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Department of Environmental Quality
Division of Radiation Control

Michael O. Leavitt
Governor
Dianne R. Nielson, Ph.D.
Executive Director
William J. Sinclair
Director

168 North 1950 West
P.O. Box 144850
Salt Lake City, Utah 84114-4850
(801) 536-4250
(801) 533-4097 Fax
(801) 536-4414 T.D.D.
www.deq.utah.gov

January 21, 2003

Donald R. Metzler, Program Manager
U.S. Department of Energy
Grand Junction Office
2597 B 3/4 Road
Grand Junction, CO 81503

SUBJECT: September 2002 Final Site Observational Work Plan for the Green River, Utah UMTRA Site: **DRC Comments**

Dear Mr. Metzler:

The Utah Division of Radiation Control (DRC) has reviewed the *Final Observational Work Plan (SOWP) for the Green River, Utah UMTRA Project Site, September 2002,* which was received on October 1, 2002. Before providing comments on the Final SOWP, we would like to report the status of our March 22, 2002 comments on the Draft SOWP. The Draft SOWP comments are presented below in italics followed by the current status of the comment. Comments associated with the Final SOWP are provided after the Draft SOWP comments.

Status of DRC Comments on the February 2002 Draft SOWP

1. Include Equipotential Head Maps. Although groundwater elevation data are provided in Appendix B, the Draft SOWP does not include any equipotential maps to characterize the ground water flow system across the site and to support statements made in the SOWP regarding the site hydrogeology. Please include equipotential maps in the Final SOWP to characterize the ground water flow system across the site with particular attention to flowlines into the discharge areas around Browns Wash and near the Green River. Also include different equipotential maps to demonstrate the hydraulic differences between the uppermost aquifer and the Buckhorn Member.

Comment Status: Equipotential maps are included in the Final SOWP for the Browns Wash alluvium, the middle sandstone unit of the Cedar Mountain Formation, and the basal sandstone unit of the Cedar Mountain Formation. Therefore, this comment has been addressed.

2. Include More Hydrographs. Figures 4-4 and 4-5 indicate a very limited use of hydrographs to show "representative" ground water elevations for each hydrostratigraphic unit. As indicated in Section 4.1.2, the Cretaceous bedrock aquifers are present under confined and semiconfined conditions. However, none of the hydrographs provided are representative of confined or semi-confined conditions. Please provide hydrographs for wells completed in the confined and semi-confined bedrock aquifers to demonstrate their hydraulic differences. In addition, please use well hydrograph comparisons to indicate the degree of hydraulic interconnection (or lack of) between the Browns Wash alluvium, Cedar Mountain unnamed member, and the

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Cedar Mountain Buckhorn Member. Such hydrographs should be used in conjunction with geochemical data plots to characterize the degree of interconnection (or lack of) between the three primary hydrostratigaphic units.

<u>Comment Status</u>: Hydrographs are included in the Final SOWP for monitoring wells completed in the Browns Wash alluvium, the middle sandstone unit of the Cedar Mountain Formation, and the basal sandstone unit of the Cedar Mountain Formation. Therefore, this comment has been addressed.

3. <u>Include Confined Head Data</u>. Water levels of flowing wells completed in the Buckhorn Member are designated with an "F" in Appendix B. However, no vertical head measurements were provided; instead, the top of casing elevation was listed as the water level value. For all future sample events, please quantify the vertical head value in any flowing wells to characterize the extent of the vertical upward hydraulic gradient (e.g., install valve and pressure gauge to shut in well and measure pressure in psi, then convert to feet). From a risk-based standpoint, the upward vertical hydraulic gradient may be a critical element in the compliance strategy and warrants measurement of vertical head.

<u>Comment Status</u>: During the additional investigation in July 2002, the only well flowing at the surface under artesian pressure was monitoring well 0582, which is completed in the basal sandstone unit of the Cedar Mountain Formation. A pressure gauge was installed on the well casing which indicated a head measurement of approximately 95 feet above ground surface, or an elevation of 4075 feet above mean sea level. Historically, monitoring well 0817, completed in the middle sandstone unit of the Cedar Mountain Formation, has flowed at the surface under artesian pressure but was not flowing during the July 2002 field investigation. As a result, this comment has been addressed.

4. <u>Specify Wells Used in Geochemistry Plots</u>. Figures 4-6 through 4-10 are used to characterize the geochemistry of the hydrostratigraphic units at the Green River site. However, no explanation is provided to indicate the location that each data point represents (e.g., well names). Please provide a legend or explanation in the Final SOWP to specify what each data point represents. In addition, please be more specific about the sampling dates of the data used in the geochemistry plots.

<u>Comment Status</u>: Trilinear Piper diagrams are provided as Figures 5-14 through 5-17 in the Final SOWP and the monitoring wells represented in the diagrams were listed in the figure explanations. However, specific well identifications are indistinguishable directly on the Piper diagrams. Please label each well with a different symbol such as a number or letter and include a legend that identifies each well with the corresponding symbol. This will provide a much better understanding of the geochemical differences between wells and may indicate whether there is any connection between different aquifer units.

5. <u>Clarify Location of Offset Well 0181</u>. Based on the scales of the maps in Figure 7-1 and Plate 1, proposed offset well 0181 is located about 75 feet northwest of existing well 0172. Because that would be too far away for a "twin" well, I asked how far you would be offsetting 0181 and your response was about 10 or 15 feet which makes more sense. Please install well 0181 as close as practicable to well 0172.

<u>Comment Status</u>: As indicated in the text on page 4-1, Figures 5-1, 5-9. and the aerial photo base, well 0181 was installed approximately 20 feet northwest of well 0172. In addition, section 3.2 of Appendix F states that well 0181 is located 18.7 feet northeast of well 0172. Therefore, this comment has been addressed.

6. <u>Include Conceptual Model of Local Flow System</u>. Please include a conceptual model for the local ground water flow system in the Final SOWP. Based on available data, DRC staff provided an interpretation of the local flow system in 1996, as summarized below (UT-DRC, 1996, p. 31). Data acquired from the additional investigation may refine or change this interpretation.

Based on downward vertical flow directions between the unnamed member and Buckhorn Member of the Cedar Mountain Formation, the disposal cell is located over a local recharge area. Nearby outcrops of the lower Cretaceous formations on and updip of the site suggest that recharge is derived directly from local precipitation.

The presence of the underlying Brushy Basin Shale Member of the Morrison Formation likely forms a no-flow boundary for the shallow unconfined aquifer due its bentonite content and extremely low permeability. Northwesterly dip of strata and northwesterly vertical joints and fractures may also play a role in the apparent northwesterly flow of ground water near the tailings cell.

Upward vertical gradients in wells completed in the Buckhorn Member near Browns Wash coupled with ground water seeps within Browns Wash indicate that Browns Wash is a local ground water discharge area associated with the Green River. Such an abrupt change in vertical flow directions over a short horizontal distance suggests a ground water flow cell of local origin and extent. Consequently, ground water contaminants that have been or may be released from the uranium tailings will likely be discharged to Browns Wash. In turn, contaminants discharged into Browns Wash will likely be discharged into the Green River by ephemeral surface flows or by ground water baseflow from the Browns Wash alluvial aquifer.

<u>Comment Status</u>. Section 5.1.2.3 of the Final SOWP includes a conceptual model of the ground water flow system and the relationships between the local and regional flow regimes. Therefore, this comment has been addressed.

7. <u>Include Bedrock Aquifer Pump Tests</u>. Section 4.1.2.2 indicates that permeability within the Cedar Mountain Formation is affected by both primary (rock matrix) and secondary (fracture) porosity. However, the only permeability tests included in the plan for additional investigation are single-well aquifer pumping tests for the alluvial wells. Since the objective of the additional field work is to better understand the hydrogeologic system, the ground water flow regime and hydraulic interconnections, and extent and magnitude of site-related ground water contamination in the aquifers beneath the site, single-well pump tests should also be conducted for the Cedar Mountain wells to evaluate the dual-porosity characteristics of this bedrock aquifer. In addition, a multi-well pump test should be conducted on well 0181 using the other bedrock wells as observation wells. These permeability tests will complement fracture survey data, improve the understanding of fracture flow in the bedrock aquifer, and possible help resolve the anomalous nitrate trend observed in well 0172.

<u>Comment Status</u>. As discussed in Section 4.2, Hydrogeologic Investigation, and explained in detail in Appendix F, aquifer pump tests were performed on the middle sandstone unit of the Cedar Mountain Formation in July 2002. Monitoring well 0181 served as the pumping well and monitoring wells 0171, 0172, 0173, 0174, and 0181 were utilized as observation wells. As indicated in Appendix F, Aquifer Pumping Test Calculation, the drawdown data indicates a dual porosity aquifer. As a result, all data were analyzed using the Moench Method for a fractured, dual porosity medium. Therefore, this comment has been addressed.

8. <u>Include Bedrock Aquifer Core Data</u>. A field survey of fracture patterns will be undertaken as described in Section 7.2.4 of the SOWP. Analysis of core samples from saturated zones of the Cedar Mountain Formation *in proposed wells 0182, 0183, 0183, and 0184 could supplement this surface survey by providing data on fracture density and aperture sizes. Please consider collecting core samples from the bedrock aquifer wells in the additional investigation.*

Comment Status. As indicated in section 4.1, Monitor Well Installation, the Rotasonic drilling method achieved excellent sample recovery during the June 2002 drilling program. Lithologic samples were logged in the field and fracture information was included in the boring logs. In addition, representative samples from selected bedrock wells were collected and archived. Therefore, this comment has been addressed.

9. Sample Ground Water Baseflow at Mouth of Browns Wash. As indicated above, the potential exists for contaminants from the uranium mill tailings to be discharged into the Green River at the mouth of Browns Wash. As pointed out in Section 5.2.3.1 of the Draft SOWP, the mouth of Browns Wash is a backwater area of the Green River because of the presence of water during most of the year. Although surface water samples have been collected at location 0526 about 600 feet upstream, no surface water or ground water baseflow samples have been collected at the mouth of Browns Wash and its ecological significance as an aquatic community was not addressed in the BLRA. Similar to the Moab site, there is a potential concern regarding potential toxic effects of E-COPCs such as ammonia on endangered fish species in the Green River. Therefore, the mouth of Browns Wash is a potential area of concern that should be included in the plan for additional investigation. Surface and ground water samples should be collected at the mouth of Browns Wash for analysis of E-COPCs including ammonia. For comparison with State surface water standards, ammonia as N should be used.

Comment Status. During July 2002 field investigation, ground water baseflow from the alluvial aquifer discharging into the mouth of Browns Wash was not sampled for ammonia as requested by the DRC. Although surface sample 0846 was collected at the confluence of Browns Wash and the Green River, and surface sample 0847 was collected about 300 feet upstream of the confluence on Browns Wash, ammonia was inadvertently omitted as an analyte. Based on the data in Appendix E, the most recent ammonium surface water analysis was collected at location 0526 in January 1992 and had a concentration of 3.5 mg/l. However, this sample location is not representative of the mouth of Browns Wash. As speculated by DOE in the Final SOWP, it is possible that unionized ammonia has largely been oxidized to nitrate based on elevated nitrate concentrations and relatively low ammonium concentrations at the site. However, without valid surface water or ground water baseflow sample results to confirm this speculation, ammonia concentrations at the mouth of Browns Wash remain an unanalyzed condition and an open issue.

10. Clarify Endangered Wildlife Species. To supplement the information that was provided in Section 5.2.3.1 of the SOWP, I spoke with Bruce Wadell at the U.S. Fish and Wildlife Service. He stated that the Colorado pikeminnow, razorback sucker, and possibly the humpback chub and bonytail chub occur in the Green River near the site. Please contact him at 801-975-3337, Ext. 125 for clarification on endangered species.

Comment Status. Based on Section 6.2.2.1 of the Final SOWP, the DRC cannot determine whether the U.S. Fish and Wildlife Service was consulted for clarification of endangered species in the Green River.

11. Alternate Concentration Limits (ACLs) vs. Supplemental Standards. In the Draft SOWP, DOE has proposed two possible compliance strategies: 1) ACLs for the Cedar Mountain Formation and the Browns Wash alluvial aquifer; and 2) ACLs for the Cedar Mountain Formation, and Supplemental Standards for the

Browns Wash alluvial aquifer. In addition, institutional controls would be implemented in conjunction with either strategy.

Based on DRC staff interpretation of the localized flow system model, geochemical data provided in the SOWP, and the apparent hydraulic interconnection between ground water in the Cedar Mountain Formation, the Browns Wash alluvium, and the Green River, DRC staff can not accept proposal 2. However, we agree that proposal 1 is a viable compliance strategy to pursue. Primarily because supplemental standards, unlike ACLs (EPA 192.02 c.3.ii.B), do not consider potential adverse effects on hydraulically connected surface water quality. To effectively apply ACLs, one appropriate POE may be at the mouth of Browns Wash where ground water baseflow discharges to the Green River.

Comment Status. As indicated in comment 11 above, the DRC was concerned that a supplemental standards strategy would not address surface water concerns associated with the mouth of Browns Wash. However, based on the monitoring plan proposed for the alternate concentration limit (ACL) compliance strategy for the Cedar Mountain Formation, surface water concerns should be sufficiently addressed. As indicated below in the DRC comments for the Final SOWP, the ground water flow system must be understood before POCs and POEs can be established for an ACL compliance strategy.

DRC Comments on the September 2002 Final SOWP

The following comments apply to the Final SOWP received by the DRC on October 1, 2002.

Geologic Cross Sections. The geologic cross sections in Figures 5-4 and 5-5 of the Final SOWP are too generalized to depict the complex subsurface hydrostratigraphy of the Green River site. Without detailed cross sections showing boring log correlations of sandstone aquifers, facies changes between wells, and water levels in wells with respect to the top of the aquifer, it was difficult to understand the hydrogeologic system at the Green River site. In order to review the Final SOWP, DRC staff constructed structural cross sections of the subsurface geology using boring logs.

Hydraulic Gradient of Cedar Mountain Middle Sandstone Unit. Point of compliance (POC) and point of exposure (POE) locations are critical monitoring points in characterizing the site hydrogeology and must be carefully considered in the review of an ACL compliance strategy. The POC should be located within a vertical surface representing the intersection of the downgradient edge of the disposal cell with the uppermost aquifer. It has been established that the uppermost aquifers at the Green River site are the Browns Wash alluvium north and west of the site, and the middle sandstone unit of the Cedar Mountain Formation beneath and downgradient of the site. The POE is defined as the location where humans, wildlife, or other environmental species could reasonably be exposed to hazardous constituents from contaminated ground water, and should be located at the downgradient edge of the property boundary. Therefore, an adequate characterization of the hydraulic gradient of the Cedar Mountain middle sandstone aquifer is critical for establishing POC and POE locations for an ACL compliance strategy. However, after reviewing the Final SOWP, there is still uncertainty regarding the hydraulic gradient and ground water flow direction of the Cedar Mountain middle sandstone unit. Based on available information, there are two possible interpretations for the Cedar Mountain middle sandstone flow system: 1) a northwest hydraulic gradient towards Browns Wash and the Green River regional discharge, or 2) a southwest hydraulic gradient towards the Green River regional discharge.

Northwest Hydraulic Gradient. After constructing a series of cross sections and correlating the sandstone units beneath the site, DRC staff constructed a map of the potentiometric surface for the middle sandstone unit of the Cedar Mountain Formation (Attachment 1). The data used for this map are summarized in Table 1 below with other hydrogeologic data.

TABLE 1
Hydrogeologic Data of the Cedar Mountain Middle Sandstone Unit

Well	July 2002 Head Elevation (feet amsl)	Top of Aquifer Elevation (feet amsl)	Sandstone Thickness (feet)	Aquifer Hydraulic Condition
171	4080.49	4073.50	21	Confined
172	4080.90	4063.90	17	Confined
173	4080.68	4052.50	13	Confined
174	4080.46	4065.60	9	Confined
175	4080.75	4085.50	32.5	Unconfined
176	4081.31	4081.60	21	Unconfined
177	Dry	4119.00	20	Dry
179	4080.79	4113.70	40	Unconfined
180	4100.83	4079.20	12	Confined
181	4080.45	4060.00	12.5	Confined
182	Dry	4043.75	9	Dry
183	4081.40	4030.00	19	Confined
184	Dry	4143.80	24	Dry
185	Dry	4124.00	24	Dry
562	Plugged 1988	4063.20	10	Confined
586	Dry	4109.30	35	Dry
587	Dry	4110.80	37	Dry
807	Plugged 1989	4073.20	32	Confined
813	Not Measured	4071.40	27	Confined
814	Plugged	4091.00	8	Dry
815	Plugged 1989	3978.40	4	Confined
817	4084.61	3983.10	40	Confined
818	Dry	4112.00	13.5	Dry
819	Dry	3982.50	11	Dry

amsl above mean sea level

The hydraulic gradient in Attachment 1 is consistent with the hydraulic gradient provided by the DRC in 1996 (Attachment 2). Both DRC maps include well 0180 as a data point and show an overall northwestward flow direction with a relatively flat hydraulic gradient in the vicinity of the disposal cell and a steep gradient east of the disposal cell. It is interesting to note that the hydraulic head in well 0180 has changed very little in seven years from a value of 4100.95 feet amsl in June 1995 to a value of 4100.83 in July 2002. Geologic cross sections and boring log correlations indicate that the well screens in monitoring wells 0177 and 0178 are completed in a different sandstone aquifer, referred to by DOE as lenticular stringer sandstones of the lower unit of the Cedar Mountain Formation. Based on lithologic descriptions, stratigraphic position, and geochemical signatures, the DRC concurs that the lower Cedar Mountain stringer sandstone aquifer is hydraulically connected with the Cedar Mountain basal sandstone unit, but hydraulically separated from the Cedar Mountain middle sandstone unit. As a result, water levels for wells 0177 and 0178 were not included in the July 2002 potentiometric surface of the Cedar Mountain middle sandstone unit (Attachment 1).

The northwest hydraulic gradient depicted in Attachment 1 is supported by fracture and joint patterns at the Green River site and the structural dip of the middle sandstone unit. Figure 5-6 of the Final SOWP indicates a predominant northwest orientation of fractures and joints at the Green River site, which supports a northwest groundwater flow direction. In addition, a structure contour map constructed on top of the middle sandstone unit indicates a northern structural gradient with a slight northwest dip component in the vicinity of the disposal cell (Attachment 4). The combination of a northern structural gradient with a northwest fracture orientation is consistent with the northwest hydraulic gradient in Attachment 1.

<u>Southwest Hydraulic Gradient</u>. Figure 5-9 of the Final SOWP depicts a southwest hydraulic gradient towards the Green River regional discharge area. The difference between the potentiometric surface depicted in DRC Attachment 1 and Figure 5-9 of the Final SOWP is caused by the presence or absence of the head measurement in well 0180. The DRC map in Attachment 1 includes the head elevation in well 0180 while Figure 5-9 of the Final SOWP does not. By removing the head measurement of well 0180 from the data set, DRC staff replicated the potentiometric surface in Figure 5-9 of the Final SOWP (Attachment 3). However, correlations of boring logs in DRC cross sections show that the middle sandstone unit of the Cedar Mountain Formation is present in well 0180 from 4079.20 and 4067.20 feet elevation above mean sea level (amsl). This sandstone correlates with the sandstone present from 4113.70 to 4073.70 feet amsl in well 0179 to the southwest, and the sandstone present from 4030.00 and 4011.00 feet amsl in well 0183.to the northeast. Because wells 0179, 0180, and 0183 are all completed in the middle sandstone unit of the Cedar Mountain Formation, the water level elevation measured in well 0180 should be included in the potentiometric surface map for the middle sandstone unit of the Cedar Mountain Formation.

<u>Hydraulic Gradient Implications for an ACL Compliance Strategy</u>. As stated above, an adequate characterization of the hydraulic gradient of the Cedar Mountain middle sandstone unit is critical for establishing POCs and POEs for an ACL compliance strategy. If the hydraulic gradient is to the southwest as indicated in Figure 5-9 of the Final SOWP, the proposed POC wells are inappropriate because they are located crossgradient of the disposal cell. In addition, there are no monitoring wells completed in the Cedar Mountain middle sandstone unit that are appropriately located to serve as a POE well for a southwest hydraulic gradient. Consequently, DOE will need to install new POC wells immediately downgradient of the disposal cell (southwest side), and a POE well will need to be installed near the downgradient edge of the property boundary.

If the hydraulic gradient is to the northwest as indicated by DRC Attachment 1, proposed POC wells 0171, 0173, 0181, and 0813 are adequate locations for monitoring ACLs for the Cedar Mountain middle sandstone unit. Although proposed POE well 0182 is in an appropriate location for a northwest hydraulic gradient, this well is screened across the basal sandstone unit of the Cedar Mountain Formation, not the middle sandstone unit. Because the basal sandstone unit of the Cedar Mountain Formation has a strong upward hydraulic gradient and is hydrogeologically isolated from the middle sandstone unit, it has not been contaminated by site-related activities. As a result, well 0182 cannot serve as a POE well for the Cedar Mountain middle sandstone unit. Therefore, a POE well needs to be installed near the downgradient edge of the State property boundary with a screened interval across the middle sandstone unit of the Cedar Mountain Formation.

Major Ion Geochemistry. The trilinear Piper diagram in Figure 5-15 summarizes major ion chemistry for the Mancos Shale, Dakota Sandstone, the Cedar Mountain Formation upper unit and the Cedar Mountain middle sandstone unit. However, one cannot compare and contrast the geochemical signatures of four hydrostratigraphic units if they are included together on the same Piper diagram without a legend. Although there is some overlap of well screens across formation boundaries, wells should be grouped by the aquifer they are completed in and a separate Piper diagram should be made for each aquifer. To the extent possible, please group the wells according to the aquifer they are completed in and prepare separate Piper diagrams for each aquifer. At the very least, all wells completed in the Cedar Mountain middle sandstone aquifer should be grouped together on one Piper diagram to compare against the Cedar Mountain lower and basal sandstone aquifers.

Summary and Conclusions

Browns Wash Alluvium. Based on the limited yield and poor water quality of the Browns Wash alluvium, the application of supplemental standards is an acceptable compliance strategy for this alluvial aquifer. However, the DRC concurs with DOE that the main monitoring concern is to assure that contaminated ground water is not adversely affecting surface water habitats near the mouth of Browns Wash and in the Green River. During the 2002 additional investigation, ground water baseflow discharge or surface water at the mouth of Browns Wash was not analyzed for ammonia as requested by the DRC. As a result, ammonia concentrations in surface water at the mouth of Browns Wash remain an unanalyzed condition and an open issue.

Cedar Mountain Formation. Uncertainty associated with the hydraulic gradient and ground water flow directions of the Cedar Mountain middle sandstone unit make it difficult to establish appropriate POC and POE well locations for the proposed ACL ground water compliance strategy. In addition, there are no appropriate POE wells available for an ACL strategy for the Cedar Mountain middle sandstone unit for a southwest or northwest hydraulic gradient. Therefore, additional wells will need to be installed to resolve the hydraulic gradient and ground water flow directions, establish appropriate POC wells, and provide an appropriate POE well for the Cedar Mountain Formation middle sandstone unit.

We appreciate the opportunity to participate in the ground water compliance strategy for the Green River, Utah UMTRA Site. If you have any questions or comments regarding this letter, please contact Rob Herbert at 801-536-4250.

Sincerely,

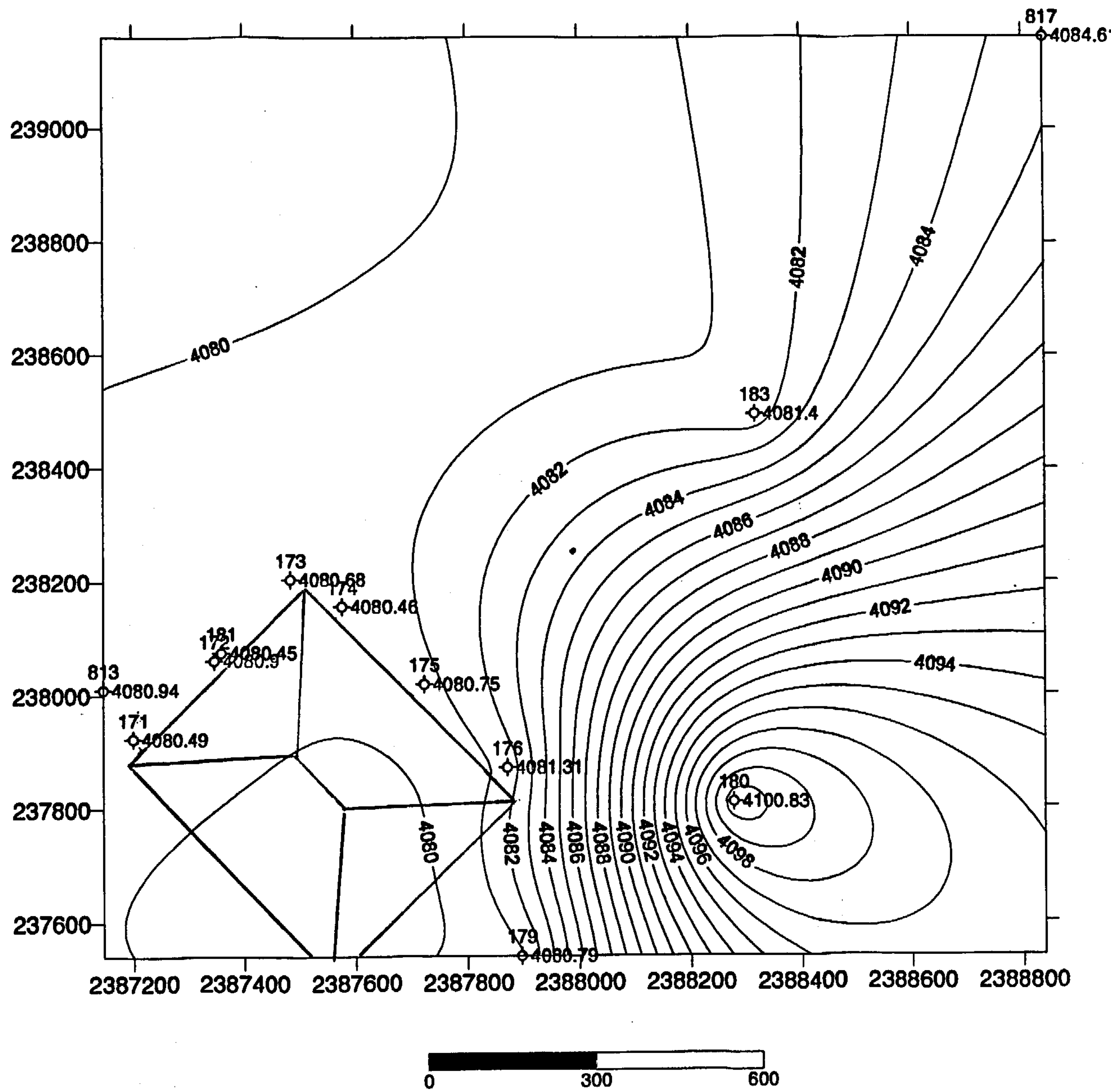
William J. Sinclair, Director
Division of Radiation Control

Attachments

Cc: Mike Layton, NRC –Washington, D.C.

Attachment 1

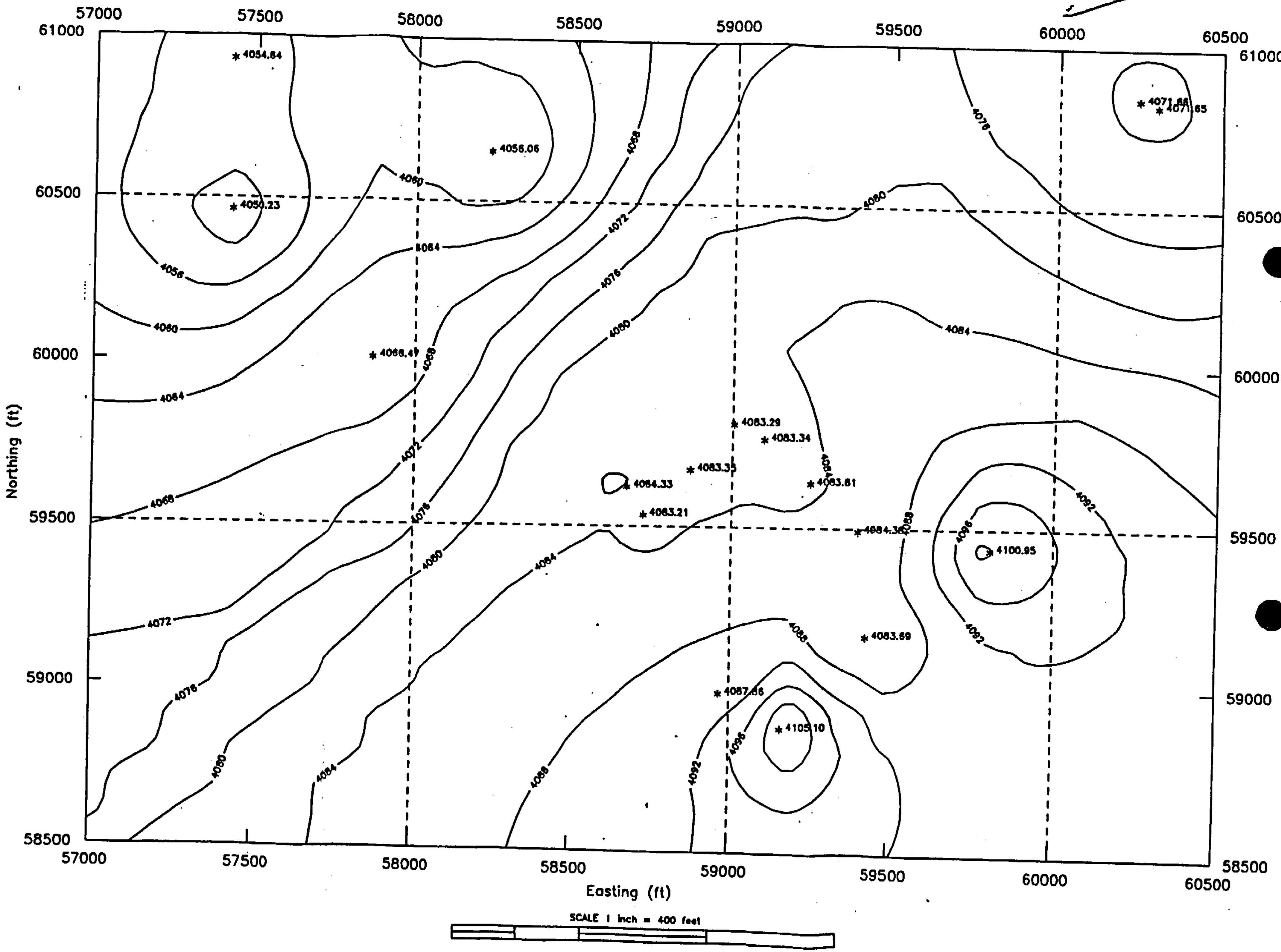
July 2002 Potentiometric Surface of Cedar Mountain Middle Sandstone Unit including water level in well 180 Green River UMTRA Site



Attachment 2

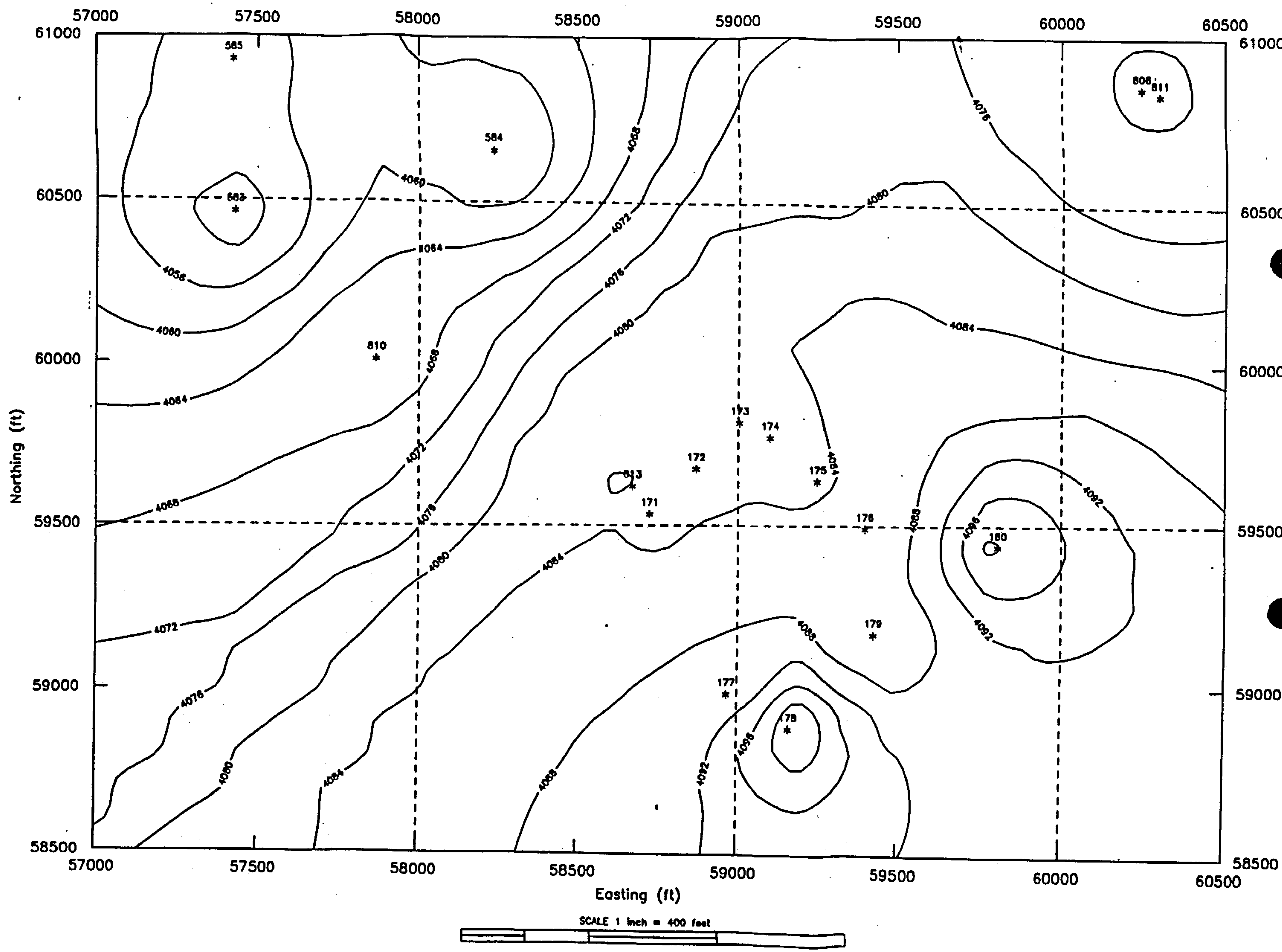
Green River UMTRA: Shallow Bedrock Aquifer Equipotential Map, ft-amsl (6/95)

Head Values



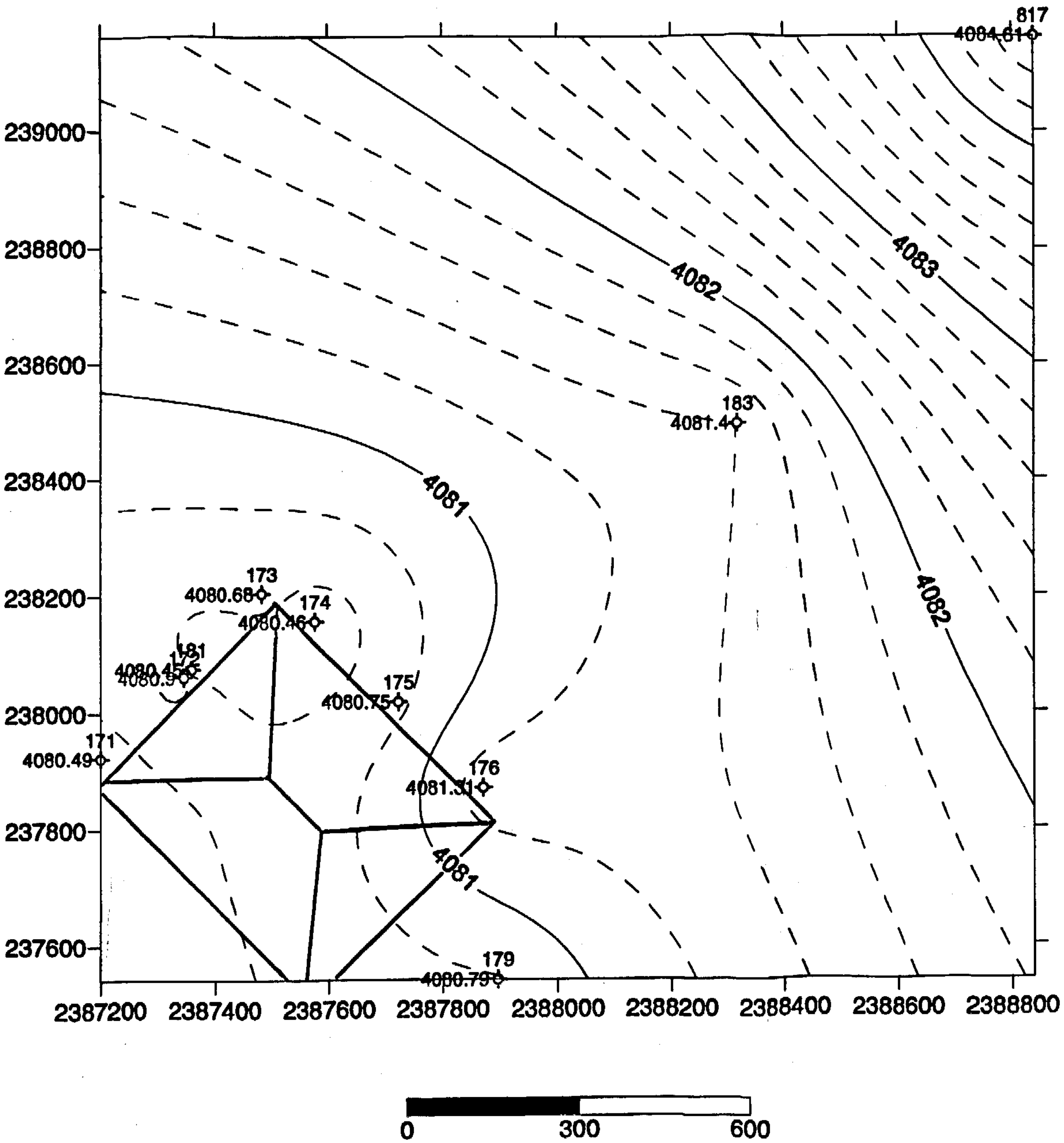
Well ID's

Green River UMTRA: Shallow Bedrock Aquifer Equipotential Map, ft-amsl (6/95)



Attachment 3

July 2002 Potentiometric Surface of Cedar Mountain Middle Sandstone Unit excluding water level in well 180 Green River UMTRA Site



Attachment 4

Top of Structure of Cedar Mountain Middle Sandstone Unit