5	--	--	--	--
	06/30/98	0001	.13U	.56U	.001U	64.9	.358	290	--	--	.0016	--	--
	06/30/98	0002	.15U	.61U	.001U	64.7	.355	283	--	--	.0015	--	--
	06/30/98	N001	--	--	--	--	--	--	17.2	--	--	--	--
0326	01/30/98	0001	.17	.4U	.001U	1180	--	2610	--	--	.0348	12.4	1U
	01/30/98	N001	--	--	--	--	--	--	9.6	13.7	--	--	--
	07/01/98	0001	.17	.66U	.001U	1450	3.4	3310	--	--	.0045	--	--
	07/01/98	N001	--	--	--	--	--	--	26.4	1.96	--	--	--
0360	07/01/98	0001	.13U	.7U	.001U	5550	7.34	11400	--	--	.0662	--	--
	07/01/98	N001	--	--	--	--	--	--	24.9	7.69	--	--	--
0427	12/19/96	N001	.19	.9U	.0012B	177	--	750	-.3	14.2	.0043	--	--
	01/30/98	0001	.17	.4U	.0013B	147	--	615	--	--	.0038	1.6	1U
	01/30/98	N001	--	--	--	--	--	--	2.3	--	--	--	--
	06/30/98	0001	.14U	.59U	.001U	63.7	.355	295	--	--	.0016	--	--
	06/30/98	N001	--	--	--	--	--	--	18.1	--	--	--	--

Surface Water Data

Loc Id	Date	Sample Id	U-238 pCi/L	V mg/L	Zn mg/L
On-Site					
0344	06/30/98	N001	--	--	--
0346	01/30/98	0001	24.5	.873	.0134B
	01/30/98	N001	--	--	--
	06/30/98	0001	--	.0023BU	.005U
	06/30/98	N001	--	--	--
0424	12/18/96	N001	--	.0067U	.0124B
	01/29/98	0001	1.3	.0015B	.004U
	01/29/98	N001	--	--	--
	06/30/98	0001	--	.0024BU	.0268B
	06/30/98	N001	--	--	--
0425	01/29/98	0001	1.3	.002B	.0058B
	01/29/98	N001	--	--	--
	06/30/98	0001	--	.0037BU	.005U
	06/30/98	N001	--	--	--
0432	12/19/96	N001	--	.0067U	.0095B
	12/19/96	N002	--	.0067U	.013B
Down Gradient					
0308	01/30/98	0001	1.3	.0017B	.004U
	01/30/98	N001	--	--	--
	06/30/98	0001	--	.002BU	.005U
	06/30/98	0002	--	.0023BU	.005U
	06/30/98	N001	--	--	--
0326	01/30/98	0001	11.6	.001U	.004U
	01/30/98	N001	--	--	--
	07/01/98	0001	--	.0023BU	.005U
	07/01/98	N001	--	--	--
0360	07/01/98	0001	--	.003BU	.005U
	07/01/98	N001	--	--	--
0427	12/19/96	N001	--	.0067U	.0136B
	01/30/98	0001	1.3	.0024B	.004U
	01/30/98	N001	--	--	--
	06/30/98	0001	--	.0021BU	.0058B
	06/30/98	N001	--	--	--

Groundwater Data

Loc Id	Date	Sample Id	Alkalinity mg/L	As mg/L	Ca mg/L	Cd mg/L	Chloride mg/L	Co mg/L	Cu mg/L	EC µmhos/cm	Eh mV	Fe mg/L	Fluoride mg/L
Upgradient													
0588	01/28/98	0001	--	.0059	82.8	.001U	149	.008U	--	--	--	.146	.233
	01/28/98	N001	322	--	--	--	--	--	--	1249	-103	--	--
	06/29/98	0001	305	.0082	74.6	.001U	164	.006U	.005U	--	--	.337	.501
	06/29/98	N001	323	--	--	--	--	--	--	1158	-235	--	--
0713	01/27/98	0001	--	.001U	449	.001U	347	.008U	--	--	--	.004U	1.3
	01/27/98	N001	459	--	--	--	--	--	--	6010	101	--	--
	06/24/98	0001	433	.001U	420	.001U	338	.006U	.005U	--	--	.003U	1.62
	06/24/98	N001	427	--	--	--	--	--	--	3981	176	--	--
0715	01/27/98	0001	--	.001U	470	.001U	280	.008U	--	--	--	.004U	1.19
	01/27/98	N001	367	--	--	--	--	--	--	5590	-143	--	--
	06/24/98	0001	374	.0012B	430	.001U	144	.006U	.005U	--	--	.003U	.879
	06/24/98	N001	376	--	--	--	--	--	--	4960	239	--	--
0744	01/26/98	0001	--	.001U	170	.001U	171	.008U	--	--	--	.004U	.621
	01/26/98	N001	248	--	--	--	--	--	--	2130	73	--	--
	06/29/98	0001	227	.001U	122	.001U	133	.006U	.005U	--	--	.003U	.733
	06/29/98	N001	242	--	--	--	--	--	--	1834	-67	--	--
0745	01/26/98	0001	--	.0012B	520	.001U	591	.008U	--	--	--	1.17	.813
	01/26/98	N001	405	--	--	--	--	--	--	6150	-24	--	--
	06/17/98	0001	345	.0014B	445	.001U	520J	.006U	.005U	--	--	1.1	.803J
	06/17/98	N001	337	--	--	--	--	--	--	4600	-13	--	--
0746	01/26/98	0001	--	.001U	518	.001U	801	.008U	--	--	--	.004U	1.82
	01/26/98	N001	411	--	--	--	--	--	--	7760	93	--	--
	06/17/98	0001	358	.001U	480	.001U	813J	.006U	.005U	--	--	.003U	1.63J
	06/17/98	N001	393	--	--	--	--	--	--	6010	210	--	--
1020	01/26/98	0001	--	.001U	573	.001U	991	.008U	--	--	--	3.13	.766
	01/26/98	N001	493	--	--	--	--	--	--	7570	-54	--	--
	06/22/98	0001	462	.001U	479	.001U	899	.006U	.005U	--	--	1.8	.849
	06/22/98	N001	447	--	--	--	--	--	--	5650	-77	--	--
1021	01/26/98	0001	--	.001UL	363L	.001UL	746L	.008UL	--	--	--	.0183BUL	.453L
	01/26/98	N001	467L	--	--	--	--	--	--	3790L	169L	--	--
	06/23/98	0001	422L	.001UL	208L	.001UL	352L	.006UL	.005UL	--	--	.0069BUL	.511L
	06/23/98	N001	449L	--	--	--	--	--	--	2170L	98L	--	--
1023	01/22/98	0001	--	.001U	474	.001U	253	.008U	--	--	--	.0042BU	.52
	01/22/98	N001	427	--	--	--	--	--	--	6880	106	--	--
	06/18/98	0001	318	.001U	439	.001U	253	.006U	.005U	--	--	.003U	.796
	06/18/98	N001	328	--	--	--	--	--	--	5190	157	--	--
1024	01/22/98	0001	--	.0026B	150	.001U	159	.008U	--	--	--	3	.324
	01/22/98	N001	495	--	--	--	--	--	--	1726	-62	--	--
	06/18/98	0001	355	.001U	101	.001U	70.8	.006U	.005U	--	--	.542	.42
	06/18/98	N001	336	--	--	--	--	--	--	999	-101	--	--
1025	01/22/98	0001	--	.001U	518	.001U	307	.008U	--	--	--	.552	1.11
	01/22/98	0002	--	.001U	525	.001U	306	.008U	--	--	--	.533	1.12
	01/22/98	N001	433	--	--	--	--	--	--	5940	-15	--	--
	06/18/98	0001	415	.001U	469	.001U	301	.006U	.005U	--	--	.321	1.25

Groundwater Data

Loc Id	Date	Sample Id	GA pCi/L	GB pCi/L	K mg/L	Mg mg/L	Mn mg/L	Mo mg/L	Na mg/L	NH4 mg/L	Ni mg/L	NO3 mg/L	pH s.u.
Upgradient													
0588	01/28/98	0001	5.24UJ	6.08U	6.33	25.3	.314	.0069B	125	--	.016U	.152B	--
	01/28/98	N001	--	--	--	--	--	--	--	--	--	--	7.8
	06/29/98	0001	18.11UJ	1183	7.3	23.4	.427	.0082B	116	16.3B	.007U	.011U	--
	06/29/98	N001	--	--	--	--	--	--	--	--	--	--	7.14
0713	01/27/98	0001	70.17J	41.18U	10.7	450	1.78	.083	600	--	.016U	10.5	--
	01/27/98	N001	--	--	--	--	--	--	--	--	--	--	7.19
	06/24/98	0001	63.33J	254.9	10.5	400	2.22	.0739	562	.0224B	.0105B	8.43	--
	06/24/98	N001	--	--	--	--	--	--	--	--	--	--	6.82
0715	01/27/98	0001	46.37UJ	60.26U	10.3	469	.233	.057	685	--	.016U	16.3	--
	01/27/98	N001	--	--	--	--	--	--	--	--	--	--	6.89
	06/24/98	0001	58.02UJ	67.45U	11.4	460	2.08	.0656	686	.0224B	.0109B	16.3	--
	06/24/98	N001	--	--	--	--	--	--	--	--	--	--	6.93
0744	01/26/98	0001	12.85UJ	13.23U	6.06	107	.821	.017	200	--	.016U	3.46	--
	01/26/98	N001	--	--	--	--	--	--	--	--	--	--	7.05
	06/29/98	0001	13.71UJ	13.57U	6.37	77.8	.694	.0185	186	1.12	.007U	.238B	--
	06/29/98	N001	--	--	--	--	--	--	--	--	--	--	7
0745	01/26/98	0001	41.63UJ	43.97U	6.42	361	1.7	.0549	619	--	.016U	.0579BU	--
	01/26/98	N001	--	--	--	--	--	--	--	--	--	--	7.51
	06/17/98	0001	35.12U	36.61U	5.53	323	1.67	.0494	590	.321	.0117B	.074BUJ	--
	06/17/98	N001	--	--	--	--	--	--	--	--	--	--	6.84
0746	01/26/98	0001	57.81UJ	65.5U	11.7	489	1.63	.186	844	--	.016U	13.4	--
	01/26/98	N001	--	--	--	--	--	--	--	--	--	--	6.77
	06/17/98	0001	80.66	54.92U	10.7	502	1.84	.168	893	.0725B	.0117B	12.8J	--
	06/17/98	N001	--	--	--	--	--	--	--	--	--	--	6.8
1020	01/26/98	0001	61.72J	60.68U	9.59	419	1.08	.0279	853	--	.016U	.0694B	--
	01/26/98	N001	--	--	--	--	--	--	--	--	--	--	7.01
	06/22/98	0001	61.92UJ	67.5U	8.65	347	.972	.0286	834	.0877B	.0101B	.132B	--
	06/22/98	N001	--	--	--	--	--	--	--	--	--	--	6.45
1021	01/26/98	0001	30.6JL	29.26L	16.8L	118L	.436L	.0311L	317L	--	.016UL	69.1L	--
	01/26/98	N001	--	--	--	--	--	--	--	--	--	--	7.02L
	06/23/98	0001	31.35JL	17.19UL	12.4L	64L	.514L	.0217L	235L	.066BL	.0088BL	.0648BL	--
	06/23/98	N001	--	--	--	--	--	--	--	--	--	--	6.57L
1023	01/22/98	0001	45.17J	50.11	8.27	447	1.73	.124	659	--	.0215B	71	--
	01/22/98	N001	--	--	--	--	--	--	--	--	--	--	6.83
	06/18/98	0001	49.61	54.54U	7.52	464	1.76	.12	699	.0142B	.0281B	71.4J	--
	06/18/98	N001	--	--	--	--	--	--	--	--	--	--	6.85
1024	01/22/98	0001	11.11J	18.26	11.1	62.5	.551	.0047B	132	--	.016U	.0249B	--
	01/22/98	N001	--	--	--	--	--	--	--	--	--	--	6.97
	06/18/98	0001	6.13U	7.84	7.98	26.4	.394	.0064B	80.9	.0264B	.0073B	.105BUJ	--
	06/18/98	N001	--	--	--	--	--	--	--	--	--	--	6.81
1025	01/22/98	0001	50.69J	44.19U	12.2	434	1.94	.0654	520	--	.0197B	33.4	--
	01/22/98	0002	54.41J	44.19U	12.1	432	1.94	.0643	530	--	.016U	33.6	--
	01/22/98	N001	--	--	--	--	--	--	--	--	--	--	6.89
	06/18/98	0001	36.45	36.71U	11	400	1.95	.0625	546	.183	.0162B	30.7J	--

Groundwater Data

Loc Id	Date	Sample Id	Ra-226 pCi/L	Ra-228 pCi/L	Se mg/L	SO4 mg/L	Sr mg/L	TDS mg/L	Tmp C	Turbidity NTU	U mg/L	U-234 pCi/L	U-235 pCi/L
Upgradient													
0588	01/28/98	0001	.14	.4U	.001U	33.9	--	640	--	--	.0022	.8U	1U
	01/28/98	N001	--	--	--	--	--	--	9.4	1.55	--	--	--
	06/29/98	0001	.13U	.57U	.001U	62.6	1	668	--	--	.0014	--	--
	06/29/98	N001	--	--	--	--	--	--	17	.98	--	--	--
0713	01/27/98	0001	.04U	.9U	.048	3060	--	5460	--	--	.0652	35.2	1.1
	01/27/98	N001	--	--	--	--	--	--	14.1	901	--	--	--
	06/24/98	0001	.12U	.51U	.049	3140	5.94	5650	--	--	.0662	--	--
	06/24/98	N001	--	--	--	--	--	--	13.9	3.18	--	--	--
0715	01/27/98	0001	.14	.6U	.0318	3720	--	6280	--	--	.0602	34.9	1U
	01/27/98	N001	--	--	--	--	--	--	14.1	139	--	--	--
	06/24/98	0001	.13U	.54U	.0404	1840	7.06	6190	--	--	.0535	--	--
	06/24/98	N001	--	--	--	--	--	--	14.9	13.6	--	--	--
0744	01/26/98	0001	.07U	.8U	.0037B	776	--	1640	--	--	.0132	5.4*	1U
	01/26/98	N001	--	--	--	--	--	--	11.2	4.42	--	--	--
	06/29/98	0001	.13U	.51U	.001U	653	1.71	1440	--	--	.0117	--	--
	06/29/98	N001	--	--	--	--	--	--	16.3	3.12	--	--	--
0745	01/26/98	0001	.06	.6U	.001U	2680	--	5310	--	--	.0381	18.8*	1U
	01/26/98	N001	--	--	--	--	--	--	13.4	9.35	--	--	--
	06/17/98	0001	.13U	.52U	.001U	2480J	5.9	5070	--	--	.038	--	--
	06/17/98	N001	--	--	--	--	--	--	12.3	2.64	--	--	--
0746	01/26/98	0001	.08	.6U	.111	3560	--	6950	--	--	.0624	32.1*	1U
	01/26/98	N001	--	--	--	--	--	--	15.5	7.83	--	--	--
	06/17/98	0001	.14U	.53U	.1	3550J	8.09	7020	--	--	.0637	--	--
	06/17/98	N001	--	--	--	--	--	--	14.7	9.2	--	--	--
1020	01/26/98	0001	.1	1U	.001U	2940	--	6340	--	--	.0566	29.2	1U
	01/26/98	N001	--	--	--	--	--	--	12.4	25.4	--	--	--
	06/22/98	0001	.13U	.53U	.001U	2730	6.04	7400	--	--	.0573	--	--
	06/22/98	N001	--	--	--	--	--	--	13.1	6.52	--	--	--
1021	01/26/98	0001	.34L	.9UL	.001UL	614L	--	2610L	--	--	.0305L	14.9L	1UL
	01/26/98	N001	--	--	--	--	--	--	9.7L	32.4L	--	--	--
	06/23/98	0001	.13UL	.5UL	.001UL	416L	2.14L	1670L	--	--	.0228L	--	--
	06/23/98	N001	--	--	--	--	--	--	13.5L	34L	--	--	--
1023	01/22/98	0001	.08	.5U	.137	3720	--	6440	--	--	.0468	23.8*	1U
	01/22/98	N001	--	--	--	--	--	--	13.9	6.61	--	--	--
	06/18/98	0001	.14U	.53U	.116	3700	4.93	6410	--	--	.0452	--	--
	06/18/98	N001	--	--	--	--	--	--	13.4	16.2	--	--	--
1024	01/22/98	0001	.29	.7U	.001U	183	--	1030	--	--	.0041	2U	1U
	01/22/98	N001	--	--	--	--	--	--	11.8	4.31	--	--	--
	06/18/98	0001	.13U	.51U	.001U	113	.828	647	--	--	.0054	--	--
	06/18/98	N001	--	--	--	--	--	--	12.3	2.32	--	--	--
1025	01/22/98	0001	.09	.4U	.0624	3100	--	5520	--	--	.0435	21.5*	1U
	01/22/98	0002	.06U	.7U	.0546	3100	--	5460	--	--	.0436	20.5*	1U
	01/22/98	N001	--	--	--	--	--	--	14.1	7.69	--	--	--
	06/18/98	0001	.13U	.51U	.0518	3020	6.88	5480	--	--	.0437	--	--

Loc Id	Date	Sample Id	U-238 pCi/L	V mg/L	Zn mg/L
Upgradient					
0588	01/28/98	0001	1U	.0014B	.004U
	01/28/98	N001	--	--	--
	06/29/98	0001	--	.0028BU	.0063B
	06/29/98	N001	--	--	--
0713	01/27/98	0001	21.8	.0035B	.004U
	01/27/98	N001	--	--	--
	06/24/98	0001	--	.0049BU	.005U
	06/24/98	N001	--	--	--
0715	01/27/98	0001	20.1	.001U	.004U
	01/27/98	N001	--	--	--
	06/24/98	0001	--	.0023BU	.005U
	06/24/98	N001	--	--	--
0744	01/26/98	0001	4.4	.001U	.004U
	01/26/98	N001	--	--	--
	06/29/98	0001	--	.0013BU	.005U
	06/29/98	N001	--	--	--
0745	01/26/98	0001	12.7	.001U	.004U
	01/26/98	N001	--	--	--
	06/17/98	0001	--	.001U	.005U
	06/17/98	N001	--	--	--
0746	01/26/98	0001	20.8	.0011B	.004U
	01/26/98	N001	--	--	--
	06/17/98	0001	--	.0017BU	.005U
	06/17/98	N001	--	--	--
1020	01/26/98	0001	18.9	.001U	.004U
	01/26/98	N001	--	--	--
	06/22/98	0001	--	.0011BU	.005U
	06/22/98	N001	--	--	--
1021	01/26/98	0001	10.2L	.001UL	.0051BL
	01/26/98	N001	--	--	--
	06/23/98	0001	--	.0017BUL	.005UL
	06/23/98	N001	--	--	--
1023	01/22/98	0001	15.6	.0015B	.004U
	01/22/98	N001	--	--	--
	06/18/98	0001	--	.0026BU	.005U
	06/18/98	N001	--	--	--
1024	01/22/98	0001	1.4	.001U	.0057B
	01/22/98	N001	--	--	--
	06/18/98	0001	--	.001U	.005U
	06/18/98	N001	--	--	--
1025	01/22/98	0001	14.5	.001U	.004U
	01/22/98	0002	14.6	.0013B	.004U
	01/22/98	N001	--	--	--
	06/18/98	0001	--	.0018BU	.005U

Groundwater Data

Loc Id	Date	Sample Id	Alkalinity mg/L	As mg/L	Ca mg/L	Cd mg/L	Chloride mg/L	Co mg/L	Cu mg/L	EC µmhos/cm	Eh mV	Fe mg/L	Fluoride mg/L
Upgradient													
1025	06/18/98	N001	410	--	--	--	--	--	--	4500	8	--	--
1026	01/23/98	0001	--	.001U	451	.001U	466	.008U	--	--	--	.0995	1.64
	01/23/98	N001	375	--	--	--	--	--	--	5310	25	--	--
	06/19/98	0001	345	.001U	424	.001U	484	.006U	.005U	--	--	.141	1.81
	06/19/98	N001	356	--	--	--	--	--	--	5050	1	--	--
1027	01/23/98	0001	--	.001B	519	.001U	416	.008U	--	--	--	.709	1.63
	01/23/98	N001	379	--	--	--	--	--	--	6150	-32	--	--
	06/19/98	0001	360	.001U	458	.001U	408	.006U	.005U	--	--	.593	1.47
	06/19/98	N001	354	--	--	--	--	--	--	4830	-51	--	--
1028	01/23/98	0001	--	.001U	460	.001U	443	.008U	--	--	--	.206	1.64
	01/23/98	N001	355	--	--	--	--	--	--	6080	-12	--	--
	06/18/98	0001	359	.001U	431	.001U	439	.006U	.005U	--	--	.357	1.68
	06/18/98	N001	341	--	--	--	--	--	--	4780	-21	--	--
CW21	06/22/98	0001	420	.001U	237	.001U	229	.006U	.005U	--	--	.0573	.553
	06/22/98	N001	426	--	--	--	--	--	--	2950	-20	--	--
On-Site													
1000	01/28/98	0001	--	.0024BL	502L	.001UL	748L	.008UL	--	--	--	1.35L	1.81L
	01/28/98	N001	305L	--	--	--	--	--	--	6880L	94L	--	--
	06/25/98	0001	415L	.0032BL	549L	.0013L	392L	.006UL	.005UL	--	--	2.43L	1.47L
	06/25/98	N001	402L	--	--	--	--	--	--	--	26L	--	--
1001	01/26/98	0001	--	.0318	563	.001U	860	.008U	--	--	--	10.3	3.75
	01/26/98	N001	478	--	--	--	--	--	--	7910	-49	--	--
	06/24/98	0001	484	.0349	490	.001U	857	.0162B	.005U	--	--	8.8	3.97
	06/24/98	N001	489	--	--	--	--	--	--	7970	-87	--	--
1002	01/27/98	0001	--	.001UL	481L	.001UL	861L	.008UL	--	--	--	1.28L	1.94L
	01/27/98	N001	386L	--	--	--	--	--	--	7670L	120L	--	--
	06/25/98	0001	475L	.001UL	480L	.001UL	415L	.0118BL	.005UL	--	--	1.17L	.99L
	06/25/98	N001	444L	--	--	--	--	--	--	--	-9L	--	--
1012	01/22/98	0001	--	.002B	533	.001U	835	.008U	--	--	--	3.66	1.7
	01/22/98	N001	458	--	--	--	--	--	--	7600	-15	--	--
	06/25/98	0001	481	.0024B	465	.001U	420	.006U	.005U	--	--	4.05	1.56
	06/25/98	N001	472	--	--	--	--	--	--	7830	-42	--	--
1013	01/26/98	0001	--	.0048B	547	.001U	845	.008U	--	--	--	3.55	1.69
	01/26/98	N001	467	--	--	--	--	--	--	7610	-31	--	--
	06/24/98	0001	493	.0071	475	.001U	406	.006U	.005U	--	--	3	.898
	06/24/98	N001	492	--	--	--	--	--	--	7740	-41	--	--
1014	01/23/98	0001	--	.0191	562	.001U	836	.0096B	--	--	--	2.99	7.44
	01/23/98	N001	545	--	--	--	--	--	--	7780	-38	--	--
	06/24/98	0001	459	.017	472	.0012	887	.006U	.005U	--	--	2.35	7.9
	06/24/98	0002	--	.0144	481	.0014	872	.0132B	.005U	--	--	1.94	7.24
	06/24/98	N001	489	--	--	--	--	--	--	8040	-14	--	--
1015	01/23/98	0001	--	.0023B	618	.001U	771	.008U	--	--	--	2.35	1.31

Groundwater Data

Loc Id	Date	Sample Id	GA pCi/L	GB pCi/L	K mg/L	Mg mg/L	Mn mg/L	Mo mg/L	Na mg/L	NH4 mg/L	Ni mg/L	NO3 mg/L	pH s.u.
Upgradient													
1025	06/18/98	N001	--	--	--	--	--	--	--	--	--	--	6.82
1026	01/23/98	0001	42.3UJ	44.14U	8.39	417	2.37	.118	653	--	.02B	1.37	--
	01/23/98	N001	--	--	--	--	--	--	--	--	--	--	7.08
	06/19/98	0001	74.13J	48.58	7.98	388	2.51	.111	670	.0203B	.016B	1.37J	--
	06/19/98	N001	--	--	--	--	--	--	--	--	--	--	6.87
1027	01/23/98	0001	41.92UJ	44.02U	7.47	369	2.58	.105	648	--	.016U	1.23	--
	01/23/98	N001	--	--	--	--	--	--	--	--	--	--	7.77
	06/19/98	0001	83.66J	45.77U	7.07	349	3.08	.1	638	.0234B	.0096B	.454BJ	--
	06/19/98	N001	--	--	--	--	--	--	--	--	--	--	6.86
1028	01/23/98	0001	41.65UJ	44.04U	8.62	420	2.2	.111	607	--	.016U	.0686BU	--
	01/23/98	N001	--	--	--	--	--	--	--	--	--	--	6.83
	06/18/98	0001	55.97	36.8U	8.56	395	2.19	.102	598	.0172B	.014B	.0752BUJ	--
	06/18/98	N001	--	--	--	--	--	--	--	--	--	--	6.87
CW21	06/22/98	0001	37.61J	27.27U	4.93	197	.868	.0158	302	.0256B	.0074B	.104B	--
	06/22/98	N001	--	--	--	--	--	--	--	--	--	--	6.88
On-Site													
1000	01/28/98	0001	149.6L	61.66UL	22.1L	224L	2.61L	.0666L	918L	--	.0308BL	3.48L	--
	01/28/98	N001	--	--	--	--	--	--	--	--	--	--	7.57L
	06/25/98	0001	125.9JL	68UL	32.4L	284L	3.44L	.0836L	922L	65.7L	.036BL	10.7L	--
	06/25/98	N001	--	--	--	--	--	--	--	--	--	--	7.12L
1001	01/26/98	0001	167.7J	77.36	61.2	368	4.43	.175	863	--	.111	.399B	--
	01/26/98	N001	--	--	--	--	--	--	--	--	--	--	7.07
	06/24/98	0001	206.7J	1113	60.4	336	4.54	.165	877	182	.0981	.192B	--
	06/24/98	N001	--	--	--	--	--	--	--	--	--	--	7.01
1002	01/27/98	0001	288JL	92.49L	36.9L	472L	2.64L	.132L	877L	--	.016UL	4.19L	--
	01/27/98	N001	--	--	--	--	--	--	--	--	--	--	7.33L
	06/25/98	0001	216.8JL	109.1L	35.6L	419L	2.7L	.108L	920L	51.6L	.0132BL	14.3L	--
	06/25/98	N001	--	--	--	--	--	--	--	--	--	--	7.2L
1012	01/22/98	0001	201.8J	66.27U	42.8	426	2.79	.192	860	--	.0261B	1.43	--
	01/22/98	N001	--	--	--	--	--	--	--	--	--	--	7.06
	06/25/98	0001	162.7J	68.32U	44.5	391	3.31	.188	872	98.5	.0234B	.011U	--
	06/25/98	N001	--	--	--	--	--	--	--	--	--	--	6.95
1013	01/26/98	0001	510.4J	104.1	29.6	474	2.92	.108	904	--	.0348B	1.02	--
	01/26/98	N001	--	--	--	--	--	--	--	--	--	--	7.07
	06/24/98	0001	335.3J	174	27.7	429	3.11	.0977	916	54.9	.036B	.708B	--
	06/24/98	N001	--	--	--	--	--	--	--	--	--	--	7.14
1014	01/23/98	0001	1930J	413.5	36.3	455	3.16	.299	909	--	.0481	.526B	--
	01/23/98	N001	--	--	--	--	--	--	--	--	--	--	7.09
	06/24/98	0001	1677J	669.9	33.6	424	3.23	.296	969	83	.0417	3.93	--
	06/24/98	0002	1521J	651.1	32	420	3.29	.308	972	83	.0506	3.92	--
	06/24/98	N001	--	--	--	--	--	--	--	--	--	--	7.03
1015	01/23/98	0001	41.78UJ	44.1U	20.5	407	3.18	.0517	804	--	.0254B	.0867B	--

Groundwater Data

Loc Id	Date	Sample Id	Ra-226 pCi/L	Ra-228 pCi/L	Se mg/L	SO4 mg/L	Sr mg/L	TDS mg/L	Tmp C	Turbidity NTU	U mg/L	U-234 pCi/L	U-235 pCi/L
Upgradient													
1025	06/18/98	N001	--	--	--	--	--	--	13.2	8.91	--	--	--
1026	01/23/98	0001	.23	.4U	.0066	2970	--	5490	--	--	.0622	28.7*	1
	01/23/98	N001	--	--	--	--	--	--	14.2	6.81	--	--	--
	06/19/98	0001	.13U	.5U	.0049B	3040	5.96	5700	--	--	.0629	--	--
	06/19/98	N001	--	--	--	--	--	--	13.7	8.58	--	--	--
1027	01/23/98	0001	.09	.7U	.0179	3030	--	5530	--	--	.0682	31.9*	1.1
	01/23/98	N001	--	--	--	--	--	--	15.6	7.38	--	--	--
	06/19/98	0001	.14U	.57U	.0116	2910	6.5	5490	--	--	.0674	--	--
	06/19/98	N001	--	--	--	--	--	--	15.1	6.07	--	--	--
1028	01/23/98	0001	.09	.7U	.001U	2990	--	5430	--	--	.059	29.5*	1U
	01/23/98	N001	--	--	--	--	--	--	13.4	8.43	--	--	--
	06/18/98	0001	.13U	.49U	.001U	2960	5.83	5500	--	--	.0587	--	--
	06/18/98	N001	--	--	--	--	--	--	13.2	12.8	--	--	--
CW21	06/22/98	0001	.15U	.6U	.001U	1330	2.42	2770	--	--	.036	--	--
	06/22/98	N001	--	--	--	--	--	--	17.2	8.44	--	--	--
On-Site													
1000	01/28/98	0001	.31L	.9UL	.001UL	2920L	--	5820L	--	--	.0846L	30.6L	1.4L
	01/28/98	N001	--	--	--	--	--	--	8.3L	1000>L	--	--	--
	06/25/98	0001	.13UL	.54UL	.001UL	1650L	7.84L	6200L	--	--	.191L	--	--
	06/25/98	N001	--	--	--	--	--	--	17.1L	24.1L	--	--	--
1001	01/26/98	0001	.58	.6	.001U	3430	--	6410	--	--	.33	115*	5.4
	01/26/98	N001	--	--	--	--	--	--	10.3	2.37	--	--	--
	06/24/98	0001	.26	.62U	.0011B	3460	6.4	6380	--	--	.314	--	--
	06/24/98	N001	--	--	--	--	--	--	15.8	3.4	--	--	--
1002	01/27/98	0001	.06L	.5UL	.001UL	3580L	--	6880L	--	--	.391L	136L	6.2L
	01/27/98	N001	--	--	--	--	--	--	11.8L	7.54L	--	--	--
	06/25/98	0001	.12UL	.53UL	.001UL	1790L	6.94L	6810L	--	--	.362L	--	--
	06/25/98	N001	--	--	--	--	--	--	15.4L	12.1L	--	--	--
1012	01/22/98	0001	.31	.7	.001U	3440	--	6620	--	--	.22	84.7*	3.5
	01/22/98	N001	--	--	--	--	--	--	11.8	12	--	--	--
	06/25/98	0001	.13U	.56U	.001U	1760	6.15	6620	--	--	.224	--	--
	06/25/98	N001	--	--	--	--	--	--	13.9	3.06	--	--	--
1013	01/26/98	0001	.16	.6U	.001U	3550	--	6790	--	--	.604	220*	9.9
	01/26/98	N001	--	--	--	--	--	--	12.9	9.35	--	--	--
	06/24/98	0001	.13U	.56U	.001U	1800	6.86	6820	--	--	.582	--	--
	06/24/98	N001	--	--	--	--	--	--	14.5	1.72	--	--	--
1014	01/23/98	0001	.18	.7U	.0043B	3580	--	6800	--	--	2.5	833*	38
	01/23/98	N001	--	--	--	--	--	--	15.4	7.03	--	--	--
	06/24/98	0001	.12U	.5U	.0072	3680	7.52	6880	--	--	2.29	--	--
	06/24/98	0002	.12U	.52U	.008	3660	7.63	6930	--	--	2.31	--	--
	06/24/98	N001	--	--	--	--	--	--	15	8.47	--	--	--
1015	01/23/98	0001	.15	.8	.001U	3330	--	6440	--	--	.0641	37.8*	1.1

Groundwater Data

Loc Id	Date	Sample Id	U-238 pCi/L	V mg/L	Zn mg/L
Upgradient					
1025	06/18/98	N001	--	--	--
1026	01/23/98	0001	20.8	.001U	.004U
	01/23/98	N001	--	--	--
	06/19/98	0001	--	.0033BU	.005U
	06/19/98	N001	--	--	--
1027	01/23/98	0001	22.8	.0011B	.004U
	01/23/98	N001	--	--	--
	06/19/98	0001	--	.0015BU	.005U
	06/19/98	N001	--	--	--
1028	01/23/98	0001	19.7	.001U	.004U
	01/23/98	N001	--	--	--
	06/18/98	0001	--	.0023BU	.005U
	06/18/98	N001	--	--	--
CW21	06/22/98	0001	--	.0024BU	.005U
	06/22/98	N001	--	--	--
On-Site					
1000	01/28/98	0001	28.2L	.0175L	.0123BL
	01/28/98	N001	--	--	--
	06/25/98	0001	--	.0205L	.0224BL
	06/25/98	N001	--	--	--
1001	01/26/98	0001	110	.063	.121
	01/26/98	N001	--	--	--
	06/24/98	0001	--	.0704	.0832
	06/24/98	N001	--	--	--
1002	01/27/98	0001	131L	.0044BL	.004UL
	01/27/98	N001	--	--	--
	06/25/98	0001	--	.0058BUL	.028BL
	06/25/98	N001	--	--	--
1012	01/22/98	0001	73.5	.0058B	.0307B
	01/22/98	N001	--	--	--
	06/25/98	0001	--	.0081B	.005U
	06/25/98	N001	--	--	--
1013	01/26/98	0001	202	.271	.0129B
	01/26/98	N001	--	--	--
	06/24/98	0001	--	.37	.0155B
	06/24/98	N001	--	--	--
1014	01/23/98	0001	835	.26	.352
	01/23/98	N001	--	--	--
	06/24/98	0001	--	.312	.317
	06/24/98	0002	--	.353	.275
	06/24/98	N001	--	--	--
1015	01/23/98	0001	21.4	.001U	.0174B

Groundwater Data

Loc Id	Date	Sample Id	Alkalinity mg/L	As mg/L	Ca mg/L	Cd mg/L	Chloride mg/L	Co mg/L	Cu mg/L	EC µmhos/cm	Eh mV	Fe mg/L	Fluoride mg/L
On-Site													
1015	01/23/98	N001	405	--	--	--	--	--	--	7120	-14	--	--
	06/22/98	0001	433	.0013B	572	.001U	825	.0105B	.005U	--	--	2.97	1.7
	06/22/98	N001	440	--	--	--	--	--	--	7470	-43	--	--
1016	01/26/98	0001	--	.0055	583	.001U	750	.008U	--	--	--	21.2	3.39
	01/26/98	N001	400	--	--	--	--	--	--	7020	-141	--	--
	06/29/98	0001	454	.0063	495	.001U	802	.006U	.005U	--	--	18.1	4.02
	06/29/98	N001	429	--	--	--	--	--	--	5740	-124	--	--
1017	01/23/98	0001	--	.001U	493	.001U	565	.008U	--	--	--	.373	1.75
	01/23/98	N001	419	--	--	--	--	--	--	7660	45	--	--
	06/22/98	0001	408	.001U	441	.001U	565	.006U	.005U	--	--	.718	1.91
	06/22/98	N001	402	--	--	--	--	--	--	7700	-13	--	--
1018	01/26/98	0001	--	.0047B	563	.001U	508	.008U	--	--	--	.156	2.56
	01/26/98	N001	356	--	--	--	--	--	--	6040	108	--	--
	06/19/98	0001	382	.0061	474	.001	477	.0096B	.005U	--	--	.167	2.43
	06/19/98	N001	380	--	--	--	--	--	--	5980	134	--	--
1019	01/26/98	0001	--	.001U	549	.001U	668	.008U	--	--	--	.32	1.16
	01/26/98	N001	398	--	--	--	--	--	--	6570	75	--	--
	06/19/98	0001	376L	.001UL	476L	.001UL	667L	.006UL	.005UL	--	--	.566L	1.51L
	06/19/98	N001	376L	--	--	--	--	--	--	5930L	99L	--	--
Down Gradient													
0590	01/28/98	0001	--	.001U	616	.001U	1160	.008U	--	--	--	.004U	.335
	01/28/98	N001	477	--	--	--	--	--	--	9080	159	--	--
	06/29/98	0001	487	.001U	395	.001U	878	.006U	.005U	--	--	.003U	.972
	06/29/98	N001	459	--	--	--	--	--	--	6940	-69	--	--
0732	01/27/98	0001	--	.001U	438	.001U	1020	.008U	--	--	--	.004U	.806
	01/27/98	N001	470	--	--	--	--	--	--	7560	162	--	--
	06/22/98	0001	443	.001U	409	.001U	1080	.006U	.005U	--	--	.003U	.843
	06/22/98	N001	480	--	--	--	--	--	--	5540	126	--	--
0736	01/27/98	0001	--	.001U	493	.001U	954	.008U	--	--	--	.004U	.576
	01/27/98	N001	488	--	--	--	--	--	--	9760	-86	--	--
	06/17/98	0001	488	.001U	528	.001U	991J	.006U	.005U	--	--	.003U	.805J
	06/17/98	N001	474	--	--	--	--	--	--	6860	211	--	--
0740	01/28/98	0001	--	.001U	510	.001U	983	.008U	--	--	--	.0067BU	.702
	01/28/98	N001	468	--	--	--	--	--	--	8550	126	--	--
	06/23/98	0001	459	.001U	463	.001U	914	.006U	.005U	--	--	.0218BU	.967
	06/23/98	0002	--	.001U	463	.001U	917	.006U	.005U	--	--	.0071BU	.834
	06/23/98	N001	444	--	--	--	--	--	--	5670	105	--	--
0742	01/27/98	0001	--	.001U	536	.001U	910	.008U	--	--	--	.392	.913
	01/27/98	0002	--	.001U	548	.001U	910	.008U	--	--	--	.39	.902
	01/27/98	N001	451	--	--	--	--	--	--	7690	-68	--	--
	06/17/98	0001	454	.001U	479	.001U	877J	.006U	.005U	--	--	.299	1.2
	06/17/98	N001	454	--	--	--	--	--	--	6710	-7	--	--

Groundwater Data

Loc Id	Date	Sample Id	GA pCi/L	GB pCi/L	K mg/L	Mg mg/L	Mn mg/L	Mo mg/L	Na mg/L	NH4 mg/L	Ni mg/L	NO3 mg/L	pH s.u.
On-Site													
1015	01/23/98	N001	--	--	--	--	--	--	--	--	--	--	7.12
	06/22/98	0001	101.1J	68.04U	20.7	391	3.52	.0474	872	47B	.0209B	.17B	--
	06/22/98	N001	--	--	--	--	--	--	--	--	--	--	7.1
1016	01/26/98	0001	75.56J	44.54U	39.1	374	2.65	.0421	760	--	.016U	.263B	--
	01/26/98	N001	--	--	--	--	--	--	--	--	--	--	7.3
	06/29/98	0001	61.28U	256J	40.7	358	3.08	.0405	800	96.5	.0172B	.0579B	--
	06/29/98	N001	--	--	--	--	--	--	--	--	--	--	7.22
1017	01/23/98	0001	43.63UJ	44.79	55.8	254	3.26	.0893	979	--	.0884	.0348BU	--
	01/23/98	N001	--	--	--	--	--	--	--	--	--	--	7.15
	06/22/98	0001	66.49UJ	67.71U	56.5	240	4.14	.0894	999	233	.0828	.121B	--
	06/22/98	N001	--	--	--	--	--	--	--	--	--	--	7.13
1018	01/26/98	0001	56.18J	37.4	55.7	191	2.57	.18	536	--	.0909	12.2	--
	01/26/98	N001	--	--	--	--	--	--	--	--	--	--	7.16
	06/19/98	0001	86.95J	84.37	52.7	173	2.64	.159	541	189	.0907	20.4J	--
	06/19/98	N001	--	--	--	--	--	--	--	--	--	--	6.84
1019	01/26/98	0001	43.72UJ	44.22U	15	444	2.68	.0858	687	--	.016U	.032BU	--
	01/26/98	N001	--	--	--	--	--	--	--	--	--	--	7.08
	06/19/98	0001	62.43UJL	67.76UL	14.2L	417L	2.89L	.0756L	685L	53L	.0116BL	.0957BUJL	--
	06/19/98	N001	--	--	--	--	--	--	--	--	--	--	6.94L
Down Gradient													
0590	01/28/98	0001	130.6J	61.95U	25.7	470	2.84	.0494	1140	--	.0222B	4.79	--
	01/28/98	N001	--	--	--	--	--	--	--	--	--	--	6.61
	06/29/98	0001	82.22	257.8J	21.1	326	2.05	.0436	836	13	.02B	2.11	--
	06/29/98	N001	--	--	--	--	--	--	--	--	--	--	6.94
0732	01/27/98	0001	48.18UJ	60.45U	9.6	436	.138	.052	1020	--	.016U	25.6	--
	01/27/98	N001	--	--	--	--	--	--	--	--	--	--	7.68
	06/22/98	0001	66.02UJ	67.67U	9.67	392	.0815	.0429	1080	.0007BU	.007U	19.1	--
	06/22/98	N001	--	--	--	--	--	--	--	--	--	--	6.62
0736	01/27/98	0001	78.04J	61.06U	10.7	475	1.1	.02	1140	--	.016U	9.55	--
	01/27/98	N001	--	--	--	--	--	--	--	--	--	--	6.98
	06/17/98	0001	122.1	55.32U	10.9	480	2	.0234	1110	.0172B	.0161B	16.7J	--
	06/17/98	N001	--	--	--	--	--	--	--	--	--	--	6.63
0740	01/28/98	0001	86.27J	61.31U	22.8	491	3.68	.104	1070	--	.0193B	.542B	--
	01/28/98	N001	--	--	--	--	--	--	--	--	--	--	7.04
	06/23/98	0001	97.47J	68.23U	21.2	423	3.69	.0932	1000	22.1B	.0182B	.287B	--
	06/23/98	0002	75.45J	68.08U	21.5	425	3.67	.0907	999	22.1B	.0141B	.279B	--
	06/23/98	N001	--	--	--	--	--	--	--	--	--	--	6.64
0742	01/27/98	0001	66.36J	61.11U	9.17	476	2.53	.0636	995	--	.016U	.249B	--
	01/27/98	0002	62.5J	60.98U	9.21	488	2.55	.0639	1020	--	.0164B	.258B	--
	01/27/98	N001	--	--	--	--	--	--	--	--	--	--	7.06
	06/17/98	0001	77.15J	68.13U	9.06	469	2.64	.0611	1000	.0387B	.0114B	.559BJ	--
	06/17/98	N001	--	--	--	--	--	--	--	--	--	--	7.08

Groundwater Data

Loc Id	Date	Sample Id	Ra-226 pCi/L	Ra-228 pCi/L	Se mg/L	SO4 mg/L	Sr mg/L	TDS mg/L	Tmp C	Turbidity NTU	U mg/L	U-234 pCi/L	U-235 pCi/L
On-Site													
1015	01/23/98	N001	--	--	--	--	--	--	13	6.54	--	--	--
	06/22/98	0001	.12U	.49U	.001U	3440	8.12	6610	--	--	.07	--	--
	06/22/98	N001	--	--	--	--	--	--	14.4	2.2	--	--	--
1016	01/26/98	0001	.09	.9U	.001U	3270	--	6040	--	--	.113	42.2*	1.8
	01/26/98	N001	--	--	--	--	--	--	12.6	3.18	--	--	--
	06/29/98	0001	.12U	.48U	.001U	3410	7.14	6340	--	--	.116	--	--
	06/29/98	N001	--	--	--	--	--	--	14.5	3.38	--	--	--
1017	01/23/98	0001	.15	.9U	.001U	3680	--	6180	--	--	.0241	13.2*	1U
	01/23/98	N001	--	--	--	--	--	--	12.4	41.2	--	--	--
	06/22/98	0001	.14U	.65	.001U	3530	7.04	6070	--	--	.0255	--	--
	06/22/98	N001	--	--	--	--	--	--	14.7	9.57	--	--	--
1018	01/26/98	0001	.12	.5	.0123	2680	--	4620	--	--	.0862	39.1*	1.4
	01/26/98	N001	--	--	--	--	--	--	11.7	5.24	--	--	--
	06/19/98	0001	.15U	.58U	.016	2520	3.93	4440	--	--	.0895	--	--
	06/19/98	N001	--	--	--	--	--	--	14.4	15.1	--	--	--
1019	01/26/98	0001	.1	.7	.001U	3230	--	6020	--	--	.0486	25.7*	1U
	01/26/98	N001	--	--	--	--	--	--	15.1	8.17	--	--	--
	06/19/98	0001	.15UL	.58UL	.001UL	3230L	6.55L	6150L	--	--	.0529L	--	--
	06/19/98	N001	--	--	--	--	--	--	14.4L	8.54L	--	--	--
Down Gradient													
0590	01/28/98	0001	.04U	.4U	.001U	3700	--	7840	--	--	.162	62.6	2.6
	01/28/98	N001	--	--	--	--	--	--	13.1	1.63	--	--	--
	06/29/98	0001	.12U	.48U	.001U	2800	5.6	5880	--	--	.121	--	--
	06/29/98	N001	--	--	--	--	--	--	14.6	.93	--	--	--
0732	01/27/98	0001	.07U	.9U	.0081	2910	--	6450	--	--	.0721	35.9	1.2
	01/27/98	N001	--	--	--	--	--	--	15	8.24	--	--	--
	06/22/98	0001	.14U	.58U	.0054	3070	7.25	6680	--	--	.0681	--	--
	06/22/98	N001	--	--	--	--	--	--	16.6	4.55	--	--	--
0736	01/27/98	0001	.02U	.9U	.0024B	3460	--	7030	--	--	.105	49	1.7
	01/27/98	N001	--	--	--	--	--	--	13.2	1.67	--	--	--
	06/17/98	0001	.14U	.55U	.0017B	3610J	7.77	7690	--	--	.125	--	--
	06/17/98	N001	--	--	--	--	--	--	16.2	.66	--	--	--
0740	01/28/98	0001	.06	.5	.001U	3600	--	7300	--	--	.146	57.3	2.3
	01/28/98	N001	--	--	--	--	--	--	12.4	6.55	--	--	--
	06/23/98	0001	.14U	.55U	.001U	3440	6.65	6900	--	--	.146	--	--
	06/23/98	0002	.12U	.48U	.001U	3440	6.65	6550	--	--	.144	--	--
	06/23/98	N001	--	--	--	--	--	--	14.9	1.31	--	--	--
0742	01/27/98	0001	.06	.9U	.0022B	3700	--	7350	--	--	.0765	36.2	1.2
	01/27/98	0002	.06	.6U	.0022B	3690	--	7380	--	--	.0748	34.1	1.2
	01/27/98	N001	--	--	--	--	--	--	15.8	1.23	--	--	--
	06/17/98	0001	.18U	.73U	.0026B	3660J	7.8	7240	--	--	.0787	--	--
	06/17/98	N001	--	--	--	--	--	--	14.7	.6	--	--	--

Groundwater Data

Loc Id	Date	Sample Id	U-238 pCi/L	V mg/L	Zn mg/L
On-Site					
1015	01/23/98	N001	--	--	--
	06/22/98	0001	--	.001U	.005U
	06/22/98	N001	--	--	--
1016	01/26/98	0001	37.6	.001U	.004U
	01/26/98	N001	--	--	--
	06/29/98	0001	--	.003BU	.0066B
	06/29/98	N001	--	--	--
1017	01/23/98	0001	8.1	.001U	.0051B
	01/23/98	N001	--	--	--
	06/22/98	0001	--	.0021BU	.005U
	06/22/98	N001	--	--	--
1018	01/26/98	0001	28.8	.621	.004U
	01/26/98	N001	--	--	--
	06/19/98	0001	--	.832	.0102B
	06/19/98	N001	--	--	--
1019	01/26/98	0001	16.2	.001U	.004U
	01/26/98	N001	--	--	--
	06/19/98	0001	--	.0018BUL	.005UL
	06/19/98	N001	--	--	--
Down Gradient					
0590	01/28/98	0001	54.1	.001U	.0092B
	01/28/98	N001	--	--	--
	06/29/98	0001	--	.0019BU	.0089B
	06/29/98	N001	--	--	--
0732	01/27/98	0001	24.1	.0021B	.004U
	01/27/98	N001	--	--	--
	06/22/98	0001	--	.0025BU	.005U
	06/22/98	N001	--	--	--
0736	01/27/98	0001	35.2	.001B	.0382B
	01/27/98	N001	--	--	--
	06/17/98	0001	--	.0022BU	.005U
	06/17/98	N001	--	--	--
0740	01/28/98	0001	48.7	.001U	.004U
	01/28/98	N001	--	--	--
	06/23/98	0001	--	.0025BU	.005U
	06/23/98	0002	--	.0015BU	.005U
	06/23/98	N001	--	--	--
0742	01/27/98	0001	25.5	.001U	.004U
	01/27/98	0002	25	.001U	.004U
	01/27/98	N001	--	--	--
	06/17/98	0001	--	.0014BU	.005U
	06/17/98	N001	--	--	--

Groundwater Data

Loc Id	Date	Sample Id	Alkalinity mg/L	As mg/L	Ca mg/L	Cd mg/L	Chloride mg/L	Co mg/L	Cu mg/L	EC µmhos/cm	Eh mV	Fe mg/L	Fluoride mg/L
Down Gradient													
1010	01/28/98	0001	--	.0018B	491	.001U	959	.008U	--	--	--	16.8	.387
	01/28/98	N001	603	--	--	--	--	--	--	7970	-124	--	--
	06/19/98	0001	654	.0022B	487	.001U	1030	.006U	.005U	--	--	15.7	.56
	06/19/98	0002	--	.0022B	483	.001U	1030	.006U	.005U	--	--	16	1.33
	06/19/98	N001	596	--	--	--	--	--	--	6420	-128	--	--
1011	01/28/98	0001	--	.001UL	591L	.001UL	1060L	.008UL	--	--	--	1.23L	1.13L
	01/28/98	N001	433L	--	--	--	--	--	--	8520L	65L	--	--
	06/25/98	0001	428	.001U	603	.001U	1100	.006U	.005U	--	--	.003U	1.89
	06/25/98	N001	424	--	--	--	--	--	--	6370	91	--	--
1022	01/27/98	0001	--	.001U	552	.001U	1040	.008U	--	--	--	3.09	.517
	01/27/98	N001	506	--	--	--	--	--	--	8000	-46	--	--
	06/23/98	0001	476	.001U	573	.001U	1030	.006U	.005U	--	--	3.33	.872
	06/23/98	N001	467	--	--	--	--	--	--	5750	-49	--	--
1029	01/27/98	0001	--	.0064	407	.001U	1050	.008U	--	--	--	8.48	.888
	01/27/98	N001	661	--	--	--	--	--	--	7900	-114	--	--
	06/29/98	0001	714	.0081	353	.001U	213	.006U	.005U	--	--	6.25	.244
	06/29/98	N001	708	--	--	--	--	--	--	7570	-93	--	--
1030	01/27/98	0001	--	.001U	409	.001U	841	.008U	--	--	--	1.13	1.6
	01/27/98	N001	430	--	--	--	--	--	--	7950	-21	--	--
	06/22/98	0001	422	.001U	372	.001U	811	.006U	.005U	--	--	.283	1.67
	06/22/98	N001	440	--	--	--	--	--	--	6900	12	--	--
Dakota Sandstone													
0724	01/28/98	0001	--	.001UL	16.6L	.001UL	1310L	.008UL	--	--	--	.0694L	2.86L
	01/28/98	N001	1852L	--	--	--	--	--	--	6820L	-410L	--	--
	06/29/98	0001	1280	.001U	8.4	.001U	584	.006U	.005U	--	--	.0126BU	2.9
	06/29/98	N001	1264	--	--	--	--	--	--	3800	-367	--	--
0726	01/29/98	0001	--	.0061L	72.2L	.001UL	4040L	.008UL	--	--	--	2.88L	.364L
	01/29/98	N001	899L	--	--	--	--	--	--	12580L	-235L	--	--
	06/26/98	0001	898L	.001UL	63.4L	.001UL	3990L	.006UL	.005UL	--	--	2.22L	.793L
	06/26/98	N001	929L	--	--	--	--	--	--	12560L	-114L	--	--
0735	01/27/98	0001	--	.0018BL	3.41L	.001UL	691L	.008UL	--	--	--	.0359UL	3.52L
	01/27/98	N001	852L	--	--	--	--	--	--	3470L	-117L	--	--
	06/23/98	0001	710L	.0054L	3.41L	.001UL	692L	.006UL	.005UL	--	--	.0716L	3.42L
	06/23/98	N001	728L	--	--	--	--	--	--	3460L	-240L	--	--
0741	01/27/98	0001	--	.001UL	30.1L	.001UL	2150L	.008UL	--	--	--	.0781L	1L
	01/27/98	N001	252L	--	--	--	--	--	--	6620L	-62L	--	--
	06/17/98	0001	266L	.001UL	28.6L	.001UL	2190JL	.006UL	.005UL	--	--	.0591L	1.37JL
	06/17/98	N001	275L	--	--	--	--	--	--	5590L	-134L	--	--
0743	01/26/98	0001	--	.001U	68.4	.001U	799	.008U	--	--	--	.0758	.309
	01/26/98	N001	384	--	--	--	--	--	--	6360	-146	--	--
	06/29/98	0001	354	.001U	67.2	.001U	694	.006U	.005U	--	--	.083	.346
	06/29/98	N001	414	--	--	--	--	--	--	5790	-292	--	--

Groundwater Data

Loc Id	Date	Sample Id	GA pCi/L	GB pCi/L	K mg/L	Mg mg/L	Mn mg/L	Mo mg/L	Na mg/L	NH4 mg/L	Ni mg/L	NO3 mg/L	pH s.u.
Down Gradient													
1010	01/28/98	0001	63.34	67.06	24.6	413	1.46	.0179	1050	--	.016U	.0481B	--
	01/28/98	N001	--	--	--	--	--	--	--	--	--	--	7.23
	06/19/98	0001	111.5J	68.31U	24.6	410	1.57	.0147	1080	7.1B	.0117B	.0481BUJ	--
	06/19/98	0002	94.47J	68.22U	25.3	407	1.57	.0149	1070	8.6B	.01B	.0499BUJ	--
	06/19/98	N001	--	--	--	--	--	--	--	--	--	--	6.77
1011	01/28/98	0001	142.9JL	61.71UL	56.3L	404L	2.92L	.174L	922L	--	.0214BL	9.06L	--
	01/28/98	N001	--	--	--	--	--	--	--	--	--	--	7.64L
	06/25/98	0001	112.3J	128.2	66.6	327	.436	.0657	859	13.2B	.0208B	65	--
	06/25/98	N001	--	--	--	--	--	--	--	--	--	--	7.02
1022	01/27/98	0001	109.1J	61.55U	15	477	2.3	.0241	1070	--	.016U	1.26	--
	01/27/98	N001	--	--	--	--	--	--	--	--	--	--	6.99
	06/23/98	0001	89.76J	68.28U	15.1	428	2.37	.0208	1030	3.52	.016B	.14B	--
	06/23/98	N001	--	--	--	--	--	--	--	--	--	--	6.43
1029	01/27/98	0001	48.79UJ	60.38U	11.3	441	1.18	.0369	1080	--	.016U	.0836B	--
	01/27/98	N001	--	--	--	--	--	--	--	--	--	--	7.09
	06/29/98	0001	69.79	477.3J	10.3	389	1.24	.0335	1020	1.77	.0076B	.011U	--
	06/29/98	N001	--	--	--	--	--	--	--	--	--	--	7.07
1030	01/27/98	0001	53.4UJ	60.91U	14.6	462	2.53	.096	1360	--	.016U	12.8	--
	01/27/98	N001	--	--	--	--	--	--	--	--	--	--	6.96
	06/22/98	0001	72.44UJ	68.09U	15.9	405	1.7	.0734	1260	.0815B	.0076B	39.4	--
	06/22/98	N001	--	--	--	--	--	--	--	--	--	--	6.6
Dakota Sandstone													
0724	01/28/98	0001	35.39UL	40.43UL	5.64L	4.98L	.0161L	.001UL	1620L	--	.016UL	.014UL	--
	01/28/98	N001	--	--	--	--	--	--	--	--	--	--	7.9L
	06/29/98	0001	35.03U	33.97UJ	3.89	2.61	.008B	.001U	1220	3.17B	.007U	.011U	--
	06/29/98	N001	--	--	--	--	--	--	--	--	--	--	7.89
0726	01/29/98	0001	74.4L	81.1UL	9.43L	19.9L	.0999L	.0047BL	2730L	--	.0239BL	.0301BL	--
	01/29/98	N001	--	--	--	--	--	--	--	--	--	--	7.33L
	06/26/98	0001	109.95UJL	2029L	9.48L	17.7L	.0873L	.001BL	2660L	.26L	.007UL	.011UL	--
	06/26/98	N001	--	--	--	--	--	--	--	--	--	--	7.19L
0735	01/27/98	0001	16.22UJL	17.6UL	2.41L	.908L	.033L	.0244L	812L	--	.016UL	.0252BL	--
	01/27/98	N001	--	--	--	--	--	--	--	--	--	--	8.53L
	06/23/98	0001	21.67UJL	19.55UL	2.44L	.883L	.0426L	.0086BL	799L	1.16L	.007UL	.0306BL	--
	06/23/98	N001	--	--	--	--	--	--	--	--	--	--	8.22L
0741	01/27/98	0001	34.15JL	30.96UL	5.16L	7.74L	.0371L	.0011BL	1430L	--	.016UL	.0315BL	--
	01/27/98	N001	--	--	--	--	--	--	--	--	--	--	8.02L
	06/17/98	0001	46.15UJL	45.2UL	5.15L	7.36UL	.0379L	.001UL	1430L	11.7BL	.007UL	.0369BUJL	--
	06/17/98	N001	--	--	--	--	--	--	--	--	--	--	8.23L
0743	01/26/98	0001	35.2UJ	40.63U	6.68	25.5	.0395	.001U	1370	--	.0216B	.175B	--
	01/26/98	N001	--	--	--	--	--	--	--	--	--	--	7.7
	06/29/98	0001	41.15UJ	44.97U	6.36	25	.0444	.001U	1350	3.31B	.0149B	.0468B	--
	06/29/98	N001	--	--	--	--	--	--	--	--	--	--	7.39

Groundwater Data

Loc Id	Date	Sample Id	Ra-226 pCi/L	Ra-228 pCi/L	Se mg/L	SO4 mg/L	Sr mg/L	TDS mg/L	Tmp C	Turbidity NTU	U mg/L	U-234 pCi/L	U-235 pCi/L
Down Gradient													
1010	01/28/98	0001	.62	.5U	.001U	3130	--	6690	--	--	.0637	25.4	1.1
	01/28/98	N001	--	--	--	--	--	--	15	8.95	--	--	--
	06/19/98	0001	.25	.52U	.001U	3220	7.25	6930	--	--	.0773	--	--
	06/19/98	0002	.16U	.63U	.001U	3200	7.22	6890	--	--	.0774	--	--
	06/19/98	N001	--	--	--	--	--	--	14.9	8.92	--	--	--
1011	01/28/98	0001	.09L	.7UL	.001UL	3230L	--	6770L	--	--	.199L	73.5L	3.2L
	01/28/98	N001	--	--	--	--	--	--	11.3L	32.4L	--	--	--
	06/25/98	0001	.12U	.52U	.0056	2970	7.45	6400	--	--	.154	--	--
	06/25/98	N001	--	--	--	--	--	--	18	1.39	--	--	--
1022	01/27/98	0001	.1	.6U	.001U	3550	--	7380	--	--	.132	52.5	2.1
	01/27/98	N001	--	--	--	--	--	--	13.4	10.5	--	--	--
	06/23/98	0001	.13U	.55U	.001U	3580	8.99	7280	--	--	.138	--	--
	06/23/98	N001	--	--	--	--	--	--	14.3	9.6	--	--	--
1029	01/27/98	0001	.13	.8U	.001U	2820	--	6460	--	--	.0471	22.2	1U
	01/27/98	N001	--	--	--	--	--	--	16.5	9.12	--	--	--
	06/29/98	0001	.12U	.48U	.001U	572	7.08	6390	--	--	.0483	--	--
	06/29/98	N001	--	--	--	--	--	--	17.5	4.28	--	--	--
1030	01/27/98	0001	.05	.5U	.0174	3930	--	7670	--	--	.0318	15.3	1U
	01/27/98	N001	--	--	--	--	--	--	16.6	6.88	--	--	--
	06/22/98	0001	.13U	.51U	.0244	3770	6.27	5930	--	--	.0398	--	--
	06/22/98	N001	--	--	--	--	--	--	16.6	27.8	--	--	--
Dakota Sandstone													
0724	01/28/98	0001	1.38L	1UL	.001UL	94.2L	--	4180L	--	--	.001UL	1.3L	1UL
	01/28/98	N001	--	--	--	--	--	--	16L	256L	--	--	--
	06/29/98	0001	.12U	.48U	.001U	728	1.65	3390	--	--	.001U	--	--
	06/29/98	N001	--	--	--	--	--	--	16.6	1.87	--	--	--
0726	01/29/98	0001	47.04L	19.8L	.001UL	1.39BL	--	7390L	--	--	.001UL	.8UL	1UL
	01/29/98	N001	--	--	--	--	--	--	14.8L	1000>L	--	--	--
	06/26/98	0001	24.16L	29.27L	.001UL	1.83BL	14.4L	7110L	--	--	.001UL	--	--
	06/26/98	N001	--	--	--	--	--	--	15.5L	467L	--	--	--
0735	01/27/98	0001	.67L	.7UL	.001UL	2.9L	--	2030L	--	--	.0028L	4.6L	1UL
	01/27/98	N001	--	--	--	--	--	--	15.4L	159L	--	--	--
	06/23/98	0001	.12UL	.5UL	.001UL	23.4L	.451L	2040L	--	--	.0052L	--	--
	06/23/98	N001	--	--	--	--	--	--	16L	--	--	--	--
0741	01/27/98	0001	1.19L	1UL	.001UL	.832BL	--	3740L	--	--	.001UL	.8UL	1UL
	01/27/98	N001	--	--	--	--	--	--	15.5L	34.3L	--	--	--
	06/17/98	0001	.22L	.54UL	.001UL	.441BJL	3.07L	3820L	--	--	.001UL	--	--
	06/17/98	N001	--	--	--	--	--	--	16.1L	8.82L	--	--	--
0743	01/26/98	0001	.11	.9U	.001U	1810	--	4310	--	--	.001U	.8U	1U
	01/26/98	N001	--	--	--	--	--	--	15	1.52	--	--	--
	06/29/98	0001	.15U	.64U	.001U	1930	5.54	4340	--	--	.001U	--	--
	06/29/98	N001	--	--	--	--	--	--	14.5	1.36	--	--	--

Groundwater Data

Loc Id	Date	Sample Id	U-238 pCi/L	V mg/L	Zn mg/L
Down Gradient					
1010	01/28/98	0001	21.3	.001U	.004U
	01/28/98	N001	--	--	--
	06/19/98	0001	--	.0017BU	.005U
	06/19/98	0002	--	.001U	.005U
	06/19/98	N001	--	--	--
1011	01/28/98	0001	66.5L	.0013BL	.0162BL
	01/28/98	N001	--	--	--
	06/25/98	0001	--	.0052BU	.0336B
	06/25/98	N001	--	--	--
1022	01/27/98	0001	44.2	.001U	.004U
	01/27/98	N001	--	--	--
	06/23/98	0001	--	.001U	.005U
	06/23/98	N001	--	--	--
1029	01/27/98	0001	15.7	.001U	.004U
	01/27/98	N001	--	--	--
	06/29/98	0001	--	.0023BU	.005U
	06/29/98	N001	--	--	--
1030	01/27/98	0001	10.6	.001U	.004U
	01/27/98	N001	--	--	--
	06/22/98	0001	--	.0024BU	.005U
	06/22/98	N001	--	--	--
Dakota Sandstone					
0724	01/28/98	0001	1UL	.0025BL	.0045BL
	01/28/98	N001	--	--	--
	06/29/98	0001	--	.0041BU	.005U
	06/29/98	N001	--	--	--
0726	01/29/98	0001	1UL	.0023BL	.0069BL
	01/29/98	N001	--	--	--
	06/26/98	0001	--	.0021BUL	.0054BL
	06/26/98	N001	--	--	--
0735	01/27/98	0001	1UL	.001UL	.004UL
	01/27/98	N001	--	--	--
	06/23/98	0001	--	.0017BUL	.005UL
	06/23/98	N001	--	--	--
0741	01/27/98	0001	1UL	.001UL	.0119BL
	01/27/98	N001	--	--	--
	06/17/98	0001	--	.0017BUL	.0057BL
	06/17/98	N001	--	--	--
0743	01/26/98	0001	1U	.001U	.004U
	01/26/98	N001	--	--	--
	06/29/98	0001	--	.0018BU	.0061B
	06/29/98	N001	--	--	--

Soil and Sediment Data

Loc Id	Date	Sample From	Sample To	Sample Id	As mg/kg	Cd mg/kg	Co mg/kg	Cu mg/kg	Fe mg/kg	Fluoride mg/kg	Kd-As mL/g	Kd-Cd mL/g	Kd-Mo mL/g	Kd-U mL/g
Upgradient														
0315	10/22/97	0	0	0002	--	--	--	--	--	--	--	--	--	--
0323	10/22/97	0	0	0002	--	--	--	--	--	--	--	--	--	--
0324	10/22/97	0	0	0002	--	--	--	--	--	--	--	--	--	--
0325	10/22/97	0	0	0002	--	--	--	--	--	--	--	--	--	--
	11/07/97	0		0002	.48	.77	1B	6.6E	1890	38.7	--	--	--	--
0330	10/22/97	0	0	0002	--	--	--	--	--	--	--	--	--	--
	11/07/97	0		0002	1.5B	.42	2.2	9.2E	3240	58.6	--	--	--	--
0335	10/22/97	0	0	0002	--	--	--	--	--	--	--	--	--	--
0337	10/22/97	0	0	0002	--	--	--	--	--	--	--	--	--	--
0338	10/22/97	0	0	0002	--	--	--	--	--	--	--	--	--	--
0339	10/22/97	0	0	0002	--	--	--	--	--	--	--	--	--	--
0342	10/22/97	0	0	0002	--	--	--	--	--	--	--	--	--	--
	11/06/97	0		0002	1.5B	.44	1.9B	6.1E	2400	79.5	--	--	--	--
0349	10/22/97	0	0	0002	--	--	--	--	--	--	--	--	--	--
	11/06/97	0		0002	.86	.38	1.1B	2.9E	1780	55.1	--	--	--	--
0350	10/22/97	0	0	0002	--	--	--	--	--	--	--	--	--	--
	11/06/97	0		0002	1.4B	.5	2.1	7.9E	2580	83	--	--	--	--
1020	02/08/98	5	7	0001	1.2	.4B	--	--	--	--	--	--	--	--
	02/11/98	10	12	0001	--	--	--	--	--	--	83.83	182.23	.1	2.414
1021	02/08/98	5	7	0001	.9B	.32B	--	--	--	--	--	--	--	--
	02/11/98	5	7	0001	--	--	--	--	--	--	358.1	356.76	.7216	3.636
1023	02/08/98	5	7	0001	1	.42B	--	--	--	--	--	--	--	--
	02/08/98	10	12	0001	.92B	.25B	--	--	--	--	--	--	--	--
	02/11/98	5	7	0001	--	--	--	--	--	--	8241	248.64	1.2698	1.788
	02/11/98	10	12	0001	--	--	--	--	--	--	75.24	48.788	.1	.968
	02/11/98	10	12	0M01	--	--	--	--	--	--	--	--	--	1.703
	02/11/98	10	12	0M02	--	--	--	--	--	--	--	--	--	1.381
	02/11/98	10	12	0M03	--	--	--	--	--	--	--	--	--	.969
	02/11/98	10	12	0M04	--	--	--	--	--	--	--	--	--	1.083
	02/11/98	10	12	0M05	--	--	--	--	--	--	--	--	--	.912
	02/11/98	10	12	0M06	--	--	--	--	--	--	--	--	--	1.572
	02/11/98	10	12	0M07	--	--	--	--	--	--	--	--	--	.871
	02/11/98	10	12	0M08	--	--	--	--	--	--	--	--	--	.693
	02/11/98	15	15.4	0001	--	--	--	--	--	--	137	64.074	.5102	1.081
	02/11/98	15	15.4	0M09	--	--	--	--	--	--	--	--	--	1.91
	02/11/98	15	15.4	0M10	--	--	--	--	--	--	--	--	--	1.711
	02/11/98	15	15.4	0M11	--	--	--	--	--	--	--	--	--	1.09
	02/11/98	15	15.4	0M12	--	--	--	--	--	--	--	--	--	1.115
	02/11/98	15	15.4	0M13	--	--	--	--	--	--	--	--	--	1.16
1024	02/11/98	5	7	0001	--	--	--	--	--	--	356.2	133.9	.7216	3.353
1025	02/11/98	5	7	0001	--	--	--	--	--	--	635.2	279.67	1.2698	2.286
	02/11/98	10	12	0001	--	--	--	--	--	--	1168	278.68	1.4973	2.674
	02/11/98	15	17	0001	--	--	--	--	--	--	228.4	64.074	.303	1.429
1028	02/11/98	5	7	0001	--	--	--	--	--	--	208.9	181.33	.4061	1.91

Soil and Sediment Data

Loc Id	Date	Sample From	Sample To	Sample Id	Mn mg/kg	Mo mg/kg	Ni mg/kg	NO3 mg/kg	Ra-226 pCi/g	Se mg/kg	SO4 mg/kg	U mg/kg	V mg/kg	Zn mg/kg
Upgradient														
0315	10/22/97	0	0	0002	--	--	--	--	--	--	--	1.8	--	--
0323	10/22/97	0	0	0002	--	--	--	--	--	--	--	1.88	--	--
0324	10/22/97	0	0	0002	--	--	--	--	--	--	--	1.08	--	--
0325	10/22/97	0	0	0002	--	--	--	--	--	--	--	2.6	--	--
	11/07/97	0		0002	149	.09B	2.7	10.2B	--	.11B	342	2.5	6.7	51.2
0330	10/22/97	0	0	0002	--	--	--	--	--	--	--	1.2	--	--
	11/07/97	0		0002	117	.12B	5.3	6.5B	--	.04U	686	.73	6.1	24.8
0335	10/22/97	0	0	0002	--	--	--	--	--	--	--	1.08	--	--
0337	10/22/97	0	0	0002	--	--	--	--	--	--	--	1.08	--	--
0338	10/22/97	0	0	0002	--	--	--	--	--	--	--	1	--	--
0339	10/22/97	0	0	0002	--	--	--	--	--	--	--	1.6	--	--
0342	10/22/97	0	0	0002	--	--	--	--	--	--	--	1.2		--
	11/06/97	0		0002	278	.1B	3.1	5.9B	--	.04U	701	.72	4.8	15.8
0349	10/22/97	0	0	0002	--	--	--	--	--	--	--	1.08	--	--
	11/06/97	0		0002	237	.05B	1.4B	7.4B	--	.04U	226	.42	3.1	37.1
0350	10/22/97	0	0	0002	--	--	--	--	--	--	--	1.36	--	--
	11/06/97	0		0002	267	.08B	3.6	6.6B	--	.04U	469	.7	4.9	25.9
1020	02/08/98	5	7	0001	--	.3B	--	--	.646	--	--	.78	--	--
	02/11/98	10	12	0001	--	--	--	--	--	--	--	--	--	--
1021	02/08/98	5	7	0001	--	.33B	--	--	.472	--	--	1.1	--	--
	02/11/98	5	7	0001	--	--	--	--	--	--	--	--	--	--
1023	02/08/98	5	7	0001	--	.14B	--	--	.611	--	--	.74	--	--
	02/08/98	10	12	0001	--	.21B	--	--	.24	--	--	.44B	--	--
	02/11/98	5	7	0001	--	--	--	--	--	--	--	--	--	--
	02/11/98	10	12	0001	--	--	--	--	--	--	--	--	--	--
	02/11/98	10	12	0M01	--	--	--	--	--	--	--	--	--	--
	02/11/98	10	12	0M02	--	--	--	--	--	--	--	--	--	--
	02/11/98	10	12	0M03	--	--	--	--	--	--	--	--	--	--
	02/11/98	10	12	0M04	--	--	--	--	--	--	--	--	--	--
	02/11/98	10	12	0M05	--	--	--	--	--	--	--	--	--	--
	02/11/98	10	12	0M06	--	--	--	--	--	--	--	--	--	--
	02/11/98	10	12	0M07	--	--	--	--	--	--	--	--	--	--
	02/11/98	10	12	0M08	--	--	--	--	--	--	--	--	--	--
	02/11/98	15	15.4	0001	--	--	--	--	--	--	--	--	--	--
	02/11/98	15	15.4	0M09	--	--	--	--	--	--	--	--	--	--
	02/11/98	15	15.4	0M10	--	--	--	--	--	--	--	--	--	--
	02/11/98	15	15.4	0M11	--	--	--	--	--	--	--	--	--	--
	02/11/98	15	15.4	0M12	--	--	--	--	--	--	--	--	--	--
	02/11/98	15	15.4	0M13	--	--	--	--	--	--	--	--	--	--
1024	02/11/98	5	7	0001	--	--	--	--	--	--	--	--	--	--
1025	02/11/98	5	7	0001	--	--	--	--	--	--	--	--	--	--
	02/11/98	10	12	0001	--	--	--	--	--	--	--	--	--	--
	02/11/98	15	17	0001	--	--	--	--	--	--	--	--	--	--
1028	02/11/98	5	7	0001	--	--	--	--	--	--	--	--	--	--

Summary of Analyte Data Evaluations By Matrix - 1998 Ecological Sampling

Analyte	Resolution	Updated Resolution	Matrix	Submatrix	Filtered/Unfiltered	Units	Test	Test Result	N	Location	Comment 1	Comment 2	Comment 3	Comment 4
Arsenic			Sediment	None	Not applicable	mg/kg	Student's-t	Means are same	11 vs. 11	OJ Site vs. Reference Area	N=11 - sufficient N (includes duplicate value)			
Cadmium			Sediment	None	Not applicable	mg/kg	KW	Means are same	11 vs. 11	OJ Site vs. Reference Area	N=11 - sufficient N (includes duplicate value)			
Cobalt			Sediment	None	Not applicable	mg/kg	Student's-t	Means are same	11 vs. 11	OJ Site vs. Reference Area	N=11 - sufficient N (includes duplicate value)			
Copper			Sediment	None	Not applicable	mg/kg	Student's-t	Means are same	11 vs. 11	OJ Site vs. Reference Area	N=11 - sufficient N (includes duplicate value)			
Fluoride		✓	Sediment	None	Not applicable	mg/kg	Student's-t	Means are same	10 vs. 10	OJ Site vs. Reference Area	N=10 - sufficient N (includes averaged field sample and duplicate)	All detects for OJ Site, 90% DF for Reference Area	Test statistic was marginal, KW results indicate not same	Parametric test is usually more robust than nonparametric test
Iron			Sediment	None	Not applicable	mg/kg	Student's-t	Means are same	10 vs. 10	OJ Site vs. Reference Area	N=10 - sufficient N (includes averaged field sample and duplicate)			
Manganese			Sediment	None	Not applicable	mg/kg	KW	Means are same	11 vs. 11	OJ Site vs. Reference Area	N=11 - sufficient N (includes duplicate value)			
Molybdenum		✓	Sediment	None	Not applicable	mg/kg	None	Not applicable	10 vs. 10	OJ Site vs. Reference Area	Only 1 OJ site detect, 9/10 reference area detects			
Ammonia as NH_3			Sediment	None	Not applicable	mg/kg	Student's-t	Means are same	11 vs. 11	OJ Site vs. Reference Area	N=11 - sufficient N (includes duplicate value)			
Nickel			Sediment	None	Not applicable	mg/kg	KW	Means are same	11 vs. 11	OJ Site vs. Reference Area	N=11 - sufficient N (includes duplicate value)			
Radium-226		✓	Sediment	None	Not applicable	pCi/g	KW	Means are same	10 vs. 10	OJ Site vs. Reference Area	N=10 - sufficient N (includes averaged field sample and duplicate)	All detects for Reference Area and OJ Site		
Radium-228	✓	✓	Sediment	None	Not applicable	pCi/g	None	Not applicable	10 vs. 10	OJ Site vs. Reference Area	Reference Area maximum detect > single OJ Site detect	N=10 - sufficient N (includes averaged field sample and duplicate)	Insufficient DF for statistics	
Selenium	✓		Sediment	None	Not applicable	mg/kg	None	Not applicable	10 vs. 10	OJ Site vs. Reference Area	Only 1 detect-OJ Site (Loc. 1236 (208) - 0.40 mg/L; DL=0.1 mg/kg)	N=10 - sufficient N (includes averaged field sample and duplicate)	Insufficient DF for statistics	
Strontium			Sediment	None	Not applicable	mg/kg	Student's-t	Means are same	11 vs. 11	OJ Site vs. Reference Area	N=11 - sufficient N (includes duplicate value)			
Sulfate			Sediment	None	Not applicable	mg/kg	Student's-t	Means are same	11 vs. 11	OJ Site vs. Reference Area	N=11 - sufficient N (includes duplicate value)			
Uranium			Sediment	None	Not applicable	mg/kg	Student's-t	Means are same	11 vs. 11	OJ Site vs. Reference Area	N=11 - sufficient N (includes duplicate value)			
Vanadium			Sediment	None	Not applicable	mg/kg	Student's-t	Means are same	11 vs. 11	OJ Site vs. Reference Area	N=11 - sufficient N (includes duplicate value)			
Zinc			Sediment	None	Not applicable	mg/kg	Student's-t	Means are same	11 vs. 11	OJ Site vs. Reference Area	N=11 - sufficient N (includes duplicate value)			
Arsenic			Surface water	None	Filtered	mg/L	KW	Means are same	10 vs. 10	Reference Area vs. OJ Site				
Cadmium			Surface water	None	Filtered	mg/L	None	Not applicable	10 vs. 10	Reference Area vs. OJ Site	No detects			
Cobalt			Surface water	None	Filtered	mg/L	None	Not applicable	10 vs. 10	Reference Area vs. OJ Site	No detects			
Copper			Surface water	None	Filtered	mg/L	None	Not applicable	10 vs. 10	Reference Area vs. OJ Site	No detects			
Fluoride		✓	Surface water	None	Filtered	mg/L	KW	Means are same	10 vs. 10	Reference Area vs. OJ Site	DF at Reference area > OJ Site; all OJ Site values are higher	Test statistic somewhat marginal		
Iron			Surface water	None	Filtered	mg/L	Student's-t	Means are same	10 vs. 10	Reference Area vs. OJ Site	Log normal values			
Molybdenum			Surface water	None	Filtered	mg/L	KW	Means are same	10 vs. 10	Reference Area vs. OJ Site				
Manganese			Surface water	None	Filtered	mg/L	KW	Means are same	10 vs. 10	Reference Area vs. OJ Site				
Ammonia as NH_3	✓		Surface water	None	Filtered	mg/L	KW	Means are different	10 vs. 9	Reference Area vs. OJ Site	Results same with or without outlier (n=10)	Graphical data available as well		
Nitrate	✓		Surface water	None	Filtered	mg/L	None	Not applicable	5 vs. 4	Reference Area vs. OJ Site	No detects OJ Site; 100%DF - Reference Area			
Nickel	✓		Surface water	None	Filtered	mg/L	None	Not applicable	10 vs. 10	Reference Area vs. OJ Site	No detects at Reference Area; 2/10 - OJ Site (low values)			
Radium-226	✓	✓	Surface water	None	Filtered	pCi/L	None	Not applicable	10 vs. 10	Reference Area vs. OJ Site	Only 1 detect (0.17 pCi/L - OJ Site Loc. 1236 (208))			
Radium-228		✓	Surface water	None	Filtered	pCi/L	None	Not applicable	10 vs. 10	Reference Area vs. OJ Site	No detects			
Selenium			Surface water	None	Filtered	mg/L	None	Not applicable	10 vs. 10	Reference Area vs. OJ Site	Only 1 detect - Reference Area			
Strontium			Surface water	None	Filtered	mg/L	KW	Means are same	10 vs. 10	Reference Area vs. OJ Site				
Sulfate			Surface water	None	Filtered	mg/L	KW	Means are same	10 vs. 10	Reference Area vs. OJ Site				
Uranium	✓		Surface water	None	Filtered	mg/L	KW	Means are same	10 vs. 10	Reference Area vs. OJ Site		Test statistic somewhat marginal	Test robustness questionable for this data set	Rechecked by looking at LN scale, not lognormal, so base conclusion on KW
Vanadium	✓		Surface water	None	Filtered	mg/L	None	Not applicable	10 vs. 10	Reference Area vs. OJ Site	No detects at Reference Area; 1 detect (0.136 mg/L) - OJ Site (1239)			
Arsenic	✓		Surface water	None	Unfiltered	mg/L	Student's-t	Means are different	10 vs. 10	Reference Area vs. OJ Site	Reference area mean > OJ Site mean			
Cadmium			Surface water	None	Unfiltered	mg/L	None	Not applicable	10 vs. 10	Reference Area vs. OJ Site	No detects - Reference Area; 1/10 OJ Site (1239)			
Cobalt			Surface water	None	Unfiltered	mg/L	None	Not applicable	10 vs. 10	Reference Area vs. OJ Site	No detects			
Copper			Surface water	None	Unfiltered	mg/L	None	Not applicable	10 vs. 10	Reference Area vs. OJ Site	No detects			
Fluoride			Surface water	None	Unfiltered	mg/L	KW	Means are same	6 vs. 10	Reference Area vs. OJ Site	Missing data for 4 locations	Log transform not done		
Iron		✓	Surface water	None	Unfiltered	mg/L	None	Not applicable	10 vs. 10	Reference Area vs. OJ Site	Maximum detect is from Reference Area			
Molybdenum	✓	✓	Surface water	None	Unfiltered	mg/L	None	Not applicable	10 vs. 10	Reference Area vs. OJ Site	All detects at OJ Site; 3/10 - detects at Reference Area	Filtered results different from unfiltered results		
Ammonia as NH_3	✓		Surface water	None	Unfiltered	mg/L	KW & Student's-t	Means are same	6 vs. 10 & 6 vs. 9	Reference Area vs. OJ Site	Result same with outlier 1270 (91 mg/L, N=10)	Missing data for 4 reference area locations	Test robustness questionable for this data set	Same with LN scale, Bartlett, t test, results same (without outlier)
Nickel		✓	Surface water	None	Unfiltered	mg/L	None	Not applicable	10 vs. 10	Reference Area vs. OJ Site	No detects at Reference Area; 1/10-OJ Site			
Radium-226	✓	✓	Surface water	None	Unfiltered	pCi/L	None	Not applicable	10 vs. 10	Reference Area vs. OJ Site	Only 1 detect (OJ Site - Loc. 1208)			
Radium-228		✓	Surface water	None	Unfiltered	pCi/L	None	Not applicable	10 vs. 10	Reference Area vs. OJ Site	No detects			
Selenium		✓	Surface water	None	Unfiltered	mg/L	None	Not applicable	10 vs. 10	Reference Area vs. OJ Site	No detects			
Sulfate			Surface water	None	Unfiltered	mg/L	KW	Means are same	6 vs. 10	Reference Area vs. OJ Site	Removing 2 high OJ Site values then means are Not the same.	Missing data for 4 locations; two high values (OJ Site locations 1226 and 1229 - [illegible])		
Strontium	✓		Surface water	None	Unfiltered	mg/L	KW	Means are different	10 vs. 10	Reference Area vs. OJ Site				
Uranium	✓		Surface water	None	Unfiltered	mg/L	KW	Means are same	10 vs. 10	Reference Area vs. OJ Site	Includes one high value (OJ Site Loc. 1229)	Test statistic somewhat marginal		
Vanadium	✓		Surface water	None	Unfiltered	mg/L	None	Not applicable	10 vs. 10	Reference Area vs. OJ Site	Only 1 detect (Loc. 1229) at OJ site, 2 detects at Reference Area (20% DF is low)			
Zinc	✓		Surface water	None	Unfiltered	mg/L	None	Not applicable	10 vs. 10	Reference Area vs. OJ Site	No detects at Reference Area; 1/10 OJ site Loc. 1228 (10% DF)			
Arsenic	✓	✓	RCO	Stems	Not applicable	mg/kg	None	Not applicable	3 vs. 5	Reference Area vs. OJ Site	Only detect at OJ Site (1.53 mg/kg - Loc. 1229); 3 detects at Reference Area are less than OJ Site detect			
Cadmium			RCO	Stems	Not applicable	mg/kg	KW	Means are same	3 vs. 5	Reference Area vs. OJ Site	This is a redo			
Cobalt			RCO	Stems	Not applicable	mg/kg	None	Not applicable	3 vs. 5	Reference Area vs. OJ Site	No detects			
Copper		✓	RCO	Stems	Not applicable	mg/kg	None	Not applicable	3 vs. 5	Reference Area vs. OJ Site	Maximum value is from Reference Area			
Iron			RCO	Stems	Not applicable	mg/kg	KW	Means are same	3 vs. 5	Reference Area vs. OJ Site	This is a redo, includes maximum OJ Site value (Loc. 1228-2093 mg/kg)	Without outlier (OJ Site Loc. 1228), maximum value is from Reference Area		
Manganese			RCO	Stems	Not applicable	mg/kg	KW	Means are same	3 vs. 5	Reference Area vs. OJ Site	This is a redo			
Molybdenum		✓	RCO	Stems	Not applicable	mg/kg	None	Not applicable	3 vs. 5	Reference Area vs. OJ Site	Only Reference Area detect is same as only OJ Site detect			
Nickel	✓		RCO	Stems	Not applicable	mg/kg	None	Not applicable	3 vs. 5	Reference Area vs. OJ Site	Only 1 detect - OJ Site Loc. 1228			
Radium-226		✓	RCO	Stems	Not applicable	pCi/g	None	Not applicable	3 vs. 5	Reference Area vs. OJ Site	No detects			
Radium-228		✓	RCO	Stems	Not applicable	pCi/g	None	Not applicable	3 vs. 5	Reference Area vs. OJ Site	No detects			
Selenium		✓	RCO	Stems	Not applicable	mg/kg	None	Not applicable	3 vs. 5	Reference Area vs. OJ Site	No detects			
Strontium			RCO	Stems	Not applicable	mg/kg	None	Not applicable	3 vs. 5	Reference Area vs. OJ Site	Maximum value is from Reference Area			
Uranium	✓		RCO	Stems	Not applicable	mg/kg	None	Not applicable	3 vs. 5	Reference Area vs. OJ Site	1/3 - Reference Area (low DF); 3/5 - OJ Site (low DF)	Maximum OJ Site detect (0.175 mg/kg) vs. only Reference Area detect (0.17 mg/kg)	Insufficient DF for statistics	
Vanadium	✓		RCO	Stems	Not applicable	mg/kg	None	Not applicable	3 vs. 5	Reference Area vs. OJ Site	1/3 - Reference Area (low DF); 3/5 - OJ Site	Maximum OJ Site detect (4.4 mg/kg - Loc. 1228) vs. only Reference Area detect (1.92 mg/kg)	Insufficient DF for statistics	
Zinc			RCO	Stems	Not applicable	mg/kg	None	Not applicable	3 vs. 5	Reference Area vs. OJ Site	Maximum value is from Reference Area			
Arsenic		✓	RCO	Roots	Not applicable	mg/kg	None	Not applicable	3 vs. 5	Reference Area vs. OJ Site	Maximum value is from Reference Area			
Cadmium			RCO	Roots	Not applicable	mg/kg	None	Not applicable	3 vs. 5	Reference Area vs. OJ Site	Maximum value is from Reference area			
Cobalt			RCO	Roots	Not applicable	mg/kg	None	Not applicable	3 vs. 5	Reference Area vs. OJ Site	Maximum value is from Reference area			
Copper			RCO	Roots	Not applicable	mg/kg	None	Not applicable	3 vs. 5	Reference Area vs. OJ Site	Maximum value is from Reference area			
Iron			RCO	Roots	Not applicable	mg/kg	None	Not applicable	3 vs. 5	Reference Area vs. OJ Site	Maximum value is from Reference area			
Manganese			RCO	Roots	Not applicable	mg/kg	None	Not applicable	3 vs. 5	Reference Area vs. OJ Site	Maximum value (Reference Area) = maximum value (OJ Site)			
Molybdenum		✓	RCO	Roots	Not applicable	mg/kg	None	Not applicable	3 vs. 5	Reference Area vs. OJ Site	Maximum detect is from Reference Area; only 1 OJ Site detect (Loc. 1228)			
Nickel			RCO	Roots	Not applicable	mg/kg	None	Not applicable	3 vs. 5	Reference Area vs. OJ Site	Maximum detect is from Reference Area			
Radium-226		✓	RCO	Roots	Not applicable	pCi/g	None	Not applicable	3 vs. 5	Reference Area vs. OJ Site	Only detect is from Reference Area			
Radium-228		✓	RCO	Roots	Not applicable	pCi/g	None	Not applicable	3 vs. 5	Reference Area vs. OJ Site	No detects			
Selenium		✓	RCO	Roots	Not applicable	mg/kg	None	Not applicable	3 vs. 5	Reference Area vs. OJ Site	Only detect is from Reference Area			
Strontium			RCO	Roots	Not applicable	mg/kg	None	Not applicable	3 vs. 5	Reference Area vs. OJ Site	Maximum value is from Reference Area			
Uranium			RCO	Roots	Not applicable	mg/kg	None	Not applicable	3 vs. 5	Reference Area vs. OJ Site	Maximum value is from Reference Area			
Vanadium			RCO	Roots	Not applicable	mg/kg	None	Not applicable	3 vs. 5	Reference Area vs. OJ Site	Maximum value is from Reference Area			
Zinc	✓		RCO	Roots	Not applicable	mg/kg	None	Not applicable	3 vs. 5	Reference Area vs. OJ Site	Maximum value (163 mg/kg OJ Site) vs. maximum value (159 mg/kg Reference Area)			
Arsenic		✓	Cattail	Stems	Not applicable	mg/kg	None	Not applicable	5 vs. 3	Reference Area vs. OJ Site	Maximum detect is from Reference Area; no OJ Site detects			
Cadmium			Cattail	Stems	Not applicable	mg/kg	KW	Means are same	5 vs. 3	Reference Area vs. OJ Site				
Cobalt			Cattail	Stems	Not applicable	mg/kg	None	Not applicable	5 vs. 3	Reference Area vs. OJ Site	No detects			
Copper		✓	Cattail	Stems	Not applicable	mg/kg	None	Not applicable	5 vs. 3	Reference Area vs. OJ Site	Maximum detect is from Reference Area			
Iron		✓	Cattail	Stems	Not applicable	mg/kg	KW	Means are same	5 vs. 3	Reference Area vs. OJ Site				
Manganese	✓	✓	Cattail	Stems	Not applicable	mg/kg	KW	Means are different	5 vs. 3	Reference Area vs. OJ Site				

APERTURE CARD

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[illegible] posted_date [illegible]

Summary of Analyte Data Evaluations By Matrix - 1998 Ecological Sampling

Analyte	Resolution	Updated Resolution	Matrix	Submatrix	Filtered/Unfiltered	Units	Test	Test Result	N	Location	Comment 1	Comment 2	Comment 3	Comment 4
Molybdenum	✓	✓	Cattail	Stems	Not applicable	mg/kg	KW	Means are different	5 vs. 3	Reference Area vs. CJ Site				
Nickel			Cattail	Stems	Not applicable	mg/kg	None	Not applicable	5 vs. 3	Reference Area vs. CJ Site	No detects			
Radium-226		✓	Cattail	Stems	Not applicable	pCi/g	None	Not applicable	5 vs. 3	Reference Area vs. CJ Site	No detects			
Radium-228		✓	Cattail	Stems	Not applicable	pCi/g	None	Not applicable	5 vs. 3	Reference Area vs. CJ Site	No detects			
Selenium		✓	Cattail	Stems	Not applicable	mg/kg	None	Not applicable	5 vs. 3	Reference Area vs. CJ Site	No detects			
Strontium		✓	Cattail	Stems	Not applicable	mg/kg	KW	Means are same	5 vs. 3	Reference Area vs. CJ Site				
Uranium			Cattail	Stems	Not applicable	mg/kg	None	Not applicable	5 vs. 3	Reference Area vs. CJ Site	Only 1 detect - Reference Area			
Vanadium			Cattail	Stems	Not applicable	mg/kg	None	Not applicable	5 vs. 3	Reference Area vs. CJ Site	Only 1 detect - Reference Area			
Zinc		✓	Cattail	Stems	Not applicable	mg/kg	KW	Means are same	5 vs. 3	Reference Area vs. CJ Site	Maximum value is from Reference Area			
Arsenic			Cattail	Roots	Not applicable	mg/kg	KW	Means are same	5 vs. 3	Reference Area vs. CJ Site	Maximum value is at CJ Site Loc. 1239			
Cadmium			Cattail	Roots	Not applicable	mg/kg	KW	Means are same	5 vs. 3	Reference Area vs. CJ Site	Maximum value is at CJ Site Loc. 1239			
Cobalt			Cattail	Roots	Not applicable	mg/kg	None	Not applicable	5 vs. 3	Reference Area vs. CJ Site	Maximum detect is from Reference Area			
Copper			Cattail	Roots	Not applicable	mg/kg	KW	Means are same	5 vs. 3	Reference Area vs. CJ Site	Maximum value is at CJ Site Loc. 1235			
Iron			Cattail	Roots	Not applicable	mg/kg	KW	Means are same	5 vs. 3	Reference Area vs. CJ Site	Maximum value is at CJ Site Loc. 1235			
Manganese			Cattail	Roots	Not applicable	mg/kg	KW	Means are same	5 vs. 3	Reference Area vs. CJ Site	Maximum value is at CJ Site Loc. 1235			
Molybdenum	✓	✓	Cattail	Roots	Not applicable	mg/kg	KW	Means are different	5 vs. 3	Reference Area vs. CJ Site	Maximum value is at CJ Site Loc. 1239			
Nickel			Cattail	Roots	Not applicable	mg/kg	None	Not applicable	5 vs. 3	Reference Area vs. CJ Site	Maximum detect is from Reference Area			
Radium-226		✓	Cattail	Roots	Not applicable	pCi/g	None	Not applicable	5 vs. 3	Reference Area vs. CJ Site	Maximum detect (Reference Area) > maximum detect (CJ Site)			
Radium-228		✓	Cattail	Roots	Not applicable	pCi/g	None	Not applicable	5 vs. 3	Reference Area vs. CJ Site	No detects			
Selenium		✓	Cattail	Roots	Not applicable	mg/kg	None	Not applicable	5 vs. 3	Reference Area vs. CJ Site	Only detect is from Reference Area			
Strontium			Cattail	Roots	Not applicable	mg/kg	KW	Means are same	5 vs. 3	Reference Area vs. CJ Site				
Uranium		✓	Cattail	Roots	Not applicable	mg/kg	None	Not applicable	5 vs. 3	Reference Area vs. CJ Site	Maximum detect is from Reference Area			
Vanadium			Cattail	Roots	Not applicable	mg/kg	None	Not applicable	5 vs. 3	Reference Area vs. CJ Site	Maximum detect is from Reference Area			
Zinc			Cattail	Roots	Not applicable	mg/kg	None	Not applicable	5 vs. 3	Reference Area vs. CJ Site	Maximum detect is from Reference Area			
Arsenic	✓	✓	Willow	Roots	Not applicable	mg/kg	None	Not applicable	2 vs. 2	Reference Area vs. CJ Site	3.3 mg/kg (CJ Site maximum) vs. 3 mg/kg (reference area maximum)	N=2 weak		
Cadmium	✓		Willow	Roots	Not applicable	mg/kg	None	Not applicable	2 vs. 2	Reference Area vs. CJ Site	1.5 mg/kg (CJ Site maximum) vs. 0.3 mg/kg (Reference Area maximum)	N=2 weak		
Cobalt	✓		Willow	Roots	Not applicable	mg/kg	None	Not applicable	2 vs. 2	Reference Area vs. CJ Site	Only 1 detect - 1.3 mg/kg (CJ Site Loc. 1233)	N=2 weak		
Copper		✓	Willow	Roots	Not applicable	mg/kg	None	Not applicable	2 vs. 2	Reference Area vs. CJ Site	Maximum (CJ Site) detect 7.1 mg/kg; no Reference Area detects	N=2 weak		
Iron	✓		Willow	Roots	Not applicable	mg/kg	None	Not applicable	2 vs. 2	Reference Area vs. CJ Site	1800 mg/kg (CJ Site maximum) vs. 1400 mg/kg (Reference Area maximum)	N=2 weak		
Manganese	✓		Willow	Roots	Not applicable	mg/kg	None	Not applicable	2 vs. 2	Reference Area vs. CJ Site	114 mg/kg (CJ Site maximum) vs. 37 mg/kg (Reference Area maximum)	N=2 weak		
Molybdenum	✓	✓	Willow	Roots	Not applicable	mg/kg	None	Not applicable	2 vs. 2	Reference Area vs. CJ Site	Only detect 0.87 mg/kg (CJ Site maximum), no Reference Area detects	N=2 weak		
Nickel			Willow	Roots	Not applicable	mg/kg	None	Not applicable	2 vs. 2	Reference Area vs. CJ Site	No detects			
Radium-226		✓	Willow	Roots	Not applicable	pCi/g	None	Not applicable	2 vs. 2	Reference Area vs. CJ Site	No detects			
Radium-228		✓	Willow	Roots	Not applicable	pCi/g	None	Not applicable	2 vs. 2	Reference Area vs. CJ Site	No detects			
Selenium	✓	✓	Willow	Roots	Not applicable	mg/kg	None	Not applicable	2 vs. 2	Reference Area vs. CJ Site	No detects	N=2 weak		
Strontium	✓		Willow	Roots	Not applicable	mg/kg	None	Not applicable	2 vs. 2	Reference Area vs. CJ Site	67.0 mg/kg (CJ Site maximum) vs. 38.2 mg/kg (Reference Area maximum)	N=2 weak		
Uranium			Willow	Roots	Not applicable	mg/kg	None	Not applicable	2 vs. 2	Reference Area vs. CJ Site	0.72 mg/kg (CJ Site maximum) vs. 0.19 mg/kg (Reference Area maximum)	N=2 weak		
Vanadium			Willow	Roots	Not applicable	mg/kg	None	Not applicable	2 vs. 2	Reference Area vs. CJ Site	3.4 mg/kg (CJ Site maximum) vs. 1.5 mg/kg (Reference Area maximum)	N=2 weak		
Zinc			Willow	Roots	Not applicable	mg/kg	None	Not applicable	2 vs. 2	Reference Area vs. CJ Site	Maximum detect is from Reference Area	N=2 weak		
Arsenic	✓	✓	Willow	Stems	Not applicable	mg/kg	None	Not applicable	2 vs. 2	Reference Area vs. CJ Site	No CJ Site detects, 2 detects out of 2 samples at Reference Area	N=2 weak		
Cadmium	✓		Willow	Stems	Not applicable	mg/kg	None	Not applicable	2 vs. 2	Reference Area vs. CJ Site	2.3 mg/kg (CJ Site maximum) vs. 1.0 mg/kg (Reference Area maximum)	N=2 weak		
Cobalt			Willow	Stems	Not applicable	mg/kg	None	Not applicable	2 vs. 2	Reference Area vs. CJ Site	No detects			
Copper			Willow	Stems	Not applicable	mg/kg	None	Not applicable	2 vs. 2	Reference Area vs. CJ Site	Maximum detect is from Reference Area	N=2 weak		
Iron			Willow	Stems	Not applicable	mg/kg	None	Not applicable	2 vs. 2	Reference Area vs. CJ Site	Maximum detect is from Reference Area	N=2 weak		
Manganese			Willow	Stems	Not applicable	mg/kg	None	Not applicable	2 vs. 2	Reference Area vs. CJ Site	Maximum detect is from Reference Area	N=2 weak		
Molybdenum	✓	✓	Willow	Stems	Not applicable	mg/kg	None	Not applicable	2 vs. 2	Reference Area vs. CJ Site	No detects	N=2 weak		
Nickel			Willow	Stems	Not applicable	mg/kg	None	Not applicable	2 vs. 2	Reference Area vs. CJ Site	No detects			
Radium-226		✓	Willow	Stems	Not applicable	pCi/g	None	Not applicable	2 vs. 2	Reference Area vs. CJ Site	No detects			
Radium-228		✓	Willow	Stems	Not applicable	pCi/g	None	Not applicable	2 vs. 2	Reference Area vs. CJ Site	No detects			
Selenium		✓	Willow	Stems	Not applicable	mg/kg	None	Not applicable	2 vs. 2	Reference Area vs. CJ Site	No detects	N=2 weak		
Strontium			Willow	Stems	Not applicable	mg/kg	None	Not applicable	2 vs. 2	Reference Area vs. CJ Site	Maximum detect is from Reference Area	N=2 weak		
Uranium	✓		Willow	Stems	Not applicable	mg/kg	None	Not applicable	2 vs. 2	Reference Area vs. CJ Site	No detects at Reference Area, only 1 detect (0.15 mg/kg at CJ Site Loc. 1239)			
Vanadium			Willow	Stems	Not applicable	mg/kg	None	Not applicable	2 vs. 2	Reference Area vs. CJ Site	No detects			
Zinc			Willow	Stems	Not applicable	mg/kg	None	Not applicable	2 vs. 2	Reference Area vs. CJ Site	Maximum detect is from Reference Area	N=2 weak		

[illegible]
KW - Kruskal Wallis
DF - Detection frequency
[illegible]
Units - sediment and vegetation - mg/kg (milligrams/kilogram), for Ra-226/Ra-228 - pCi/g (picocuries/gram)
Units - surface water - mg/L (milligrams/liter), for Ra-226/Ra-228 - pCi/L (picocuries/liter)
[illegible]

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Calculations for
Human Health Risk Assessment

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GRAND JUNCTION RISK CALCULATIONS
1998 PLUME DATA

$$\text{Intake} = \frac{CW \times IR \times EF \times ED}{BW \times AT}$$

where[1]:

Intake is in (mg/kg-d)
CW = chemical concentration in water (mg/L); site-specific
IR = ingestion rate (L/d); 2 L/day adult; default
ED = exposure duration (years); 30 yrs for adult; default
EF = exposure frequency (d/yr); 350 days/yr; default
BW = body weight (kg); 70 kg adult; default
AT = averaging time; ED x 365 d/yr non-carc., 70yr x 365 d/yr carc.

Hazard Quotient (HQ) = Intake/Reference Dose (RfD)
Risk = Chronic Daily Intake (averaged over 70 years) x Slope Factor
For radionuclides, Risk = SF x CW x IR x EF x ED (slope factor accounts for average lifetime risk); concentrations expressed in pCi/L

Contaminant	CW-MAX mg/L	IR	EF	ED	BW	AT	Intake-max	RfD[2]	HQ-MAX	%Risk	CW-MEAN mg/L	Intake-mean	HQ-MEAN	%Risk
Arsenic	0.0349	2	350	30	70	10950	0.0010	0.0003	3.187	8.13	0.005	0.000137	0.4566	6.42
Cadmium	0.0013	2	350	30	70	10950	0.0000	0.0005	0.071	0.18	0.001	0.000027	0.0548	0.77
Cobalt	0.0162	2	350	30	70	10950	0.0004	0.06	0.007	0.02	0.007	0.000192	0.0032	0.04
Fluoride	7.57	2	350	30	70	10950	0.2074	0.06	3.457	8.81	1.93	0.052877	0.8813	12.39
Iron	21.2	2	350	30	70	10950	0.5808	0.3	1.936	4.94	3.88	0.106301	0.3543	4.98
Manganese	4.54	2	350	30	70	10950	0.1244	0.047	2.646	6.75	2.82	0.077260	1.6438	23.12
Molybdenum	0.299	2	350	30	70	10950	0.0082	0.005	1.638	4.18	0.101	0.002767	0.5534	7.78
Nickel	0.111	2	350	30	70	10950	0.0030	0.02	0.152	0.39	0.035	0.000959	0.0479	0.67
Uranium	2.5	2	350	30	70	10950	0.0685	0.003	22.831	58.22	0.304	0.008329	2.7763	39.05
Vanadium	0.832	2	350	30	70	10950	0.0228	0.007	3.256	8.30	0.0857	0.002348	0.3354	4.72
Zinc	0.352	2	350	30	70	10950	0.0096	0.3	0.032	0.08	0.0349	0.000956	0.0032	0.04
								HI =	39.215			HI=	7.1103	

Non-carcinogens - Inhalation through water use in residential setting*

Ammonia (max)	0.655	15	350	30	70	10950	0.1346	0.0286	4.706
Ammonia (mean)	0.201	15	350	30	70	10950	0.0413	0.0286	1.444

*IR = 15 m^3/d of air default; concentration in air = water concentration x site-specific volatilization factor x conversion factor
For Grand Junction, volatilization factor = .000595; conversion factor is 1000L/m3
Maximum NH3 in Grand Junction ground water is 1.1 mg/L, mean is .337 mg/L

Carcinogens - Groundwater Ingestion Only (Adults)

Contaminant

Arsenic	CW	IR	EF	ED	BW	AT	Intake	SF[1]	Risk
U234+238	0.0349	2	350	30	70	25550	0.00041	1.5	6.15E-04
	1668	2	350	30	na	na	3.50E+07	5.32E-11	1.86E-03
	422	2	350	30	na	na	8.86E+06	5.32E-11	4.71E-04

[1] All exposure factors are from EPA 1989b

[2] Data are mainly from EPA's Integrated Risk Information System (IRIS); other values are from EPA Region III Risk-Based Concentration Table

Attachment 3

Calculations for Human Health Risk Assessment

Soil and Sediment Data

Loc Id	Date	Sample From	Sample To	Sample Id	As mg/kg	Cd mg/kg	Co mg/kg	Cu mg/kg	Fe mg/kg	Fluoride mg/kg	Kd-As mL/g	Kd-Cd mL/g	Kd-Mo mL/g	Kd-U mL/g
On-Site														
0309	10/22/97	0	0	0002	--	--	--	--	--	--	--	--	--	--
0310	10/22/97	0	0	0002	--	--	--	--	--	--	--	--	--	--
	11/07/97	0		0002	3.4B	1.1	2.6	11.3E	4170	77.5	--	--	--	--
0311	10/22/97	0	0	0002	--	--	--	--	--	--	--	--	--	--
0312	10/22/97	0	0	0002	--	--	--	--	--	--	--	--	--	--
	11/06/97	0		0002	1.5B	.5	1.8B	6.6E	2360	51	--	--	--	--
0313	10/22/97	0	0	0002	--	--	--	--	--	--	--	--	--	--
0327	10/22/97	0	0	0002	--	--	--	--	--	--	--	--	--	--
0328	10/22/97	0	0	0002	--	--	--	--	--	--	--	--	--	--
	11/07/97	0		0002	1.9B	.55	2.4	9.5E	2630	34.7	--	--	--	--
0344	10/22/97	0	0	0002	--	--	--	--	--	--	--	--	--	--
	11/06/97	0		0002	2.5B	.59	2.1	10E	3430	60.2	--	--	--	--
0345	10/22/97	0	0	0002	--	--	--	--	--	--	--	--	--	--
0346	10/22/97	0	0	0002	--	--	--	--	--	--	--	--	--	--
	11/06/97	0		0002	1.7B	.51	2.3	10.7E	2550	39.5	--	--	--	--
0348	10/22/97	0	0	0002	--	--	--	--	--	--	--	--	--	--
1012	02/06/98	12	13.25	0001	.74B	.4B	--	--	--	--	--	--	--	--
1013	02/06/98	9	11	0001	3.3	.28B	--	--	--	--	--	--	--	--
	02/06/98	11	13	0001	3.7	.23B	--	--	--	--	--	--	--	--
1014	02/06/98	13	14.25	0001	3.2	.97	--	--	--	--	--	--	--	--
	02/06/98	17	19	0001	1.4	.73	--	--	--	--	--	--	--	--
1015	02/06/98	10	12	0001	1.1	.36B	--	--	--	--	--	--	--	--
	02/06/98	14	15.4	0001	.82B	.37B	--	--	--	--	--	--	--	--
1016	02/08/98	9	11	0001	1.5	.18B	--	--	--	--	--	--	--	--
	02/08/98	13	14.3	0001	1.2	.23B	--	--	--	--	--	--	--	--
1017	02/08/98	9	11	0001	1	.29B	--	--	--	--	--	--	--	--
	02/08/98	11	13	0001	1.6B	.18B	--	--	--	--	--	--	--	--
SUB1	02/06/98	.5		0001	.98B	.4B	--	--	--	--	--	--	--	--
SUB2	02/06/98	1		0001	1.8	.22B	--	--	--	--	--	--	--	--
Down Gradient														
0301	10/22/97	0	0	0002	--	--	--	--	--	--	--	--	--	--
0304	10/22/97	0	0	0002	--	--	--	--	--	--	--	--	--	--
0306	10/22/97	0	0	0002	--	--	--	--	--	--	--	--	--	--
0307	10/22/97	0	0	0002	--	--	--	--	--	--	--	--	--	--
0308	10/22/97	0	0	0002	--	--	--	--	--	--	--	--	--	--
	11/06/97	0		0002	1.1	.37	2B	7E	1720	43.6	--	--	--	--
0317	10/22/97	0	0	0002	--	--	--	--	--	--	--	--	--	--
0326	10/22/97	0	0	0002	--	--	--	--	--	--	--	--	--	--
	11/07/97	0		0002	1.8B	.59	1.4B	10.8E	1890	69	--	--	--	--

Soil and Sediment Data

Loc Id	Date	Sample From	Sample To	Sample Id	Mn mg/kg	Mo mg/kg	Ni mg/kg	NO3 mg/kg	Ra-226 pCi/g	Se mg/kg	SO4 mg/kg	U mg/kg	V mg/kg	Zn mg/kg
On-Site														
0309	10/22/97	0	0	0002	--	--	--	--	--	--	--	1.4	--	--
0310	10/22/97	0	0	0002	--	--	--	--	--	--	--	1.88	--	--
	11/07/97	0		0002	342	.49B	5.2	14.7B	--	.04U	4100	1.5	34.8	50.9
0311	10/22/97	0	0	0002	--	--	--	--	--	--	--	1.48	--	--
0312	10/22/97	0	0	0002	--	--	--	--	--	--	--	1.52	--	--
	11/06/97	0		0002	329	.1B	2.7	10.7B	--	.04U	581	.65	7.6	26.2
0313	10/22/97	0	0	0002	--	--	--	--	--	--	--	1.32	--	--
0327	10/22/97	0	0	0002	--	--	--	--	--	--	--	1.04	--	--
0328	10/22/97	0	0	0002	--	--	--	--	--	--	--	1.4	--	--
	11/07/97	0		0002	334	.09B	3	6.3B	--	.04U	515	.8	7.4	17.5
0344	10/22/97	0	0	0002	--	--	--	--	--	--	--	2.2	--	--
	11/06/97	0		0002	170	.18B	4.6	13.8B	--	.04U	490	1.3	18.2	36.7
0345	10/22/97	0	0	0002	--	--	--	--	--	--	--	1.44	--	--
0346	10/22/97	0	0	0002	--	--	--	--	--	--	--	1.72	--	--
	11/06/97	0		0002	312	.1B	3	15.8B	--	.04U	637	.84	9.8	28.9
0348	10/22/97	0	0	0002	--	--	--	--	--	--	--	1.44	--	--
1012	02/06/98	12	13.25	0001	--	1.4B	--	--	.473	--	--	1.5	--	--
1013	02/06/98	9	11	0001	--	7.5	--	--	.423	--	--	23.9	--	--
	02/06/98	11	13	0001	--	3.5B	--	--	.289	--	--	10.4	--	--
1014	02/06/98	13	14.25	0001	--	1.3B	--	--	.492	--	--	45.2	--	--
	02/06/98	17	19	0001	--	.8B	--	--	.309	--	--	7.7	--	--
1015	02/06/98	10	12	0001	--	.79B	--	--	.443	--	--	.95	--	--
	02/06/98	14	15.4	0001	--	1B	--	--	.249	--	--	.56	--	--
1016	02/08/98	9	11	0001	--	.77B	--	--	.229	--	--	1.7	--	--
	02/08/98	13	14.3	0001	--	.34B	--	--	.319	--	--	.6	--	--
1017	02/08/98	9	11	0001	--	.68B	--	--	.472	--	--	.99	--	--
	02/08/98	11	13	0001	--	.53B	--	--	.38	--	--	.59	--	--
SUB1	02/06/98	.5		0001	--	.33B	--	--	.602	--	--	1.2	--	--
SUB2	02/06/98	1		0001	--	.5B	--	--	.614	--	--	1.4	--	--
Down Gradient														
0301	10/22/97	0	0	0002	--	--	--	--	--	--	--	1.28	--	--
0304	10/22/97	0	0	0002	--	--	--	--	--	--	--	1.24	--	--
0306	10/22/97	0	0	0002	--	--	--	--	--	--	--	1.56	--	--
0307	10/22/97	0	0	0002	--	--	--	--	--	--	--	1.28	--	--
0308	10/22/97	0	0	0002	--	--	--	--	--	--	--	1.44	--	--
	11/06/97	0		0002	300	.07B	1.8	8.6B	--	.04U	387	.58	4	16.1
0317	10/22/97	0	0	0002	--	--	--	--	--	--	--	4.36	--	--
0326	10/22/97	0	0	0002	--	--	--	--	--	--	--	2	--	--
	11/07/97	0		0002	302	.36B	2.6	11.7B	--	.04U	2140	1.6	4.4	43.5

Attachment 4

Geochemical Modeling (PHREEQC) For Ammonium Speciation

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```
------------------
Reading data base.
------------------

        SOLUTION_MASTER_SPECIES
        SOLUTION_SPECIES
        PHASES
        EXCHANGE_MASTER_SPECIES
        EXCHANGE_SPECIES
        SURFACE_MASTER_SPECIES
        SURFACE_SPECIES
        END
-------------------------------------
Reading input data for simulation 1.
-------------------------------------

        TITLE Ammonia at GJ
        SOLUTION 1
                units   mg/L
                pH              7.13
                pE              -0.22
                density         1.0
                Alkalinity      408.0
                Ca              441.0
                Cl              565.0
                Mg              240.0
                K               56.5
                Na              999.0
                S(6)            3530.0  as SO4
                N(5)            0.121 as NO3
                N(-3)           233.0 as NH4
        END
-----
TITLE
-----

 Ammonia at GJ

-------------------------------------------
Beginning of initial solution calculations.
-------------------------------------------

Initial solution 1.

-----------------------------Solution composition------------------------------

        Elements           Molality       Moles

        Alkalinity        8.206e-03   8.206e-03
        Ca                1.107e-02   1.107e-02
        Cl                1.604e-02   1.604e-02
        K                 1.454e-03   1.454e-03
        Mg                9.936e-03   9.936e-03
        N(-3)             1.300e-02   1.300e-02
        N(5)              1.964e-06   1.964e-06
        Na                4.374e-02   4.374e-02
        S(6)              3.699e-02   3.699e-02

----------------------------Description of solution----------------------------

                              pH  =   7.130
                              pe  =  -0.220
               Activity of water  =   0.998
                  Ionic strength  =   1.152e-01
              Mass of water (kg)  =   1.000e+00
           Total carbon (mol/kg)  =   9.063e-03
              Total CO2 (mol/kg)  =   9.063e-03
             Temperature (deg C)  =  25.000
         Electrical balance (eq)  =   1.994e-03
                      Iterations  =   8
                         Total H  = 1.110724e+02
                         Total O  = 5.568040e+01

---------------------------------Redox couples---------------------------------

        Redox couple             pe  Eh (volts)

        N(-3)/N(5)          5.5015       0.3254

----------------------------Distribution of species----------------------------

                                                    Log       Log        Log
        Species            Molality    Activity  Molality  Activity     Gamma

        OH-               1.794e-07   1.347e-07    -6.746    -6.870    -0.124
        H+                9.043e-08   7.413e-08    -7.044    -7.130    -0.086
        H2O               5.551e+01   9.978e-01    -0.001    -0.001     0.000
C(4)              9.063e-03
        HCO3-             7.541e-03   5.882e-03    -2.123    -2.230    -0.108
        CO2               9.568e-04   9.825e-04    -3.019    -3.008     0.012
        CaHCO3+           2.367e-04   1.846e-04    -3.626    -3.734    -0.108
```

```
        MgHCO3+            1.889e-04   1.461e-04    -3.724    -3.835    -0.111
        NaHCO3             1.042e-04   1.070e-04    -3.982    -3.971     0.012
        CaCO3              1.497e-05   1.538e-05    -4.825    -4.813     0.012
        CO3-2              1.005e-05   3.721e-06    -4.998    -5.429    -0.432
        MgCO3              7.341e-06   7.539e-06    -5.134    -5.123     0.012
        NaCO3-             2.897e-06   2.241e-06    -5.538    -5.650    -0.111
Ca                1.107e-02
        Ca+2               6.546e-03   2.460e-03    -2.184    -2.609    -0.425
        CaSO4              4.277e-03   4.392e-03    -2.369    -2.357     0.012
        CaHCO3+            2.367e-04   1.846e-04    -3.626    -3.734    -0.108
        CaCO3              1.497e-05   1.538e-05    -4.825    -4.813     0.012
        CaOH+              7.103e-09   5.495e-09    -8.149    -8.260    -0.111
        CaHSO4+            2.465e-09   1.907e-09    -8.608    -8.720    -0.111
Cl                1.604e-02
        Cl-                1.604e-02   1.209e-02    -1.795    -1.917    -0.123
H(0)              2.087e-17
        H2                 1.043e-17   1.072e-17   -16.982   -16.970     0.012
K                 1.454e-03
        K+                 1.370e-03   1.033e-03    -2.863    -2.986    -0.123
        KSO4-              8.397e-05   6.496e-05    -4.076    -4.187    -0.111
        KOH                4.696e-11   4.822e-11   -10.328   -10.317     0.012
Mg                9.936e-03
        Mg+2               5.403e-03   2.123e-03    -2.267    -2.673    -0.406
        MgSO4              4.336e-03   4.453e-03    -2.363    -2.351     0.012
        MgHCO3+            1.889e-04   1.461e-04    -3.724    -3.835    -0.111
        MgCO3              7.341e-06   7.539e-06    -5.134    -5.123     0.012
        MgOH+              1.341e-07   1.038e-07    -6.873    -6.984    -0.111
N(-3)             1.300e-02
  18    NH4+               1.166e-02   8.544e-03    -1.933    -2.068    -0.135
 114    NH4SO4-            1.273e-03   9.848e-04    -2.895    -3.007    -0.111
    17  NH3                6.396e-05   6.568e-05    -4.194    -4.183     0.012
N(5)              1.964e-06
        NO3-               1.964e-06   1.457e-06    -5.707    -5.836    -0.130
Na                4.374e-02
        Na+                4.176e-02   3.234e-02    -1.379    -1.490    -0.111
        NaSO4-             1.875e-03   1.450e-03    -2.727    -2.839    -0.111
        NaHCO3             1.042e-04   1.070e-04    -3.982    -3.971     0.012
        NaCO3-             2.897e-06   2.241e-06    -5.538    -5.650    -0.111
        NaOH               2.801e-09   2.876e-09    -8.553    -8.541     0.012
O(0)              0.000e+00
        O2                 0.000e+00   0.000e+00   -58.453   -58.442     0.012
S(6)              3.699e-02
        SO4-2              2.514e-02   8.947e-03    -1.600    -2.048    -0.449
        MgSO4              4.336e-03   4.453e-03    -2.363    -2.351     0.012
        CaSO4              4.277e-03   4.392e-03    -2.369    -2.357     0.012
        NaSO4-             1.875e-03   1.450e-03    -2.727    -2.839    -0.111
        NH4SO4-            1.273e-03   9.848e-04    -2.895    -3.007    -0.111
        KSO4-              8.397e-05   6.496e-05    -4.076    -4.187    -0.111
        HSO4-              8.336e-08   6.449e-08    -7.079    -7.191    -0.111
        CaHSO4+            2.465e-09   1.907e-09    -8.608    -8.720    -0.111

------------------------------Saturation indices-------------------------------

        Phase              SI log IAP  log KT

        Anhydrite       -0.30   -4.66   -4.36  CaSO4
        Aragonite        0.30   -8.04   -8.34  CaCO3
        Calcite          0.44   -8.04   -8.48  CaCO3
        CO2(g)          -1.54  -19.69  -18.15  CO2
        Dolomite         0.95  -16.14  -17.09  CaMg(CO3)2
        Gypsum          -0.08   -4.66   -4.58  CaSO4:2H2O
        H2(g)          -13.82  -13.82    0.00  H2
        NH3(g)          -5.95    5.06   11.01  NH3
        O2(g)          -55.48   27.64   83.12  O2

------------------
End of simulation.
------------------

------------------------------------
Reading input data for simulation 2.
------------------------------------

-----------
End of run.
-----------
```

% (mol)		mg/L
89.7	NH_4^+	209.9
9.8	$NH_4SO_4^-$	144.8
0.5	NH_3	1.1

$V_p = 10^{-5.95}$ Atm.

Attachment 4

Geochemical Modeling (PHREEQC) For Ammonium Speciation

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Appendix J

Economic Feasibility Study for Treatment of Background Ground Water for Municipal Water Supply

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Grand Junction Alluvial Aquifer Treatability Study and Cost Estimate

Submitted to

MACTEC-ERS
Grand Junction Office
U.S. Department of Energy
2597 B¾ Road
Grand Junction, CO 81503

Attn: Dick Dayvault, P.G.

Project No.

3405.00.00.00

December 1, 1998

MACTEC Environmental
Technologies Company, L.L.C.
A SUBSIDIARY OF MACTEC, Inc.

1819 Denver West Drive
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Golden, CO 80401

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1.0 Introduction

This study and cost estimate is an addendum to the Grand Junction UMTRA Site Observation Work Plan (SOWP). As such, background information that is already included in the body of the SOWP will not be included in this addendum, unless specific references are necessary.

1.1 Purpose

The U. S. Department of Energy – Grand Junction Office (DOE-GJO) is proposing to implement supplemental standards as the compliance strategy at the Grand Junction UMTRA Site. Specifically, the "limited use ground water" standard would be applied in accordance with Title 50 Code of Federal Regulations, Part 192.11(e) (50 CFR 192.11(e)). Criteria (2) of the standard would apply to the alluvial ("uppermost") aquifer, and states:

"Wide spread, ambient contamination not due to activities involving residual radioactive materials from a designated processing site exists that cannot be cleaned up using treatment methods reasonably employed in public water systems."

This study and cost estimate will demonstrate that background water upgradient of the contamination plume meets this criteria. The "Guidelines for Ground-Water Classification Under the EPA Ground-Water Protection Strategy" (USEPA, 1988, pg. 6-1) provide the methodology for two assessments to conduct the study and cost estimate. The assessments are:

1. A treatment technology selection, in which all common technologies employed in the treatment of drinking water are identified and their potential applicability is determined. From this information, one or more alternative treatments or group of treatments (if any) are identified as potential treatment systems.
2. An economic feasibility test, in which the alternative treatment or treatments are evaluated to determine the ultimate cost to treat the water in the aquifer to drinking water standards.

The assessments and subsequent conclusions will consider numerical ground water standards established by the Environmental Protection Agency (EPA) under the Uranium Mill Tailings Radiation Control Act (UMTRCA) (40 CFR 192), the Safe Drinking Water Act (SDWA) (40 CFR 141 and 143), and any authority granted to the State of Colorado under the SDWA. Standards under UMTRCA will be given primary consideration. (In the absence of UMTRCA standards, SDWA standards and state authority will be considered.

In addition, consideration will be given to any institutional controls that have been or will be implemented by the City of Grand Junction or Mesa County.

1.2 Organization

This report is organized as follows:

- Section 2.0 presents the background information required to make the treatment technology selection and perform the two assessments.
- Section 3.0 reviews the chemistry of each of the contaminants in the ground water, describes the potential treatment technologies, and selects a conceptual treatment alternative.
- The economic feasibility assessment is performed in Section 4.0.
- The conclusions are presented in Section 5.0.

2.0 Background Information

2.1 Influent Water Quality

Table 2-1 presents the information known about the background water in the alluvial aquifer. The background levels of trace minerals and salts are presented showing the maximum, minimum and mean concentrations.

2.2 Effluent Water Quality

For purposes of the technology selection, the minimum effluent water quality must be defined. Because this is an evaluation of the aquifer as a potential source of municipal drinking water, the Maximum Contaminant Levels (MCLs) outlined under the UMTRCA (40 CFR 192, Table 1 to Subpart A) and the SDWA, (40 CFR 141.11, 141.23 and 41.62) are applicable. Secondary Maximum Contaminant Levels (SMCLs) under the SDWA (40 CFR 143.3) are applicable as guidelines for states but unenforceable. Likewise, Maximum Contaminant Level Goals (MCLGs) are applicable for evaluation purposes, but are also unenforceable (40 CFR 141.50). Table 2-1 Outlines these standards and compares them to constituents known to be found in upgradient background waters within the alluvial aquifer.

2.3 Estimated Water Availability

The following information was presented concerning how much ground water could be supplied to any potential treatment system.

- Volume of water per year flowing through the aquifer is 8,080 acre-feet per year (7.2 million gallons per day or 2.63 billion gallons per year).
- Hydraulic conductivity is estimated to be 70 feet per day.
- Aquifer is estimated to extend from 20 feet below ground surface (bgs) to 50 feet bgs where it is bounded by bedrock.

The throughput of the aquifer was estimated using an average hydraulic conductivity that is higher than that measured in the field. Because this is an overestimate of the amount of useable ground water available, using this to determine the maximum population that can be supplied by the aquifer will result in a conservative cost estimate when the per capita cost of the treatment system is calculated due to economies of scale in the treatment system.

Table 2-1. Background Concentrations and Applicable Regulatory Standards

Constituent (mg/l)	Background Mean	Maximum	Minimum	UMTRA MCL[1]	MCL[2]	SDWA SMGL[3]	MCLG[4]
Alkalinity as CaCO3	414	493	328				
Ammonia as NH4	0.099	0.321	0.014				
Arsenic	(0.001)	(0.001)	(0.001)	0.05	0.05		
Cadmium	(0.001)	(0.001)	(0.001)	0.01	0.005		0.005
Calcium	454	573	208				
Chloride	496	991	144			250	
Cobalt	0.006	0.008	(0.001)				
Copper	0.005		(0.001)			1.0	1.3
Fluoride	1.02	1.82	0.45		4.0	2.0	
Gross Alpha (pCi/L)	51.0	81.0	31.0		15.0		0
Gross Beta (pCi/L)	62	255	17				
Hardness (as $CaCO_3$)	2598	3660	963			75[5]	
Iron	0.507	3.13	0.003			0.3	
Magnesium	384	502	64				
Manganese	1.47	2.22	0.23			0.05	
Molybdenum	0.076	0.186	0.022	0.1			
Nickel	0.009	0.02	(0.001)		0.14		0.14
Nitrate as N	22	71	0.06	10	10	–	10 - 20
pH(s.u.)	6.89	7.51	6.45			6.5 - 8.5	
Potassium	10	17	6				
Radium (pCi/L)	0.52	1.2	0.04	5			
Selenium	0.047	0.137	0.001	0.0[illegible]	0.05		0.05
Sodium	634	8[illegible]3	235				
Strontium	5.115	8.09	2.14				
Sulfate	2767	3720	416			250	
TDS	5611	7400	1670			500	
Uranium	0.05	0.066	0.023	0.044			0
Vanadium	0.002	0.003	0.001				
Zinc	0.004	0.005	0.004			5	

[1] Maximum Contaminant Level, UMTRA Standard [40 CFR 192, Table 1, Subpart A]

[2] Maximum Contaminant Level, SDWA standard [40 CFR 141.23 and 141.62]

[3] Secondary Maximum Contaminant Level [40 CFR 143.3]

[4] Maximum Contaminant Level Goal [40 CFR 141.50 and 141.51]

[5] While not a published SMCL, this is a number recommended by the National Society of Professional Engineers for potable water [Lindeburg, 1997, pg. 7-12].

3.0 Treatment Technology Selection

3.1 Review of Constituents of Concern

The constituents of concern (COC) in the alluvial aquifer water are those constituents listed in Table 2-1 that have concentrations greater than the MCL or the SMCL. A brief review of each of the COCs is presented below along with a description of the appropriate treatment technologies for each.

3.1.1 Hardness (Calcium and Magnesium)

Water hardness is caused by multi-valent positive metallic ions such as calcium, magnesium, iron and manganese. Hardness reacts with soap to reduce its cleansing effectiveness, and to form scum on the water surface and ring around the bathtub. Water with a hardness above 350 mg/L (as $CaCO_3$) is referred to as saline or brackish water.

Water containing bicarbonate (HCO_3^-) ions form a precipitate when heated, referred to as scale, which fouls water heaters and piping. This hardness is known as carbonate hardness. Remaining hardness due to sulfates, chlorides and nitrates is known as non-carbonate hardness (NCH).

Although high values of hardness are not organically dangerous, public acceptance of the water supply requires a hardness of well below 150 mg/L. Except for special industrial uses, potable water should have the carbonate hardness reduced to at least 40 mg/L and the total hardness should be below 75 mg/L [Lindeburg, 1997, pg. 7-11].

Calcium and magnesium can be easily removed with lime-soda softening or ion exchange softening. Softening is also appropriate for iron and manganese removal if the iron and manganese ions have been oxidized prior to the softening treatment [Kemmer, 1988, pg. 6.6].

3.1.2 Iron

Even in low concentrations, iron is objectionable because it stains bathroom fixtures, causes a brown color in laundered clothing and affects taste. The SMCL of water is 0.3 mg/L for this reason. Water originally pumped from anaerobic sources (such as ground water) may contain ferrous (Fe^{+2}) ions, which are invisible and soluble. When exposed to oxygen, insoluble ferric (Fe^{+3}) ions form which give the water the rust coloration.

Ferrous iron is easily treated through aeration to ferric iron that will quickly precipitate as iron hydroxide. Residual ferric iron, if any, is reduced by softening and by media filters [Kemmer, 1988, pg. 6.13].

3.1.3 Nitrate

Nitrate is the product of the natural breakdown of ammonia and comes into water from agricultural and human activities. Nitrates in ground water are rarely due to dissolving minerals. Nitrate concentrations in drinking water are limited to 44 mg/L due to its adverse health effects to humans.

Nitrate is difficult to treat. Anion exchange is the only chemical process that removes nitrate. Other desalinization technologies such as reverse osmosis and distillation are also applicable. Nitrate can be converted to gaseous nitrogen through a biological process [Kemmer, 1988, pg. 6.13].

3.1.4 Manganese

Manganese ions are similar in effect to iron ions. Manganous (Mn^{+2}) manganese oxidizes to manganic (Mn^{+4}) manganese to give water a brownish color. The SMCL for manganese is 0.05. Treatment of manganese is also the same as with iron [Lindeburg, 1997, pg. 7-12].

3.1.5 Chloride

Since almost all chloride salts are highly soluble in water, chloride is common in freshwater supplies. The recommended upper limit (SMCL) for chloride in drinking waters is 250 mg/L. This is based entirely on taste and not on any known health hazards.

Anion exchange is the only chemical process capable of removing chlorides from water. However, physical processes such as evaporation and reverse osmosis can separate feed water into two streams, one with a greatly reduced chloride content and the other with an increased content [Kemmer, 1988, pg. 6.6].

3.1.6 Fluoride

Low amounts of fluoride (between 0.8 and 1.2 mg/L) have been shown to reduce the population tooth cavity rate. However, excess fluoride concentrations cause tooth staining and brittle teeth. Although the MCL for fluoride is 4.0 mg/L, the SMCL for fluoride is 2.0 mg/L which is the level at which notable tooth damaged will be caused.

Lime precipitation (softening) will reduce the fluoride concentration as will anion exchange [Kemmer, 1988, pg. 6.13].

3.1.7 Sulfate

Sulfate is typically found in the range from 5 to 200 mg/L. The SMCL of 250 mg/L for sulfate is based on taste and its potential cathartic effect.

High sulfate levels may be reduced measurably by massive lime treatment because calcium sulfate is insoluble at levels greater than 2,000 mg/L [Kemmer, 1988, pg. 6.9]. Sulfate concentrations may also be reduced by anion exchange or by reverse osmosis if precautions are taken to ensure sulfate precipitation does not occur with the treatment unit [Lindeburg, 1997, pg. 7-32].

3.1.8 Selenium

Although a necessary nutritional factor for animals and humans, elevated concentrations of selenium are highly toxic which is why the MCL is 0.05 mg/L. Selenium can exist in three ionic forms:

- As elemental selenium (Se^0) which is insoluble in water;
- As the selenite (Se^{+4}) ion which is easily precipitated by lime softening; and
- As the selenate (Se^{+6}) ion which very soluble in water and is typically removed by anion exchange or by reverse osmosis.

It should be noted that selenate and sulfate are removed equally by anion exchange in proportion to their relative concentrations in the feed water [Lewis, 1998, pg. 1].

3.1.9 Uranium and Gross Alpha

Uranium is one of the heavier radionuclides and is generally not very soluble. Because uranium is a potential source of alpha radiation (measured as gross alpha), the UMTRA MCL for uranium is 0.044 mg/L.

Soluble uranium may be removed using ion exchange and, because the uranium atom is so large, reverse osmosis is very effective. Although simple, treatment of uranium to acceptable levels is typically very expensive. This is because the treatment process may first have to remove a significant amount of more common contamination such as calcium and magnesium before the soluble radionuclides can be reduced to acceptable levels [Kemmer, 1988, pg. 6.27].

3.2 Description of Commonly-Employed Technologies

Using the methodology laid out in the "Guidelines for Ground-Water Classification Under the EPA Ground-Water Protection Strategy", USEPA, June 1988, "commonly-employed" treatment technologies must be screened to determine what, if any, technology or combination of technologies can treat the water to drinking water standards. Table 3-1 presents a list of those technologies considered "commonly-employed" in the drinking water industry and their effectiveness in treating each of the COCs listed above. The technologies in Table 3-1 are based on the list provided in the guidelines. Although the guidelines are ten years old, the list of water treatment technologies is still appropriate. The advantages, disadvantages and limitations of each potentially applicable technology are briefly presented in Table 3-2.

Table 3-1. Common Treatment Technologies Applicability to Constituents of Concern

Technology	Hardness	Chloride	Flouride	Iron	Manganese	Nitrate	Selenium	Sulfate	Uranium
Aeration	No	No	No	Yes[3]	Yes[3]	No	No	No	No
Air Stripping	No	No	No	No	No	No	No	No	No
Carbon Exchange	No	No	No	No	No	No	No	No	No
Chemical Softening/ Precipitation	Yes	No	No	Yes	Yes	No	Yes[3]	Yes	Yes
Chlorination	No	No	No	No	No	No	No	No	No
Fluorination	No	No	No	No	No	No	No	No	No
Media Filtration	Yes[2]	Yes[2]	Yes[2]	Yes[2]	Yes[2]	Yes[2]	Yes[2]	Yes[2]	Yes[2]
Desalinization[1]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ozonation	No	No	No	Yes[3]	Yes[3]	No	No	No	No

[1] Includes distillation, electrodialysis, ion exchange and reverse osmosis.

[2] Applicable to suspended contaminants only. Will not affect dissolved contaminants.

[3] Effectiveness depends on the valence state of the ion.

Table 3-2. Technology Advantages, Disadvantages and Limitations

Technology	Advantages	Disadvantages	Limitations
Air Stripping/ Aeration	Low Capital and O&M High removal efficiencies for some contaminants Pretreatment is generally not required for ground water Equipment purchased off the shelf	Temperature sensitive (cold) contaminants May result in air pollution or a need for Emission Control	Removes only volatile contaminants Suspended solids in influent may lead to removal efficiency loss due to biological growth (air stripping only)
Carbon Adsorption	Low energy requirements High removal efficiencies for a wide range of contaminants over a broad concentration range.	Management of spent carbon can be expensive and problematic -Regeneration -Disposal -Replacement High capital and operating costs	For organics removal where concentrations are high, frequent carbon regeneration necessary Suspended solids should not exceed 50 mg/L Oil & grease should not exceed 10 mg/L Requires steady hydraulic loading
Chemical Precipitation	Equipment is readily available & easy to operate Low energy requirements Low capital and O&M costs	Generates large quantities of sludge which must be treated & disposed Effluent quality may vary considerably	Frequent laboratory testing required to maintain high efficiencies pH dependent No concentration limit
Membrane Filtration, Reverse Osmosis	Excellent removal of charged anions and cations Good removal of high molecular weight organics Effective treatment for removal of dissolved solids	High energy requirements Requires extension pilot analyses for each system Highly sophisticated instrumentation & control Generates a concentrated brine which may require treatment Pretreatment almost always required High capital & O&M costs	Suspended solids must be low to prevent fouling Operating temperatures must be between 65 & 85 F Precipitation on membrane may be a problem
Media Filtration (e.g. sand filters)	Highly reliable Relatively simple; easy to operate & control Multiple media can be used to improve efficiencies	Process generates a backwash which must be treated	Requires fairly steady hydraulic loads Influent suspended solids should not exceed 200 mg/L Pretreatment may be required if suspended solids exceed 100 mg/L
Ion Exchange	Synthetic resins can tolerate wide range of temperature and pH Can remove a variety of cationic & anionic inorganic and organic contaminants Low energy requirements	High level of training necessary for operation Generates concentrated regenerant brine which must be disposed Generally, but not always, high capital and O&M	Influent concentrations should not exceed 4,000 mg/L Oil & grease should not exceed 10 mg/L Influent should not contain chemical oxidants (e.g. ozone) Filtration required as pretreatment if suspended solids exceed 20 mg/L in the influent
Ozonation and Chemical Oxidation	Reduces chemical residuals generated (particularly trihalomethanes) No dissolved solids generated	High capital and O&M costs High energy Requires high level of training & safety precautions for operation	Treats only contaminants which can be oxidized Does not remove iron-cyanide complexes
Floatation	Easily implemented Usually highly effective for hydrocarbons with densities near or less than that of water Low capital & O&M Low energy requirements	May require substantial chemical addition Generates large quantities of sludge to be treated & disposed	Narrow range of removal e.g., not effective for contaminants with density greater than that of water

3.2.1 Technically Inapplicable Technologies

From the information presented in Tables 3-1 and 3-2, several technologies are not applicable for treating the alluvial aquifer water. These technologies are air stripping, carbon adsorption, chlorination and fluorination. It should be noted that the background water in the alluvial aquifer is assumed not to contain organic chemicals or any harmful bacteria that would require disinfection, which is why most of these technologies are inapplicable.

3.2.2 Potentially Applicable Technologies

The remaining technologies are considered applicable to this situation. A brief discussion of how each technology could be applied to this situation is presented below.

3.2.2.1 Aeration and Ozonation

Aeration can be used where there is a high concentration of carbon dioxide, where tastes and odors are objectionable. In addition, where iron and manganese are present in amounts above 0.3 mg/L, aeration is used as a pretreatment to a softening step [Lindeburg, 1997, pg. 7-21].

Ozonation refers to the generation of ozone and its addition to water to chemically oxidize contaminants. Its primary use is for disinfection but it achieves the same results as aeration with respect to the treatment of iron and manganese. Ozonation is very expensive and is only used in specific instances where chemical disinfection is not effective. Ozonation is typically used to treat iron contamination.

3.2.2.2 Chemical Softening/Precipitation

Softening refers to the removal of calcium and magnesium through precipitation. This technology consists of the addition of lime and soda ash to the feed water resulting in the formation of a magnesium hydroxide and calcium carbonate precipitate. Typically, lime treatment has added benefits of disinfection, iron and manganese removal, and clarification (because it must be followed by a media filtration step).

The first step of chemical softening is the addition of lime to remove all carbonate hardness. The second step is the addition of soda ash and lime to remove the remaining NCH. These two steps are performed in large settling basins or clarifiers. After treatment, the water is treated with carbon dioxide to lower the pH and assist in precipitation. The final step in softening is the use of media filters to remove any residual suspended precipitate step [Lindeburg, 1997, pg. 7-21].

At concentrations greater than 2,000 mg/L, calcium sulfate can also be precipitated through overdosing of lime prior to the soda ash application. This results in water with

500 to 600 mg/L of calcium and 1,400 to 1,500 mg/L of sulfate. However, this approach is rarely taken in drinking water treatment for two reasons:

1. The excess calcium added through the lime overdosing would have to be removed by adding soda ash.
2. For drinking water purposes, the sulfate level achievable through precipitation will still be six times the acceptable level and some additional form of sulfate treatment will be required.

The drawback of this technology is that, in essence, it is an exercise in ion exchange. Except for the removal of carbonate hardness, this technology succeeds only in replacing calcium and magnesium ions with sodium ions. Since sodium is a smaller atom this will have some effect on the Total Dissolved Solids (TDS) content of the water, but the technology overall is not an effective treatment of high saline or briny water.

3.2.2.3 Ion Exchange Softening

This technology uses ion exchange resins to remove magnesium and calcium ions from water by replacing them with sodium ions. The sodium ions are attached to an insoluble resin and are preferentially replaced on the resin by magnesium and calcium ions. Periodically, ion exchange beds must be regenerated using a sodium chloride salt solution. This has a drawback of creating a high volume of concentrated calcium-magnesium-sodium chloride salt solution that must be disposed of [Lindeburg, 1997, pg. 7-29].

In this application, ion exchange resins have an additional drawback. In treating water with high sulfate concentrations, ion exchange softeners are prone to calcium sulfate precipitation in the resin, which is irreversible and destroys the resin. For this reason, this softening technology is not applicable as a treatment option.

3.2.2.4 Media Filtration

Filtration is used in water treatment to remove or reduce suspended solids. Media filtration consists of the use of silica sand, fine anthracite or calcium carbonate of specific sizes as the filter. The filter can be regenerated through backwashing and is very effective at suspended solids removal [Lindeburg, 1997, pg. 7-25].

Media filtration is ineffective in dissolved solids removal and therefore is not appropriate as a primary treatment in this situation. However, most water treatment processes involving coagulation and precipitation must be followed by media filtration for complete removal of suspended contaminants. If one of these technologies is used, a media filter will be required as a post treatment.

3.2.2.5 Desalinization

Desalinization refers to those technologies which are designed to produce potable water from seawater or similar feed waters with a high salt content, particularly sodium and chloride salts. Desalinization technologies include distillation, electrodialysis, ion exchange and reverse osmosis. The following is a brief description of each of the desalinization technologies [Lindeburg, 1997, pg. 7-32]:

- Distillation: The water is vaporized, leaving the salt behind. The vapor is reclaimed by condensation.
- Electrodialysis: Positive and negative ions flow through selective membranes under the influence of an induced electrical current.
- Ion exchange: Water is passed through a filter bed of exchange material. Ions in the insoluble exchange material are displaced by ions in the water. When exchange material is spent, it is regenerated with a rejuvenating solution such as sodium chloride (salt); or, in the case of common cationic resins, sulfuric and hydrochloric acids are used as regenerants.
- Membrane separation (ultrafiltration, reverse osmosis): This is the least expensive method of demineralization. Membrane filtration refers to the use of a semi-permeable membrane as a filter through which water is forced. The membrane is manufactured to have an effective pore size such that only contaminants smaller than the pore size pass through the membrane with the water. Depending on the effective pore size of the membrane, a considerable differential pressure may be required to force the water through the membrane. The contaminants larger than the effective pore size remain on the inlet side and are removed as a concentrated salt solution.

Ultrafiltration is the term used for membrane filtration systems with effective pore sizes from 10 to 100 angstroms that are designed to remove simple sugars, proteins and dyes. Reverse osmosis is the term used for membrane filtration systems with the smallest effective pore size designed for true desalination of water.

Reverse osmosis systems have pore sizes so small that most single-atom metal cations and all molecular anions can not pass through the membrane. Reverse osmosis systems produce a treated water, referred to as the permeate, that is very low in dissolved solids. Reverse osmosis has become a common technology in desalinating seawater and treating highly impacted industrial wastewaters. In these applications, they have essentially displaced all other desalinization technologies because of the savings in energy and operating costs (evaporative systems can cost as much as $0.20 per gallon to produce drinking water from energy costs alone) [Lindeburg, 1997, pg. 7-32].

Reverse osmosis potable water systems typically operate at pressures of 400 pounds per square inch when used to desalinate seawater and produce about 2 gallons per day per square foot of membrane surface area. These systems typically operate at 75% efficiency, i.e. for every three gallons of potable water produced; one gallon of concentrate must be disposed of. In addition to disposal of the concentrate, the other major drawback of reverse osmosis systems is their sensitivity to calcium and magnesium precipitation. For waters of any significant hardness, softening is always required as a pretreatment.

3.3 Development of Conceptual Treatment System

3.3.1 Conceptual Treatment System

Table 3-1 and the preceding discussion of technologies indicate that no single treatment technology will achieve the effluent requirements alone. However, with the information available a conceptual treatment system can be developed that will meet the requirements. An effective conceptual system is presented in Figure 3-1 and consists of aeration, lime-soda softening (including recarbonation and media filtration) and reverse osmosis.

Desalinization technologies are the only ones capable of achieving the effluent requirements for the selenium in selenate form, sodium, nitrate, chloride and fluoride. Of the desalinization technologies, reverse osmosis will be the least expensive. However, to be used in this application a softening pretreatment will be required to avoid precipitation fouling of the membranes. Furthermore, reverse osmosis will also guarantee the removal of any residual metal contaminants such as selenite, manganese and uranium that may not be completely removed by the chemical softening and precipitation pretreatment.

The process chemistry for each of the components of the system is discussed below. The estimated effluent water quality of the conceptual system is presented in Table 3-3.

3.3.1.1 Aeration

As an initial pretreatment, aeration will be used to ensure that the iron and manganese ions are fully oxidized. A significant amount of iron and manganese hydroxide precipitation is expected in the aeration lagoon. Furthermore, the aeration will ensure that any soluble iron leaving the lagoon will be easily removed by the lime-softening step. A 75% reduction of the iron and manganese is expected by this treatment.

3.3.1.2 Softening and Media Filtration

A softener will be required to remove the hardness from the water prior to the reverse osmosis step. The softening will be achieved by adding lime (calcium hydroxide) which will react with the calcium bicarbonate to form calcium carbonate that will precipitate. The reaction is as follows:

$$Ca(HCO_3)_2 + Ca(OH)_2 \rightarrow 2CaCO_3 \downarrow + 2H_20$$

This reaction will remove all the carbonate hardness and cause a net reduction in total dissolved solids in the water. However, according to Table 2-1, calcium is present in

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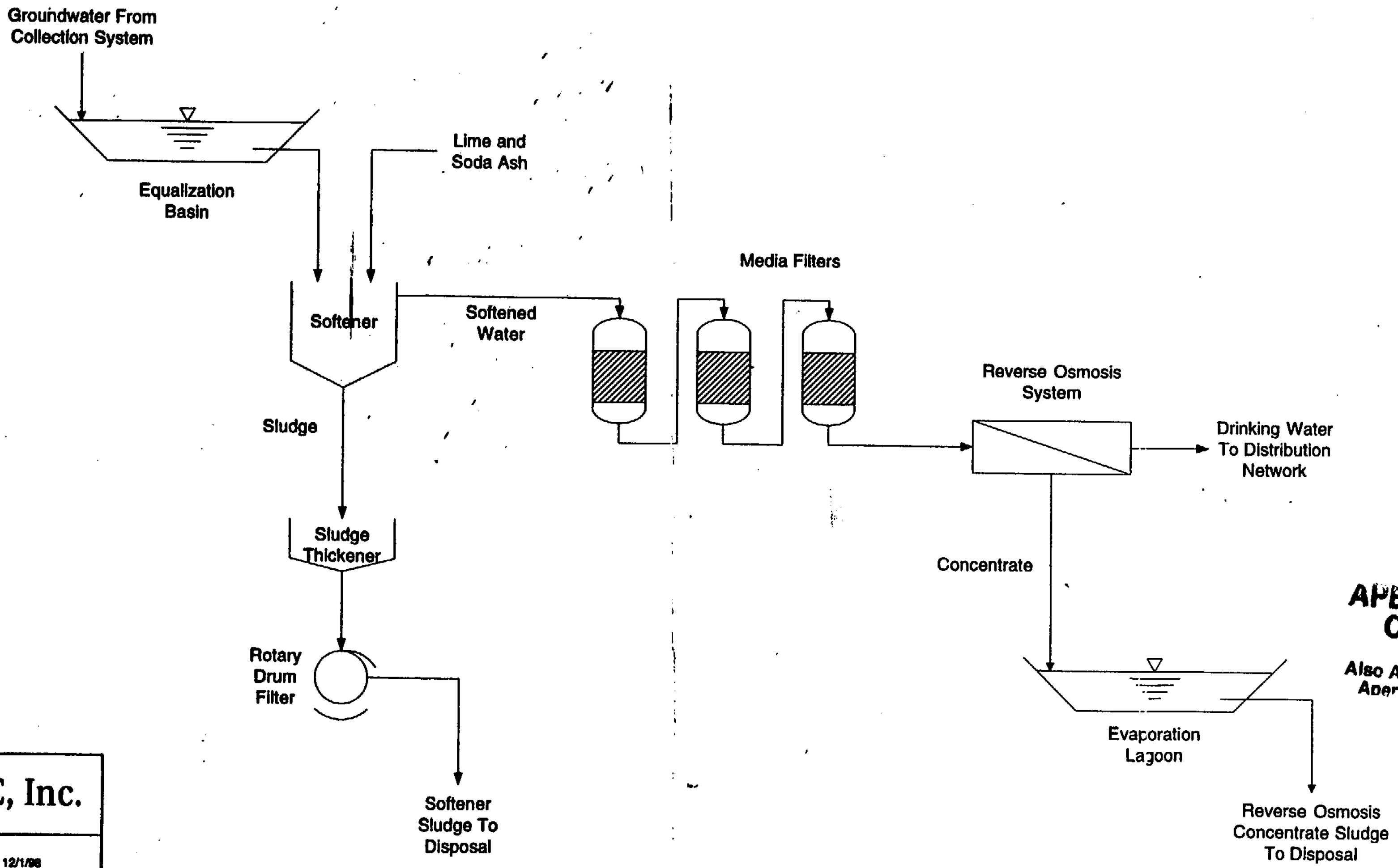

MACTEC, Inc.

TITLE FIGURE 3-1	DATE 12/1/98
DESCRIPTION CONCEPTUAL PROCESS FLOW DIAGRAM ALLUVIAL AQUIFER TREATMENT SYSTEM	
DRAWN BY GCL	FULL FILENAME

9902250203-05

Table 3-3. Estimated Effluent Quality

Constituent (mg/l)	Effluent Mean	UMTRA MCL[1]		SDWA	
			MCL[2]	SMGL[3]	MCLG[4]
Alkalinity as CaCO3	< 100				
Ammonia as NH4	< 0.01				
Arsenic	(0.001)	0.05	0.05		
Cadmium	(0.001)	0.01	0.005		0.005
Calcium	< 35				
Chloride	< 50			250	
Cobalt	(0.001)				
Copper	(0.001)			1.0	1.3
Fluoride	< 0.1		4.0	2.0	
Gross Alpha (pCi/L)	(0.001)		15.0		0
Gross Beta (pCi/L)	(0.001)				
Hardness (as $CaCO_3$)	< 75			75[5]	
Iron	(0.001)			0.3	
Magnesium	< 10				
Manganese	(0.001)			0.05	
Molybdenum	(0.001)	0.1			
Nickel	(0.001)		0.14		0.14
Nitrate as N	< 1	10	10		10 - 20
pH(s.u.)	8.0			6.5 - 8.5	
Potassium	< 1				
Radium (pCi/L)	(0.001)	5			
Selenium	(0.001)	0.01	0.05		0.05
Sodium	< 75				
Strontium	(0.001)				
Sulfate	< 75			250	
TDS	< 250			500	
Uranium	(0.001)	0.044			0
Vanadium	(0.001)				
Zinc	(0.001)			5	

[1] Maximum Contaminant Level, UMTRA Standard [40 CFR 192, Table 1, Subpart A]

[2] Maximum Contaminant Level, SDWA standard [40 CFR 141.23 and 141.62]

[3] Secondary Maximum Contaminant Level [40 CFR 143.3]

[4] Maximum Contaminant Level Goal [40 CFR 141.50 and 141.51]

[5] While not a published SMCL, this is a number recommended by the National Society of Professional Engineers for potable water [Lindeburg, 1997, pg. 7-12].

excess of the alkalinity. Therefore, an additional step will be required to remove the remaining non-carbonate hardness.

The non-carbonate hardness is reduced through the addition of soda ash (Na_2CO_3). The reactions are as follows:

$$Ca(SO_4 \text{ or } Cl_2) + Na_2CO_3 \rightarrow CaCO_3 \downarrow + Na_2(SO_4 \text{ or } Cl_2)$$

$$Mg(SO_4 \text{ or } Cl_2) + Na_2CO_3 + Ca(OH)_2 \rightarrow Mg(OH)_2\downarrow + CaCO_3\downarrow + Na_2(SO_4 \text{ or } Cl_2)$$

The calcium and magnesium in the effluent of the softening step is dictated by solubility chemistry. The limit of 35 mg/L of calcium carbonate and 10 mg/L of magnesium hydroxide (as calcium carbonate) is expected Furthermore, the remaining iron and manganese are expected to be removed along with 50% of the selenium (the assumed amount of selenite ion in the feed water). In addition, uranium becomes insoluble at pH 10 and 95%+ of the uranium is expected to precipitate out in the lime softening step.

3.3.1.3 Reverse Osmosis

For the purposes of this report, the reverse osmosis step will be assumed completely effective in removing the remaining COCs to acceptable levels. The COCs coming from the softening treatment are nitrate, selenate, sulfate, sodium and chloride.

While this system will effectively treat the background water to the effluent requirements for calcium and magnesium, it will also create a significant amount of waste that must be disposed of. This waste will be either in the filter cake generated by the softening/precipitation step or in the concentrate rejected by the reverse osmosis unit.

4.0 Economic Feasibility Test

4.1 Treatment System Size

The maximum population that can be supplied with potable water by the conceptual treatment system can be estimated based on the technologies used. As previously mentioned, a conservative estimate of the treatment capability of a reverse osmosis unit is a 3 to 1 ratio of treated water to rejected concentrate. A conservative assumption can be made that the reverse osmosis unit is the only source of water loss in the treatment system and that the treatment system can provide 3 gallons of potable water for every 4 gallons of ground water treated. In practice, however, water will also be lost through evaporation from the aeration pond and in the sludge removal from the softener.

Using this assumption, 75% of the influent 7.2 million gallons per day or 5.41 million gallons per day of potable water can be provided by this system. This is equivalent to nearly 1.975 billion gallons a year. Based on the numbers provided in the ground water classification guidelines [USEPA, 1988, pg. 6-23] this would serve 19,750 households or approximately 54,000 people.

4.2 Estimated Treatment System Cost

The costs for each major piece of the treatment system are presented in Table 4-1. A brief discussion of how the costs were estimated

4.2.1 Collection/Extraction System

Given the hydraulic conductivity and depth of the aquifer, the potential production rate of a well can be estimated if a well diameter, depth of pumping drawdown and radius of influence are assumed. For the purposes of this analysis, eight-inch-diameter production wells and a conservative radius of influence of 50 feet are assumed. With these assumptions, the following formula [King, 1996, pg. 142] can be used to determine the production rate of a well.

$$Q = (K2\pi rh)dh/dr$$

Where Q is the production rate, K is the hydraulic conductivity, r is the radius of the well, h is the depth of the aquifer at the well (including drawdown), dh is the drawdown and dr is the radius of influence of the well. Using this equation, the maximum production will occur when the drawdown of the well is exactly half of the depth of the aquifer. Considering that and including our assumptions, this equation becomes:

$$Q = (70 \text{ ft/day} \times 2 \times 3.14 \times 0.33 \text{ ft} \times 15 \text{ ft}) \times 15 \text{ ft} / 30 \text{ ft}$$

$$Q = 1{,}088 \text{ ft}^3\text{/day} = 8{,}138 \text{ gallons/day}$$

Table 4-1. Estimated Treatment System Costs

System Component	Capital Cost	Operating Cost	Annualized Cost[1]	Annual Cost per Household[1]
Aeration System	$2,000,000	$10,000	$171,173	$9
Softener System[2]	$2,500,000	$5,884,000	$6,085,466	$308
Collection System	$8,860,000	$221,500	$935,496	$47
Media Filter System	$1,250,000	$50,000	$150,733	$8
Reverse Osmosis System	$5,000,000	$500,000	$902,932	$46
Evaporation System	$5,000,000	$100,000	$502,932	$25
Softener Sludge Disposal	$0	$1,638,850	$1,638,850	$83
Reverse Osmosis Sludge Disposal	$0	$2,737,500	$2,737,500	$139
Operating Labor	$0	$300,000	$300,000	$15
System Totals	$24,610,000	$11,441,850	$13,425,081	$680

[1] Annualized costs are based on a 30 year lifespan and a real discount rate of 7%.

[2] Includes the chemical feed system and the clarifier system.

Therefore, approximately 886 production wells would be required to produce the total potential aquifer yield of 7.2 million gallons per day.

The estimated drilling and installation cost per well is $100 per foot of well depth or a total $5,000 per well. For simplicity, the cost of extraction pumps and interconnecting piping required to feed the treatment system is assumed to be an additional $5,000 per well. Routine maintenance and operating costs of $250 per well per year are assumed for the wells and entire collection system.

4.2.2 Treatment System Capital Equipment and Operating Costs

The estimated costs for equipment were supplied by Ms. Sophia O'Halloran of the United States Filter Corporation and include estimates of the following costs:

- The equipment costs,
- The costs associated with new buildings and structures which may be required,
- The installation costs,
- The startup and shakedown costs,
- The permitting costs, if any, and
- Any other one-time costs incurred during the first year of operation.

It should be noted that land acquisition costs were specifically excluded from the capital cost. The operating cost include the following costs:

- Chemical costs,
- Maintenance costs,
- Energy costs,
- Operation labor costs,
- Ongoing permit fees, and
- Any other costs that recur on a regular basis.

Maintenance and energy cost estimates for the equipment were also provided by United States Filter. The operation labor requirements for the treatment system were estimated to be four full time employees for 24 hour operation. The operation labor requirements for the collection system were estimated to be one full time employee. The cost per full time employee is estimated at $60,000 per year.

4.2.2.1 Chemical Costs

By far the largest operating costs will be the costs for lime and soda ash used in the softener. The chemical reactions in the softener were presented in section 3.3.1.2. From these reactions the amount of chemical required for treatment can be determined.

Calcium hydroxide is added to the softener in the form of hydrated lime that is typically 93% pure. The lime precipitation step is expected to remove an average of 414 mg/L of calcium carbonate alkalinity from the water. This requires 414 mg/L of lime as calcium carbonate, which corresponds to 2.75 pounds of 93% pure lime per 1,000 gallons of water. Calcium hydroxide is also required for magnesium non-carbonate hardness (NCH) removal. The amount required to remove an average of 384 mg/L will be 10.4 pounds of 93% pure lime per 1,000 gallons of water. The total calcium hydroxide usage will then be 13.2 pounds of 93% pure lime per 1,000 gallons of water or approximately 17,300 tons per year of lime. The bulk price of lime delivered to Grand Junction provided by Mr. Ken Parfit of Van Waters and Rogers was $0.12 per pound, which represents an annual cost of $4.15 million in lime. However, this price was estimated using trucks to deliver the lime. If rail is used a delivered cost is expected to be approximately half that, $0.06 per pound or an annual cost of $2.08 million.

Soda ash is added in the softening process as a 59% pure sodium monoxide (Na_2O) which is equivalent to 99.2% Na_2CO_3. Soda ash will be required to precipitate both calcium NCH and magnesium NCH. The amounts required will be 6.5 and 14.2 pounds of 59% pure sodium monoxide per 1,000 gallons of water respectively. Or a total of 20.7 pounds of 59% pure sodium monoxide per 1,000 gallons of water or approximately 27,200 tons per year of soda ash. An estimate of the bulk price of soda ash delivered by rail was provided by the FMC Corporation as $0.07 per pound, so this represents an annual cost of $3.81 million in soda ash.

4.2.2.2 Waste Disposal Costs

The other significant operating cost of this system will be waste disposal. There will be two major waste streams from this treatment system, the softener sludge and the concentrate from the reverse osmosis system. Softener sludge is typically handled by thickening until it can be disposed at a local landfill. On the other hand, reverse osmosis concentrate is typically discharged to the environment or concentrated further by evaporation into a sludge that is then disposed of. Discharge of this sludge to the environment will not be possible due to its expected salt, selenium and uranium content.

Using the chemical reactions presented in section 3.3.1.2, the expected mass of calcium carbonate and magnesium hydroxide precipitated in the softener can be estimated. The reactions indicate that for every gram of calcium hardness removed, 5 grams of calcium carbonate will be precipitated. Likewise, for every gram of calcium NCH removed 2.5 grams of calcium carbonate will be precipitated. Lastly, for every gram of magnesium NCH removed 4 grams of calcium carbonate and 2.5 grams of magnesium hydroxide will be precipitated. Using the average concentrations of magnesium and calcium, an estimated 3,738 mg/L of solids will precipitate during the softening treatment. This corresponds to approximately 224,500 pounds per day or 112 tons per day of solids generation.

Typically, precipitated solids are disposed of at a landfill as sludge. Standard sludge handling equipment generate a sludge which is 25% by weight solids [Lindeburg, 1997, pg. 8-28]. Therefore, the softener would generate approximately 448 tons of sludge per day that must be disposed of. Typical sludge disposal costs range from $10 to $50 per ton depending on the transport distances. The tipping fee for sewer sludge disposal at the

Mesa County Landfill is \$7 per ton. If a \$3 per ton transport fee is assumed, a sludge disposal cost of \$10 per ton is obtained.

The reverse osmosis is expected to produce 1.8 million gallons per day of a concentrate that is expected to have approximately 25,000 mg/L of TDS. Typically, some form of an evaporation lagoon or thermal evaporator would then be used to increase the TDS to 250,000 mg/L. The concentrate would then be a sludge that would be disposed of. Using these assumptions, the reverse osmosis system would generate 180,000 gallons of 25% solids sludge per day or 750 tons of sludge per day.

Unfortunately, with this influent water quality it is likely that the sludge from the reverse osmosis concentrate would be classified as a D010 toxic hazardous waste under the Resource Conservation and Recovery Act (RCRA) (40 CFR 261.1, Table 1) due to the selenium content of the sludge. Disposal of this sludge as a hazardous waste would cost at least \$200 per ton. Using these assumptions, this would require \$54 million dollars in hazardous waste disposal per year.

However, a conservative assumption can be made that the reverse osmosis concentrate sludge will not be hazardous and can be disposed of with the softener sludge at \$10 per ton in the local landfill.

4.3 Cost Evaluation

The estimated costs for the complete treatment system are presented in Table 4-1. The costs are broken down into capital costs, operating costs, total annualized cost and the annual cost per household. The total annualized cost was calculated using the equations presented in the guidelines for ground water classification [USEPA, 1988, pg. D-4]. The equations for this calculation are the following:

$$\text{Total Annualized Cost} = f\,CC + OMC$$

$$f = r / (1 - 1/(1+r)^n)$$

Where f is the annualization factor annual cost, CC is the capital cost, OMC is the operations and maintenance costs, r is the real discount rate, and n is the lifetime of the equipment in years. In order to perform this calculation, the useable lifetime of the equipment must be estimated and the real discount rate must be obtained from the Office of Management and Budget.

For the purposes of this evaluation, the following are assumed:

- All equipment has a lifetime of 30 years.
- The real discount rate over those 30 years will be 7%.
- The equipment will have no resale value at the end of its useable lifetime.

In addition, calculating the operating cost assumes that the operating cost will be fixed over the lifetime of the equipment.

4.4 Threshold Evaluation

The guidelines for ground water classification [USEPA, 1988, pg. D-23] provides a graph for use in determining the economic threshold for use in economic feasibility tests. For a system serving a population of 54,000 people, the threshold is approximately $300 per household or $110 per person (based on 2.75 people per household).

This threshold was determined in 1988. When indexed for inflation the threshold becomes approximately $400 per household per year.

5.0 Conclusions

When the threshold for economic feasibility of $400 per household is compared to the estimated treatment cost of $680 per household, it is apparent that alluvial aquifer meets the definition of a Class III ground water. The assessments show that it is not economically feasible to use the ground water as a potable drinking water source.

It should be noted that the costs presented are conservative estimates of the cost of a treatment system. Although each of the major components of an effective system are included, some important elements have not been quantified because of the difficulty in obtaining accurate estimates in a short period of time. These elements are as follows:

- The size and cost of the property required for the system, and
- The cost of a material handling system that would be required to handle the 27,200 tons of soda ash and 17,300 tons of lime used annually.

The costs of these elements of the treatment system would not be negligible. In addition, The very real potential of creating a hazardous waste from the reverse osmosis concentrate was completely sidestepped in this evaluation using a conservative assumption.

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6.0 References

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JHT 43280

5.17.4.2

TO: RHEYDEBURG

FROM: RCONWAY

DATE: 4/24/91

SUBJECT: GRAND JUNCTION

After extensive review and research of the Grand Junction area surrounding the processing site I conclude that there are no persons in the vicinity drinking water from the underground aquifer. This conclusion was drawn from various sources of information including; visual physical inspection, personal contact of approximately 40% of the properties in the area, documentation of State of Colorado well permit records, documentation of City of Grand Junction water service records and documentation of Ute Water District records.

Attached are maps of the City sewer lines in the area, computer listings for people on City water and Ute water, State well permit records and hand written documentation of persons contacted. If you should have any questions or require a more detailed description please contact me. I hope this satisfies the requirement necessary to satisfy the NRC.

cc: MMiller
KBostick
RPortillo