DRINKING WATER SOURCE PROTECTION PLAN
HUMMINGBIRD WELL
TOWN OF SPRINGDALE WATER SYSTEM
SPRINGDALE, UTAH

December 2010

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EXECUTIVE SUMMARY

This Drinking Water Source Protection (DWSP) Plan has been prepared for the Town of Springdale Water System (System No. 27017) for Hummingbird Well to comply with the Utah Administrative Code R309 – 600 entitled *Source Protection: Drinking Water Source Protection for Groundwater Water Sources* (Utah DWSP Rule).

A delineation report was developed to provide the Town of Springdale Water System with a map that delineated the four DWSP zones required by the relative Utah DWSP Rule for the groundwater management purposes. The producing aquifer of the well was classified as a protected aquifer. An inventory of existing potential contamination sources (PCSs) has been completed. The identification and assessment of current controls have been developed for the existing PCSs. A management programs for the existing PCSs and a management program to control or prohibit any future PCSs to be located within the protection zones of the well have been prepared.

This report also includes an implementation schedule, a resource evaluation, a recordkeeping section, a contingency plan, a public notification, and a section regarding the pesticide and volatile organic chemical (VOC) monitoring waivers.

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1.0 INTRODUCTION

This Drinking Water Source Protection (DWSP) Plan report for Hummingbird Well in the Town of Springdale Water System was prepared in compliance with the Utah Drinking Water Rule R309 – 600, *Source Protection: Drinking Water Source Protection for Ground-Water Sources*. According to the of State of Utah Division Drinking Water, or Utah DDW, a DWSP plan for a single water source should include a delineation report, an inventory of potential contamination sources, an assessment of potential contamination source hazards, a management program for existing potential contamination sources, a management program for future potential contamination sources, an implementation schedule, a resource evaluation, a recordkeeping section and a optional section regarding pesticide and volatile organic chemical (VOC) monitoring waivers (Utah DDW, 2008). A contingency plan and a public notification plan are required for an entire water system.

1.1 System Information

System Name	Town of Springdale Water System
System Number	27017
System Type	Existing Public Community
Address	Town of Springdale 118 Lion Boulevard Springdale, Utah 84767

1.2 Source Information

Hummingbird Well is located on the west bank of the North Fork of the Virgin River in Springdale (**Figure 1**). The source information is summarized as follows:

Source Name and Number	Hummingbird Well, WS002
Water Right Number	81-585
Point of Diversion	N 711 feet E 1944 feet from W4 Corner of Section 28,

	Township 41 S, Range 10 W, Salt Lake Base and Meridian
Source Type	Well, existing source, active

1.3 Designated Person

Name and Title	Robby Totten, Public Works Superintendent
Address	118 Lion Boulevard Springdale, Utah 84767
Phone	(435) 772-3434 (Office) (435) 619-8496 (Cell)

2.0 DELINEATION REPORT

Two procedures to delineate source protection areas are described in the DWSP Rule R309-600: the preferred delineation procedure and the optional two-mile radius delineation procedure. In this study, the preferred delineation procedure was applied in the delineation of the following four protection zones for the groundwater management purposes:

1. Zone 1 is called the **accident prevention zone**, consisting of an area within a 100-foot radius from the wellhead or margin of the spring collection area. No future pollution sources will be allowed to be located in this area.

2. Zone 2 is called the **attenuation zone**, comprising an area within a 250-day groundwater time of travel (TOT) to the wellhead or margin of the spring collection area. The public water system (PWS) should prohibit the future location of pollution sources within zone two, unless the potential pollution source agrees to implement design or operating standards which prevent discharges to the groundwater.

3. Zone 3 is called the **waiver criteria zone**, comprising an area within a 3-year groundwater TOT to the wellhead or margin of the spring collection area. This zone was established to match the source monitoring waiver reevaluation period of 3 years. The waiver was designed for analysis of water samples collected from the drinking water source for VOCs and pesticides. Waivers for these two parameter groups can be issued to systems that delineate protection zones and list the potential contamination sources within these zones. Since waivers are reevaluated every three years, systems should delineate a 3-year groundwater TOT protection area around their sources on which to base their waiver.

4. Zone 4 is called the **remedial action zone**, comprising an area within a 15-year groundwater TOT to the wellhead or margin of the spring collection area. Its purpose is to provide protection to the drinking water source and to afford sufficient time for remediation or developing a new source in case of a contamination incident.

The following sections discuss the geology and aquifer characteristics, well construction data, and hydrogeologic methods and present the delineation calculations.

2.1 Geologic Data

The geology and hydrogeology around and in the vicinity of Springdale were previously addressed by several sources, including Doelling, et al (2002), Willis et al (2002), Doelling and Davis (1989), and Utah Board of Water Resources (1993).

2.1.1 General Topography

The general area around Springdale is located within the Colorado Plateaus physiographic province near its western margin. The province consists of a series of plateaus, mesas, and buttes which reflect the geologic units and their structures. Interrupting the horizontal or gently dipping strata are major faults, monoclinal folds, and groups of anticlines and synclines, domes and basins. Streams have eroded deep canyons or precipitous escarpments in many areas. General altitudes drop from north to south in this area. A series of high plateaus mark the western boundary of the Colorado Plateaus in Utah. Zion National Park is near the western edge of the Grand Staircase, which starts at the Grand Canyon in Arizona and "stair-steps" northward to the high plateaus of southern Utah.

The largest water producing area is around the headwaters of the North Fork of the Virgin River and its tributaries. Hummingbird Well is far downstream of this area. Following the topography of the drainage basin, the North Fork of the Virgin River drains southwesterly and is confluent with the East Fork of the Virgin River 1.5 miles south/southwest of Springdale.

2.1.2 Local Geological Setting and Groundwater Resources

A portion of the geologic map including the study area is shown in **Figure 2**, which is modified from the Interim Geologic Maps of the Springdale East and Springdale West Quadrangles (Doelling, et al, 2002, and Willis, et al, 2002). A copy of the associated descriptions of geologic map units is attached in **Appendix A**. The Town of Springdale and its surrounding areas are dominated by various sedimentary rocks and recent mass-movements and related deposits. Exposed geological units in this area range from the Triassic to Quaternary in age.

In this area, bedding of the geologic formations is fairly flat and no faults, folds, anticlines, synclines, and monoclines are shown on the map. Landslides or slump scarps can be seen in several locations.

Groundwater supplies come from both the unconsolidated and consolidated aquifers. Natural recharge to the groundwater in Virgin River area is mostly by infiltration of precipitation as well as seepage from the streams passing over recharge areas of the aquifer outcrops. Most of the springs receive their supply from deep percolation of precipitation that falls on adjacent higher areas within the local watershed. The Navajo Sandstone (Jn) is the principle aquifer in southern Utah. Navajo Sandstone is massive, cliff-forming, cross-bedded, locally highly jointed sandstone, as thick as 2,200 feet and forms cliffs, deep canyons, and impressive spires, promontories, and monoliths. Shallower aquifers exist in unconsolidated alluvial fan, colluvial, mass-movement and related deposits. These deposits are generally poorly sorted clay, silt, sand, gravel, and locally rock-fall blocks and boulders. Water in Hummingbird Well is likely from the young alluvial fan and colluvial deposits (Qafc).

2.1.3 Well Log

Hummingbird Well was drilled and constructed by Boyd Bradshaw Well Drilling Company using cable tool in February, 1971. The driller's report (well log) for the well is included in **Appendix B**. Materials encountered during the well drilling are summarized in **Table 1**.

Table 1. Materials Encountered during Drilling

Depth below Ground Surface (ft)		Description
From	To	
0	10	Sandy loom
10	38	Sand, gravel
38	68	Gravel
68	70	Clay, gravel
70	84	Gravel
84	100	Clay

The well was drilled through some unconsolidated materials/deposits, mainly sand, gravel and clay. The depth of the completed well is 100 feet. A 16 inch diameter steel well casing was installed from the ground surface to the bottom of the well. The casing was perforated from 73 to 83 feet below ground surface (BGS). Neither gravel pack nor surface seal was placed in between the borehole and the casing.

2.2 Well Construction Data

Based on the information obtained from the well log, a summary of the well construction data is presented in **Table 2**.

Table 2. Well Construction Data Summary

Well completion date	February 26, 1971
Well driller's log	**Appendix B**
Elevation of wellhead	3,940 feet (estimated) above mean sea level (MSL)
Well diameter	16 inches
Total depth of completed well	100 feet
Length of screened or perforated intervals	10 feet
Screened or perforated depths	73-83 feet BGS
Grouting depth/surface seal	No
Depth to static water level	26 feet BGS (February 26, 1971)
Method of drilling	Cable tool
Casing type	Weld steel
Current maximum pumping rate	148 gpm (water right)
Maximum projected pumping rate	148 gpm
Maximum well yield	N/A
Pump type	Submersible
Installation depth of pump	N/A

2.3 Aquifer Data Summary

As required by *Utah DWSP for Ground Water Sources Rule R309-600*, this section summarizes the saturated thickness of the producing aquifer (water bearing unit), hydraulic conductivity/ transmissivity, assumed effective porosity, and direction and hydraulic gradient of groundwater flow.

2.3.1 Saturated Thickness of the Producing Aquifer

The well log showed that the thickness of the gravel layer at the perforated section is 14 feet. Therefore, the saturated thickness of the producing aquifer was assumed to be 14 feet. The assumption is conservative. It is very possible that the producing aquifer is thicker than 14 feet since a gravel/clay layer, another gravel layer and a sand/gravel layer are located above the perforated section.

2.3.2 Aquifer Test - Hydraulic Conductivity/Transmissivity

No pumping test was performed during and after the well drilling. The current condition of the well is not suitable for a pumping test because the water surface in the well cannot be measured.

A test well is located approximately 4,000 feet southeast of Hummingbird Well. A 30-hour constant rate pumping test was conducted in the test well by the well driller. The geologic conditions shown in **Figure 2** and the formation materials recorded in the well log (**Appendix B**) indicate that this well was installed in the same formation as Hummingbird Well. Therefore, the pumping test data obtained from the test well was used to analyze the aquifer characteristics. **Table 3** presents the available pumping test information.

Table 3. Pumping Test Data

Wellhead elevation	4,000 feet above MSL (estimated)
Pre-pumping water level	128 feet BGS
Constant pumping rate	60 gpm
Time-drawdown data	N/A
Total drawdown in pumped well	75 feet
Duration of drawdown test	30 hours
Recovery test?	No

Aquifer transmissivity was estimated by using a simplified well equation (Heath, 1983):

$$T = 308\,Q / s \qquad (1)$$

where, T is the transmissivity (feet^2/day), Q is the pumping rate (gpm), and s is the drawdown (feet). For the test well pumping test, Q = 60 gpm, s = 75 feet, and T is calculated to be 246.4 feet^2/day using Equation 1.

T value varies from well to well. To estimate the T value for Hummingbird Well, the hydraulic conductivity of the aquifer should be calculated first. The relationship between the transmissivity and the hydraulic conductivity is as follows:

$$K = T / B \qquad (2)$$

where, K is the aquifer hydraulic conductivity (feet/day), and B is the saturated thickness of the aquifer (feet). For test well, T = 246.4 feet^2/day, B = 93 feet (estimated based on the well log), and

K is calculated to be 2.65 feet/day using Equation 2. Conservatively, a higher *K* value of 5 feet/day was used in this delineation report. For Hummingbird Well, *B* = 14 feet, *K* = 5 feet/day, and *T* is calculated to be 70 feet^2/day using Equation 2.

2.3.3 Direction of Groundwater Flow and Hydraulic Gradient

Groundwater data are not available to accurately determine the direction of groundwater flow and hydraulic gradient in the vicinity of Hummingbird Well. Generally, if the topographic and groundwater divides coincide, the direction of groundwater flow follows the topographic slope and surface runoff direction. For the purpose of TOT zone delineation, it is assumed that the direction of regional groundwater movement follows the local drainage basin from northwest to southeast. The local groundwater flow moves along the Blacks Canyon from northwest toward the well with an ambient angle of S69°E.

Because no groundwater elevation contour maps covering the area in the vicinity of the well have been reported, the hydraulic gradient cannot be accurately calculated. It was assumed that the general groundwater gradient in this area is equal to the bed slope of Blacks Canyon. This assumption is conservative because the gradient of groundwater flow is typically flatter than the surface gradient in the same area. Along the canyon, as shown in **Figure 1**, the horizontal distance is 6,500 feet between the contours of 3,960 and 4,600 feet. Therefore, the hydraulic gradient in the vicinity of the well was estimated to be 0.0985 (= (4,600 – 3,960)/6,500).

2.3.4 Assumed Porosity

As described in Sections **2.1.2** and **2.1.3**, the aquifer lies within some unconsolidated deposits composed of sand and gravel. According to Freeze and Cherry (1979), the porosity for unconsolidated deposits ranges from 0.25 to 0.70. Representative porosity values for coarse to fine unconsolidated deposits range from 0.28 to 0.34 (Driscoll, 1995). Conservatively, an effective porosity value of 0.20 was used in the delineation calculations.

2.4 Hydrogeologic Methods and Delineation of DWSP Zones

There are several methods to delineate the DWSP zone boundaries. A two-dimensional semi-analytical flow model, WHPA, which can offer reasonable accuracy at the least cost, was used in this study. This approach is accepted by the Utah DDW if the model is applicable to the hydrogeologic setting of interest.

Groundwater moving in an unconsolidated deposit aquifer can be treated as a porous medium flow. In a porous medium, groundwater movement is governed by Darcy's Law

$$v = Q / A = K i \quad (2)$$

where v is specific discharge (ft/day), Q is discharge rate (ft^3/day), A is area of cross-section (ft^2), and i is hydraulic gradient (ft/ft).

The average linear velocity v_a through the portion occupied by voids in a porous medium is given by

$$v_a = v / n \quad (3)$$

where n is porosity of the material composing the porous medium.

Conceptually, calculation of the TOT boundary can be simplified based on

$$d = v_a t \quad (4)$$

where d is the radial distance from the well to the TOT boundary line, and t is the given time of travel (e.g. 250 days, 3 years or 15 years).

The particle tracking method is often used for delineating the DWSP zones. Time related capture zones are delineated by placing a series of water particles at sequential locations along the perimeter of a small circle representing the well boundary. Individual path-lines for each of these particles are then traced using reverse tracking. The capture zone consists of the entire region enclosed by the delineated path-lines. This method is used in WHPA.

2.4.1 Delineation of DWSP Zone 1

The accident prevention zone (DWSP Zone 1) for Hummingbird Well is set at an arbitrary fixed radius of 100 feet from the wellhead. Due to the scale of the topographic map, Zone 1 is too small to be accurately depicted on the map showing the protection area.

2.4.2 Delineation of DWSP Zones 2, 3, and 4

The delineation of the DWSP zone (TOT zone) boundaries within unconsolidated deposit aquifer was performed through particle tracking as computed using the semi-analytical model WHPA, which was developed by the EPA (Blandford and Huyakorn 1991), and later modified by the International Ground Water Modeling Center in 1993. WHPA modeling is based on the Darcy's law (Equation 3) that applies to porous medium flows – groundwater flows in a porous medium such as an unconsolidated deposit aquifer (Freeze and Cherry, 1979). Four modules, each with different capabilities, are available within the WHPA model. The GPTRAC module was chosen for the well site simulation because of its ability to delineate time-related capture zones while accounting for the potential effects of well interference from nearby wells.

Input parameters required by WHPA include: well location(s), transmissivity, aquifer thickness, effective porosity, regional hydraulic gradient, groundwater flowing direction, time of travel, discharge rate, well radius, and boundary conditions. The primary input parameters of WHPA models for delineating Hummingbird Well DWSP zone boundaries are tabulated in **Table 4**.

Table 4. Parameter Values Used in WHPA Model for DWSP Zones

Model Parameter	Symbol	Unit	Value
Transmissivity	T	$feet^2/day$	70
Aquifer thickness	B	feet	14
Effective porosity	n	dimensionless	0.20
Hydraulic gradient	i	dimensionless	0.048
Angle ambient of flow	--	degree	S69°E (-21°)
Time of travel	t	days	250, 1,095, 5,475
Discharge rate	Q	$feet^3/day$	28,490 (148 gpm)
Well radius	r	feet	0.667 (16 inches)

The model outputs for the calculated 250-day, 3-year and 15-year TOT zones are included in **Appendix C**. These results show that the three TOT zones extend respectively 1,360, 3,980 and 15,590 feet to the northwest direction.

2.4.3 Well Interference Analysis

A water right search was performed within Sections 28, 29, and 32, Township 41 S, Range 10 W. The search results are included in **Appendix D**. There were not any active production wells

identified in the searched area. Therefore, well interference to Hummingbird Well is not anticipated from any wells.

2.5 Map Showing Boundaries of the DWSP Area

The dimensions of Zones 2 through 4 are summarized in **Table 5** and shown in **Figure 1**. Because the up-gradient boundary of the 15-year TOT zone modeled by WHPA extends over the regional watershed boundary – the ridge line of the mountain, this portion of the boundary, as shown in **Figure 1**, was delineated by demarcating the topographic divides on the USGS map. The WHPA model output also shows that the down-gradient boundary of the TOT zones extend through to the east bank of the North Fork of the Virgin River. A stream is normally considered as a hydraulic boundary for shallow groundwater flow and the spring water is not likely from the east side of the river. Therefore, the down-gradient boundaries for the DWSP zones were delineated along the west bank of the North Fork of the Virgin River. The land on the east bank of the river is included in a DWSP zone that was determined in a surface water DWSP plan (Tetra Tech, Inc., 2003).

Table 5. Dimensions of DWSP Zones

Zone /Description	Delineation Identification	Maximum Length in Down-gradient Direction (ft)	Maximum Length in Up-gradient Direction (ft)	Maximum Width in Cross-gradient Direction (ft)
2 – Attenuation	250-Day TOT	570	1,360	1,780
3 – Waiver criteria	3-Year TOT	570	3,980	3,000
4 – Remedial action	15-Year TOT	570	10,060	3,830

2.6 Protected Aquifer Conditions

According to Utah DWSP for Ground Water Sources Rule 309-600, for an aquifer to be classified as being under protected conditions, the following conditions must be met: (a) a natural protective layer of clay, at least 30 feet in thickness, is present above the aquifer; (b) the public water system provides data to indicate the lateral continuity of the clay layer to the extent of zone two; and (c) the well has been grouted from the ground surface to a depth of at least 100 feet and for a thickness of at least 30 feet through the protective clay layer. Apparently the producing aquifer for Hummingbird Well does not meet the protected aquifer conditions – no 30 foot thick natural protective layer and no surface grouting installed (**Appendix B**, **Tables 1** and **2**). It is an unprotected aquifer.

3.0 INVENTORY OF POTENTIAL CONTAMINATION SOURCES

A checklist of potential contamination sources (PCSs), as listed in Chapter 5 of Source Protection User's Guide prepared by the Utah DDW (Utah DDW, 2008), was completed through review of USGS topographic maps, historic aerial photographs and site inspections, and is attached in **Appendix E**.

3.1 List of Potential Contamination Sources

The delineated DWSP zones for Hummingbird Well cover approximately 1.2 square mile area of the Town and Zion National Park. Identified PCSs are shown in **Figure 1** and summarized in **Table 6**.

Table 6. Summary of PCSs

PCS	Total Number of PCSs	PCSs in Zone 1	PCSs in Zone 2	PCSs in Zone 3	PCSs in Zone 4
City facilities, hotel, restaurants, theaters and tourist shops	9	0	5	3	1
Old gas station (now tourist shop)	1	0	1	0	0
Park	1	0	0	1	0
Clinic	1	0	0	1	0
Residential chemical uses	17	0	15	2	0
Dirt roads	Figure 1	0	Figure 1	Figure 1	Figure 1
State Route 9	1	0	1	1	1
Sewer lines	Figure 1	0	Figure 1	Figure 1	Figure 1
Submersible pump	1	1	0	0	0

3.2 Hazard Identification

3.2.1 City Facilities, Hotels, Restaurants, Theaters and Tourist Shops

The city facilities (one Town Hall, one library and community center) and one hotel are located in Zone 3 (**Figure 1**). Two hotels, one hotel with restaurant, one restaurant with theater and two tourist shops are located along the State Route 9 in Zone 2 as shown in **Figure 1**. The Dixie Amphitheater is in Zone 4. The potential hazards from this type of PCS are similar to those associated with residential chemical uses (See Section **3.2.5**).

3.2.2 Old Gas Station

One old gas station (now tourist shop) is located at the west side of the State Route 9, about 500 feet southwest of the well (**Figure 1**). The potential hazard from the PCS is gasoline and diesel.

3.2.3 Park

One City Park is located at the mouth of Blacks Canyon in Zone 3 (**Figure 1**). The potential hazards associated with the park include improper application of chemical fertilizer and pesticides.

3.2.4 Medical Clinic

One medical clinic is located in Zone 3 (**Figure 1**). Hazardous medical solvents, chemical solutions and other wastes may enter the groundwater system by infiltrating the soil cover of drainage ditch.

3.2.5 Residential Chemical Use

There are 26 residential homes located in Zones 2 and 3 (**Figure 1**). These homes are owned by the Springdale residents. Many hazardous products and chemicals such as cleaners, oils and pesticides may be used in the residential areas. When discarded, these products are called household hazardous waste (HHW). HHW is discarded materials and products that are ignitable, corrosive, reactive, toxic or otherwise listed as hazardous by the EPA. Fertilizers may also be used on lawns and gardens. The main constituent in fertilizer is usually nitrogen. If the nitrate level in drinking water is too high, infants, up to the age of six months, can develop a fatal disease called blue baby syndrome (methemoglobenemia). Drinking water that contains 10 milligrams of nitrate-nitrogen per one liter of water exceeds the drinking water standard and should not be used, especially for infant formula.

3.2.6 Roads

The State Route 9 is a major road that runs through the Town to Zion National Park. Residential dirt roads used for normal traffic are located within DWSP Zones 2 and 3 (**Figure 1**). A dirt road runs from the Town to Blacks Canyon, which is partly in DWSP zones. Potential hazards associated with roads are related to accidental spills and releases of petroleum and chemical products from vehicles traveling on the roads. Potential environmental risks associated with these roads to the well are generally very low.

3.2.7 Sewer Lines

The residential homes and business buildings within the DWSP zones are all connect to the Springdale sewer system. The sewer lines carry waste from residential homes, commercial businesses, churches, schools, and office buildings in this area. The potential hazards include various kinds of household waste.

3.2.8 Submersible Pump Used to Pump Hummingbird Well

Hummingbird Well is equipped with a submersible pump. Submersible pumps may contain such lubricants as petroleum products, PCB or mercury.

3.3 Prioritized Inventory

The PCSs were prioritized in **Table 7** according to the nature of the potential source contaminant, volume of the potential contaminant and distance of the PCS from Hummingbird Well.

1. The submersible pump that is installed in Hummingbird Well is considered the most dangerous PCS. Contaminants can be directly introduced into the drinking water system or groundwater aquifer via this well if the pump is improperly maintained or used.
2. The old gas station in Zone 2 is considered the second most dangerous PCSs because of its nature and it is relatively close to the well.
3. The medical clinic, residential chemical uses, the sewer lines, City Park, city facilities, hotels, restaurants, theaters and tourist shops are considered the third to seventh most dangerous PCSs.
4. The State Route 9 and the dirt roads are considered the least dangerous PCSs.

Table 7. Prioritized Inventory of PCSs

Priority	PCSs	Contact	Address	Phone No.
1	Submersible pump	Rick Wixom	118 Lion Boulevard Springdale, Utah 84767	(435) 772-3434
2	Whiptail Grill	Travis Barney	445 Zion Park Blvd Springdale, Utah 84767	435-772-0283
3	Residential chemical uses	Rick Wixom	118 Lion Boulevard Springdale, Utah 84767	(435) 772-3434
4	Medical clinic	Mike and Helen McMahan	120 Lion Boulevard Springdale, Utah 84767	435-772-3226
5	Sewer lines	Rick Wixom	118 Lion Boulevard Springdale, Utah 84767	(435) 772-3434
6	Park	Rick Wixom	118 Lion Boulevard Springdale, Utah 84767	(435) 772-3434
7	City facilities	Rick Wixom	118 Lion Boulevard Springdale, Utah 84767	(435) 772-3434
7	Cliffrose Lodge and Gardens (Hotel 1)	Colin Dockstader	281 Zion Park Blvd Springdale, Utah 84767	435-772-3234
7	Quality Inn RV and Campground (Hotel 2)	Stewart Ferber	479 Zion Park Blvd Springdale, Utah 84767	435-772-3237
7	Flanigans Inn and Spa/Spotted Dog Café (Hotel and Restaurant)	Larry McKown	450 Zion Park Blvd Springdale, Utah 84767	435-772-3244
7	Zion Canyon Giant Screen Theater (Restaurant and Theater)	Bob Orton	145 Zion Park Blvd Springdale, Utah 84767	435-772-2400
7	Dixie Amphitheater	Rick Wixom	118 Lion Boulevard Springdale, Utah 84767	(435) 772-3434
7	Zion Adventure Co. (Tourist Shop 1)	Jonathan Zambella	36 Lion Boulevard Springdale, Utah 84767	435-772-1001
7	Old Tsunami Building (Tourist Shop 2)	Rene Goodnow	180 Zion Park Blvd Springdale, Utah 84767	801-223-3158
8	State Route 9	Carl Johnson, UDOT Region 4	1345 South 350 West Richfield, Utah 84701	(435) 896-1303
8	Dirt Roads	Rick Wixom	118 Lion Boulevard Springdale, Utah 84767	(435) 772-3434

4.0 ASSESSMENT OF POTENTIAL CONTAMINATION SOURCE HAZARDS

There are four types of hazard controls. They are regulatory, best management and pollution prevention practices (BMPs), physical and negligible quantity controls. Hazards of PCSs identified within the DWSP zones of Hummingbird Well, as described in Section **3.0**, were assessed as following categories.

All the hazard controls related in this section will be reassessed on a three-year basis.

4.1 City Facilities, Hotels, Restaurants, Theaters and Tourist Shops

Best management and pollution prevention practices are applicable to these PCSs. This category of PCSs cannot be considered as adequately controlled.

4.2 Old Gas Station

All the four fuel tanks in the old Texaco Gas Station were removed in 1989 when the station closed. However, they are still included in the Utah State Underground Storage Tank (UST) program. A copy of the related UST List sheet published by Utah Department of Environmental Quality Division of Environmental Response and Remediation is included in **Appendix F**.

Regulatory controls are applicable for the Gas Stations. The Utah Division of Environmental Response and Remediation (DERR) is in charge of enforcement of the following rules:

1. R311-200 through R311-211, UAC – Underground Storage Tank Rules. The Underground Storage Tank Rules protect groundwater resources by preventing and detecting leaks and spills from underground storage tanks. Sites that are contaminated by leaking underground storage tanks must be cleaned up. Also, a fund has been established in the State to make sure that the owners and operators of underground storage tanks can pay for correcting the problems they create if their underground storage tanks leak.
2. Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA commonly called Superfund) - Section 19-6-301 through 19-6-325 of Utah Code Annotated - The Hazardous Substances Mitigation Act authorizes the executive director of the Department of Environmental Quality to regulate hazardous substances releases by making rules consistent with the substantive requirements of CERCLA to establish the requirements for remedial investigation studies and remedial action plans.
3. 40 CFR Part 300 of the Code of Federal Regulations - The National Oil and Hazardous Substances for Pollution Contingency Plan establishes the organizational structure and

specifies the procedures for remediating pollution when oil or hazardous substances are discharged or released into the environment.

4. SARA Title III - 40 CFR Part 355 of the Code of Federal regulations - SARA Title III provides early comprehensive emergency planning for responding to potential releases of toxic chemicals.

Facilities must notify the local emergency planning committee when an "extreme hazardous substance" is present in an amount greater than the appropriate "threshold planning quantity". These facilities are required to prepare or have available a material safety data sheet (MSDS) for each hazardous chemical and submit it to appropriate local emergency planning committee.

This regulation requires public access to information submitted to local emergency planning committees. Each emergency response plan, MSDS, inventory form, toxic chemical release form and follow-up emergency release notification is to be made available to the general public during normal working hours at the location designated for the local emergency planning committee.

This PCS can be considered as adequately controlled through the regulations.

4.3 Park

Best management and pollution prevention practices are applicable to the park. This PAS cannot be considered as adequately controlled.

4.4 Medical Clinic

Negligible quality controls are applicable to this PCS because: 1. the clinic office is very small; 2. this PCS is located within Zone 3; 3. it is connected to the Springdale sewer system; and 4. no hazardous medical solvent and chemical solution have been found using in the clinic. Therefore, this medical clinic can be considered as adequately controlled.

4.5 Residential Chemical Use

Best management and pollution prevention practices are applicable to these PCSs. This category of PCSs cannot be considered as adequately controlled.

4.6 Roads

Regulatory controls are applicable to this category of PCSs. The following regulations are promulgated:

1. Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA commonly called Superfund) – Sections 19-6-301 through 19-6-325 of the Utah Code Annotated – The Hazardous Substances Mitigation Act authorizes the executive director of the Department of Environmental Quality (DEQ) to regulate hazardous substances releases by making rules consistent with the substantive requirements of CERCLA, to establish the requirements for remedial investigation studies and remedial action plans.
2. 40 CFR Part 300 of the Code Federal Regulations – The National Oil and Hazardous Substances Pollution Contingency Plan establishes the organizational structure and specifies the procedures for remediating pollution when oil or hazardous substances are discharged or released into the environment.
3. 40 CFR Part 355 of the Code of Federal Regulations – SARA Title III provides early comprehensive emergency planning for responding to potential releases of toxic chemicals.
4. The U.S. Department of Transportation and the Environmental Protection Agency have established controls and restrictions for transportation of hazardous chemicals.

However, the hazards from accidental spills along the roads cannot be considered as adequately controlled and have been addressed in the Contingency Plan (Section **10.0**).

4.7 Sewer Lines

Physical controls and regulatory controls are applicable to the sewer lines. According to Utah DWSP Rule R309-600, sewer lines that comply with the following criteria may be assessed as adequately controlled contamination sources.

(a) Zone one – If the conditions specified in R309-600-13(3) (i and ii) below are met, all sewer lines within zone one shall be constructed in accordance with R309-204-6(4) and must be at least 10 feet from the wellhead.

   (i) There is at least 5 feet of suitable soil between the bottom of the sewer lines and the top of the maximum seasonal ground-water table or perched water table. (Suitable soils contain adequate sand/silt/clay to act as an effective effluent filter within its depth for the removal of pathogenic organisms and fill the voids between particle such as gravel, cobbles, and angular rock fragments); and

(ii) There is at least 5 feet of suitable soil between the bottom of the sewer lines and the top of any bedrock formations. (For the purposes of this rule, unsuitable soils or bedrock formations shall include soil or bedrock formations that have such low permeability that they prevent downward passage of effluent, or soil or bedrock formations with open joints or solution channels that permit such rapid flow that effluent is not removed. This includes coarse particles such as gravel, cobbles, or angular rock fragments with insufficient soil to fill the voids between the particles. Solid or fractured bedrock such as shale, sandstone, limestone, basalt, or granite are unacceptable.)

(b) Zone One and Two – If the conditions identified in R309-600-13(3)(a) (i and ii) above cannot be met, any sewer lines within zones one and two or a management area shall be constructed in accordance with R309-204-6(4) and must be at least 300 feet from the wellhead or margin of the collection area.

The following information is provided to demonstrate that the two conditions (i and ii) above are met:

As described in Section **2.1**, Hummingbird Well is installed in the young alluvial fan and colluvial deposits (Qafc) consisting mostly of clay, silt, sand and gravel. Qafc is up to 40 feet in thickness. The wellhead is located more than 10 feet from any sewer line and the aquifer (see the well log in **Appendix B**) at least 20 feet below any sewer lines. The "at least 5 feet of suitable soil between the bottom of the sewer lines and the top of the maximum seasonal ground-water table" and "at least 5 feet of suitable soil between the bottom of the sewer lines and the top of any bedrock formations" criteria are complied with. Also, it is understood that all sewer lines in Springdale were constructed in accordance with Utah Rule R309-204-6(4).

Therefore, sewer lines within DWSP zones can be assessed as adequately controlled PCSs.

4.8 Submersible Pump Used to Pump Hummingbird Well

Negligible quantity control is applicable to the submersible pump installed in Hummingbird Well. Should petroleum products, PCB, or mercury be contained in the pumps and released to the groundwater, the quantity is negligible compared to the volume of the pumped water. Therefore, the submersible pump is considered as adequately controlled.

5.0 MANAGEMENT PROGRAM FOR EXISTING POTENTIAL CONTAMINATION SOURCES

The following management programs are prepared for the PCSs that are considered as not adequately controlled.

5.1 City Facilities, Hotels, Restaurants, Theaters and Tourist Shops

The same strategy as that related in Section **5.3** applies to these categories of PCSs.

5.2 Park

The same strategy as that related in Section **5.3** applies to this PCS.

5.3 Residential Chemical Use

The primary management strategy for residential chemical use is ongoing public education. A packet of information including the Household Hazardous Waste Fact Sheet, the Fertilizer Fact Sheet and the Pesticides Fact Sheet (**Appendix G**) prepared by the Utah DDW will be sent to homeowners within the protection zones of Hummingbird Well. The fact sheets include the BMPs for handling HHW and proper use of fertilizers and pesticides.

5.4 Roads

The hazards from accidental spills along the roads have been addressed in the Contingency Plan (Section **10.0**).

6.0 MANAGEMENT PROGRAM FOR FUTURE POTENTIAL CONTAMINATION SOURCES

The land around Hummingbird Well is controlled by Town of Springdale, and no future activities that may cause subsurface contamination will be allowed within this area. The management program for future PCSs within the entire DWSP zone area will involve working with private homeowners, communities and the government agencies because the Town does not have zoning authority for the land within these zones. Portions of the combined DWSP Zones 2, 3, and 4 are located on private lands under the jurisdiction of the Town. Approximately one half of the DWSP area is in Zion National Park managed by the U.S. National Park Service (USNPS).

To control and prohibit future location of PCSs within the DWSP area in Springdale authorities, Town of Springdale will make the residents be aware of, through the Public Notification (Section **12.0**) and the Fact Sheets (Section **5.0** and **Appendix G**), that it is (they are) in a management area of a drinking water source.

To control and prohibit future location of PCSs within the DWSP area in Zion National Park, Town of Springdale will send a copy of the approved DWSP Plan to the USNPS local office. The USNPS can then evaluate more thoroughly proposed land uses that may become pollution sources to Hummingbird Well. It is believed that the USNPS officers understand the importance of protecting groundwater resources and follow the U.S. Public Law 100-4: the Clean Water Act and Utah 1993 Administrative Code R317-6: Administrative Rules for Ground Water Quality Protection, when they review new land development applications. If the Clean Water Act and Rules for Ground Water Quality Protection are followed, any future pollution sources can be controlled or prohibited.

A public notification regarding the DWSP for the Town of Springdale Water System (see Section **12.0**) will be included in the annual Consumer Confidence Report (CCR) and distributed to the public through a news letter and published online: http://www.springdaletown.com.

Furthermore, when a new development is proposed within the DWSP area of Hummingbird Well, the following will happen:

1. The Town will determine the type of the PCS that will accompany that development.
2. If the development is in Zion National Park, the USNPS local office will be made aware that the development is within the management area of a Hummingbird Well.
3. Each PCS will be assessed as controlled or not controlled. Individual homeowners and applicable PCSs will be added to the PCS inventory.

7.0 IMPLEMENTATION SCHEDULE

Once the Utah DDW approves this DWSP Plan, Town of Springdale will: 1. contact and send a copy of the plan to the USNPS local office; and 2. contact and send the Fact Sheets to the homeowners within the DWSP zones. This process may take six months to one year. 3. The public notification will be distributed to the public through a news letter and published online as soon as possible.

8.0 RESOURCE EVALUATION

Town of Springdale will use the existing staff to implement the DWSP plan. Therefore, no extra expense is anticipated. The other cost to implement this DWSP plan is minimal and will be funded from monthly service charges or connection fees.

9.0 RECORDKEEPING

All the records regarding the DWSP Plans will be kept in the Town of Springdale office that is located at 118 Lion Boulevard, Springdale, Utah 84767. Town of Springdale will document changes as the plan is continuously updated to show current conditions in the protection zones. As the plan is executed, Town of Springdale will document the implementation of each management strategy as it is implemented and update the DWSP Plan every six years.

10.0 CONTINGENCY PLAN

A Contingency Plan for the entire water system was prepared and submitted to the Utah DDW concurrently with the submission of the *Updated Drinking Water Source Protection Plan for North Fork of Virgin River* (Sunrise, 2010).

11.0 PESTICIDE AND VOC MONITORING WAIVERS

According to the Utah DDW (Utah DDW, 2008), there are three types of monitoring reduction waivers for either the pesticides or volatile organic chemical (VOC) parameter group available to public water suppliers: reliably and consistently waiver, use waiver and susceptibility waiver.

A use waiver can be issued for either the pesticides or VOC parameter group if a system can verify that none of the chemicals or pesticides in these parameter groups have been used in a given protection area in the past five years. If a source does not qualify for a use waiver, the Utah DDW will evaluate the historical laboratory results of water samples collected from the source and establish an appropriate water quality-monitoring program for VOCs and pesticides. If the laboratory results consistently demonstrate good water quality produced by the source, the Utah DDW may consider issuing a reliably and consistently waiver. If a system does not qualify for a use waiver and a reliably and consistently waiver has not been issued, a susceptibility waiver may be issued if the drinking water source meets the requirements listed in the Chapter 11 of the Source Protection User's Guide (Utah DDW, 2008).

Because residential homes are located within the DWSP zones of Hummingbird Well, VOCs and pesticides may have been used in this area. Therefore, the spring does not qualify for a use waiver. Also, since the historical record shows that the spring has not produced good quality water, the spring does neither qualify for a susceptibility waiver nor a reliably and consistently waiver.

12.0 PUBLIC NOTIFICATION

A Public Notification for the entire water system was prepared and submitted to the Utah DDW concurrently with the submission of the *Updated Drinking Water Source Protection Plan for North Fork of Virgin River* (Sunrise, 2010).

13.0 REFERENCES

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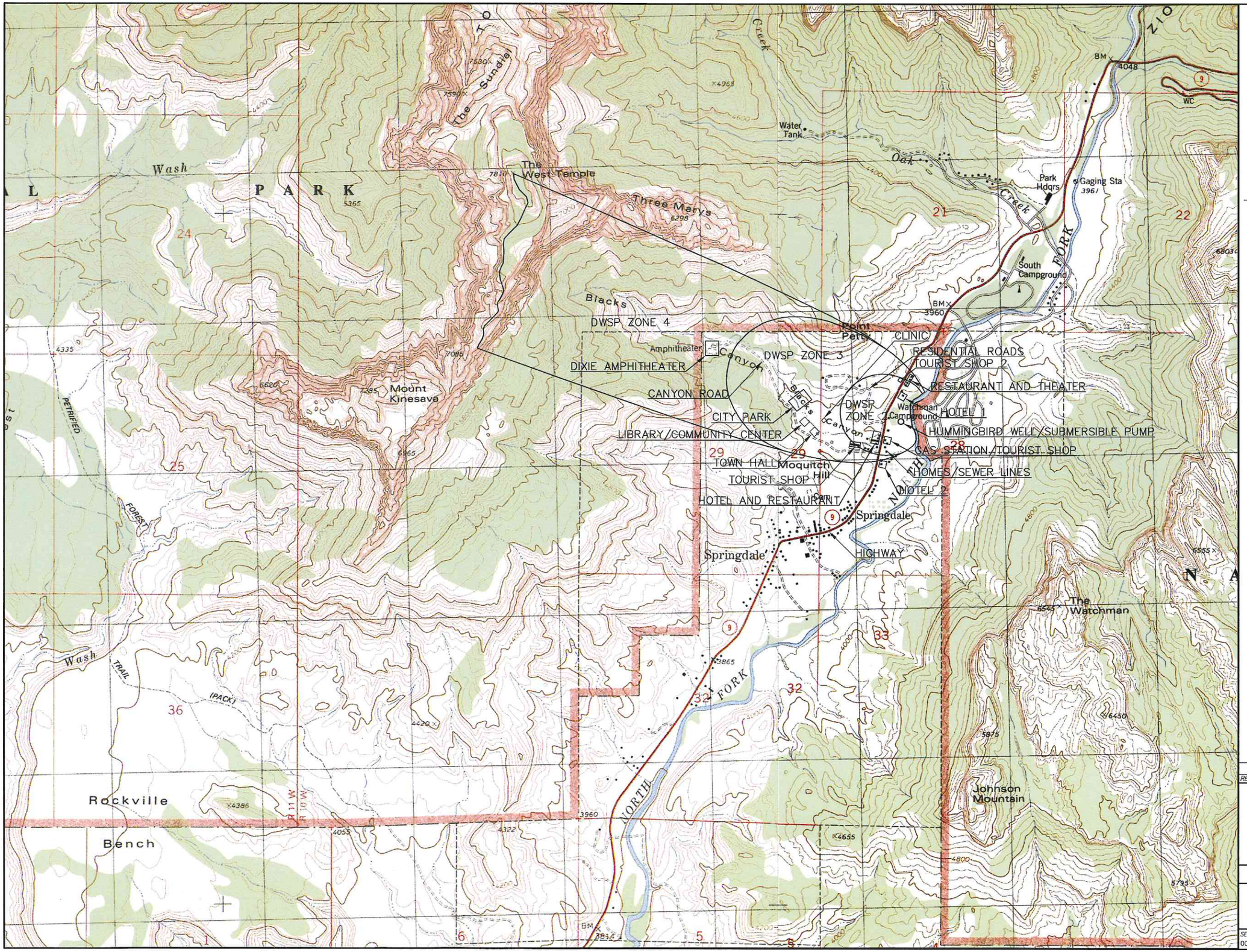
FIGURES



NORTH

SCALE
0 1000 2000
HORIZ: 1" =2000'

LEGEND

DWSP ZONE BOUNDARY

REV NO.	COMMENT	DATE

SUNRISE ENGINEERING
12227 SOUTH BUSINESS PARK DRIVE, SUITE 220
DRAPER, UTAH 84020
TEL 801.523.0100 · FAX 801.523.0990
www.sunrise-eng.com

TOWN OF SPRINGDALE

PRELIMINARY EVALUATION REPORT
HUMMINGBIRD WELL
LOCATION MAP WITH DWSP ZONES

SEI NO.	DESIGNED	DRAWN	CHECKED	SHEET NO.	
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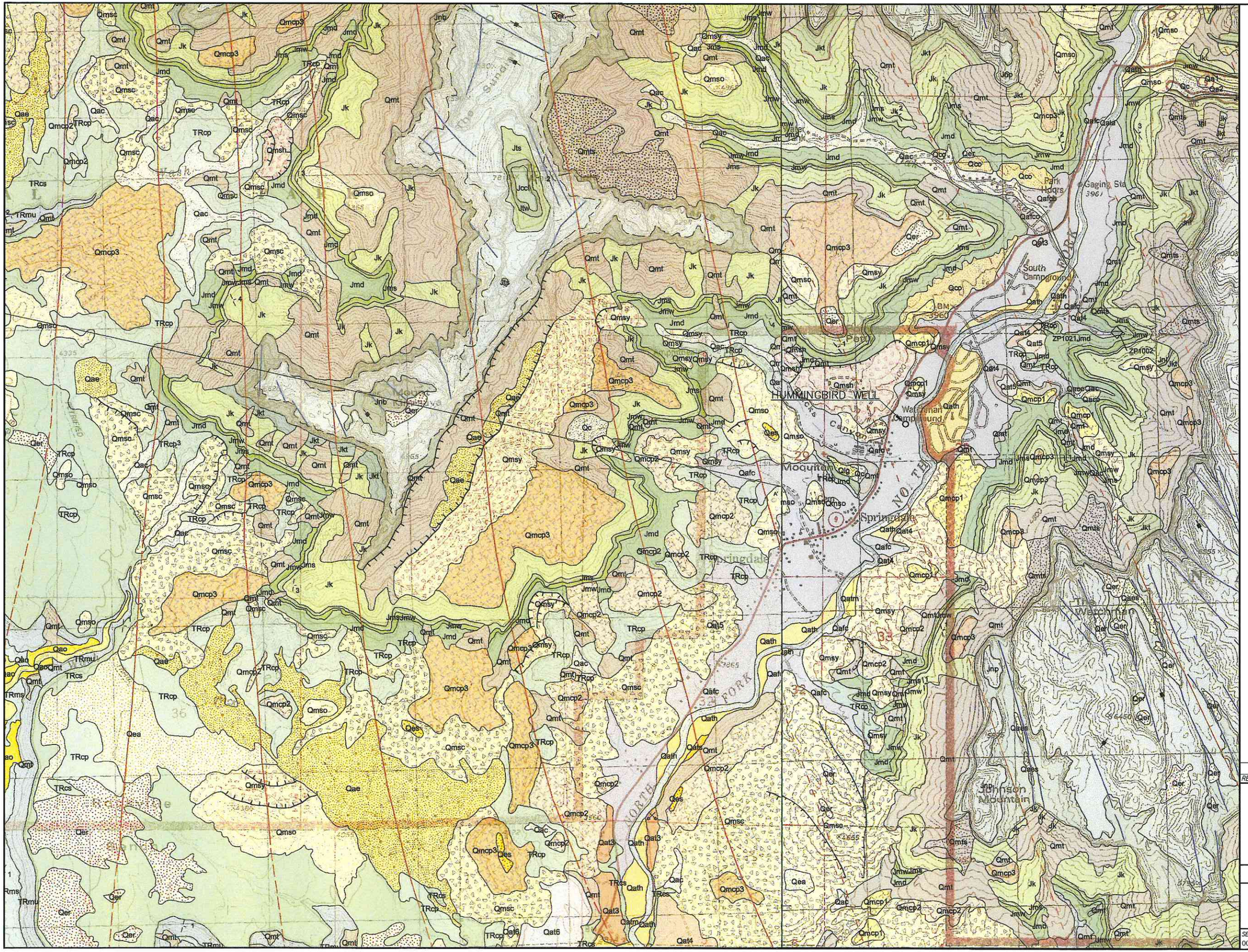

NORTH

SCALE
0 1000 2000
HORIZ: 1" =2000'

REV NO.	COMMENT	DATE

SUNRISE ENGINEERING
12227 SOUTH BUSINESS PARK DRIVE, SUITE 220
DRAPER, UTAH 84020
TEL 801.523.0100 · FAX 801.523.0990
www.sunrise-eng.com

TOWN OF SPRINGDALE

DWSP PLAN
HUMMINGBIRD WELL
LOCAL GEOLOGY

SEI NO.	DESIGNED	DRAWN	CHECKED	SHEET NO.	FIGURE 2
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APPENDICES

Appendix A
Description of Geologic Units

Springdale West Quadrangle
Description of Map Units

QUATERNARY

Fill Deposits

Qf **Fill (Historical)** -- Fill in small dams and dikes; most road fill not shown; 0 to 30 feet (0-10 m) thick.

Alluvial Deposits

Low-level alluvial deposits of the Virgin River (upper Holocene) -- Moderately to well-sorted gravel, sand, silt, and clay in lenses and thin layers deposited by fluvial processes in larger, well-graded river valleys; generally reddish brown to pale brown; clasts are subrounded to well-rounded, mixed exotic (derived from sources many miles upstream) and locally derived (from within quadrangle area), and are mostly quartzite, sandstone, basalt, limestone, and chert; most clasts are pebble to small cobble sized; a few locally derived clasts are more than 3 feet (1 m) in diameter; differs from alluvial deposits in small side canyons in that clasts are significantly better sorted and a large percentage are exotic; forms river channels and terraces up to about 25 feet (8 m) above the modern river level; 0 to 30 feet (0-9 m) thick.

Working with low-level terrace deposits in the Springdale area, Hereford and others (1995) recognized four episodes of terrace construction that are distinguished by elevation above the active channel, development of soils and vegetation, dating of trees, and archeological artifacts. Terrace deposits shown on this map approximately correlate with Hereford and others' divisions, but are more generalized -- age and correlation of most terrace segments were determined from aerial photographs and only locally verified, and mapped terrace segments locally include segments from other fluvial episodes too small to map separately.

Qala **Level 1 (active channel) alluvial deposits (Historical)** -- Deposits in active river channel up to average annual high-water line about 4 feet (1.2 m) above modern river channel; deposited or reworked by the Virgin River mostly after A.D. 1980. Note: the river position shown on the gray topographic base map was based on 1973 aerial photographs; the position of the river channel shown on the geologic map (map unit Qala) was based on 1994 aerial photographs; during that time interval, the river channel has migrated significantly (unlike upstream in the Springdale East quadrangle [Doelling and others, 2002]).

Qatm **Level 2 ("modern") alluvial terrace deposits (Historical)** -- Deposits between about 4 feet (1.2 m) and 8 feet (2.4 m) above the active channel; generally vegetated with weeds and shrubs such as tamarisk; commonly covered every few years to decades by floods during unusually high spring runoff and following intense thunderstorms; Hereford and others (1995) referred to these sediments as the "modern" level and noted that they were deposited mostly between A.D. 1940 and 1980.

Qath **Level 3 ("historic") alluvial terrace deposits (Historical)** -- Deposits forming terraces 8 to 15 feet (2.4-4.6 m) above active channel; commonly mantled by fine-grained overbank silt, sand, and clay deposits; vegetated by cottonwood trees and mature shrubs; Hereford and others (1995) called these deposits the "historic" level; historic photographs show that the sediments of this level were deposited mostly between A.D. 1883 and 1926 (1926 to 1940 was a period of arroyo cutting) (Hereford and others, 1995).

Qats **Level 4 ("settlement and late prehistoric") alluvial terrace deposits (upper Holocene)** -- Deposits forming terraces 15 to 25 feet (4.6-8 m) above the active channel; generally forms a broad terrace along the Virgin River and in side canyons; where not cultivated, surface is covered mostly by sagebrush and is above the zone of abundant cottonwood trees in the river flood plain; in many areas terraces of this level are mostly covered by Qafc deposits; Hereford and others (1995) named this surface the "settlement surface" because it was the main surface for houses and cultivation by earlier pioneer settlers in the middle to late 1800s; they noted that the pioneer fields and settlements on these surfaces were occasionally flooded during unusually high spring runoff; the settlement surface contains no Ancestral Puebloan (Anasazi) Indian artifacts, indicating that the sediment was deposited after about A.D. 1200; Hereford and others (1995) noted that river deposition on this surface ended by about A.D. 1880 as renewed river and arroyo cutting lowered the river channel; as generalized for this map, this unit locally includes surfaces between about 25 and 33 feet (8-10 m), but locally as low as 20 feet (6 m) above the active channel, that are part of what Hereford and others referred to as "prehistoric" and that may date to A.D. 800-1200.

Qat3, Qat4, Qat5, Qat6

High-level alluvial terrace deposits (middle Holocene to middle Pleistocene) -- Moderately to well sorted, pale-gray to pale-brownish-gray cobble gravel with sand, silt, and clay in lenses and matrix; clasts are mostly exotic and consist of quartzite, basalt, sandstone, limestone, and chert; form terrace remnants that cap hills and bluffs near the Virgin River; show moderate soil development; locally partially mantled by windblown sand, colluvium, and talus; as mapped, locally includes a thin apron of colluvium that sloughed downslope from the terraces; terraces of several different levels are grouped into four map units based on height above the nearby active river channel: Qat3 between 30 and 90 feet (9-27m) above the channel, Qat4 from 90 to 140 feet (27-43 m), Qat5 from 140 to 190 (43-58 m),and Qat6 from 190 to 250 feet (58-76 m); 0 to 80 feet (0-24 m) thick.

The age of river-terrace and other deposits that are graded to the Virgin River can be estimated using calculated long-term incision rates, combined with amount of soil development and lithification. Present height of remnants of well-dated basaltic lava that flowed into the ancestral river channel indicates about 1,300 feet (400 m) of incision in the last one million years, or 1.3 feet (0.4 m) per thousand years. Using this rate, Qat3 deposits are calculated between about 20,000 and 70,000 years old, Qat4 deposits between 70,000 and 110,000 years old, Qat5 deposits between 110,000 and 150,000 years old, and Qat6 deposits between 150,000 and 190,000 years old. However, these calculations do not take into account fluctuations in incision rates during this time, which could shift these age estimates significantly; in addition, low-level deposits show incision of 25 feet (8 m) or more in just the last few hundred years, though this type of variation probably reflects short-term cyclicity more than long-term incision rates; thus, Qat3 deposits, which would be affected most by short-term cyclicity, may be as young as middle Holocene.

Qa1 **Level 1 alluvial stream deposits (upper Holocene)** -- Stratified, fine- to coarse-grained, pale-orange to yellowish-brown sand with varying amounts of poorly to moderately sorted clay, silt, and subangular to subrounded pebble to small boulder gravel with sandstone, limestone, and basalt clasts; mapped along larger tributaries of the Virgin River; up to about 10 feet (3 m) above the active channel; less well sorted than Qala and Qatm deposits and does not include exotic clasts; generally less than 10 feet (3 m) thick.

Qa2 **Level 2 alluvial stream deposits (Holocene)** -- Same as Qa1deposits except forms incised terraces 10 to 30 feet (3-9 m) above the active channel and locally covered by windblown silt and fine-grained sand; as much as 20 feet (6 m) thick.

Qay **Younger alluvial deposits (upper Holocene)** -- Similar to and includes deposits equivalent to both Qa1 and Qa2 deposits, but correlation uncertain; includes deposits up to about 30 feet (9 m) above the stream channel.

Qao **Older alluvial deposits (Holocene to Upper Pleistocene)** -- Deeply incised and eroded remnants of older alluvial fan and stream channel deposits 20 to about 80 feet (6-24 m) above nearby washes; mapped in small side channels; 0 to 10 feet (0-3 m) thick.

Qam **Alluvial mud deposits (Holocene to upper Pleistocene)** -- Pale-yellowish-gray to reddish-gray clay and silt, with generally minor sand; locally includes lenses of pebble to cobble gravel; mantles broad gentle slopes on nonresistant units; derived primarily from weathering of Petrified Forest Member of Chinle Formation; 0 to 20 feet (0-6 m) thick.

Qagp **Alluvial gypsiferous deposits (Holocene to upper Pleistocene)** -- Pale- to medium-gray to reddish-gray gypsum, silt, clay, and, and pebble to cobble gravel; forms a moderately resistant punky gypsiferous soil cap over outcrops of Shnabkaib Member of Moenkopi Formation; caps surfaces 20 to 60 feet (6-18 m) above the local washes; 0 to 10 feet (0-3 m) thick.

Qaf2 **Level 2 alluvial-fan deposits (Holocene to upper Pleistocene)** -- Dissected remnants of pale-reddish-brown to reddish-gray, moderately to poorly sorted, boulder- to clay-sized sediment deposited on low to moderate slopes by debris flows and ephemeral streams; locally includes colluvial and talus deposits, and locally mantled by eolian sand; form mounds and erosional remnants up to about 50 feet (15 m) above washes; low-level (younger) alluvial fans are included in Qac and Qae deposits; 0 to 50 or more feet (0-15+ m) thick.

Qap2 **Alluvial pediment-mantle deposits (upper Pleistocene)** -- Dissected remnants of pale-reddish-brown to reddish-gray, moderately to poorly sorted, boulder- to clay-sized sediment that forms a planar cap over erosional remnants of Coal Pits Wash lacustrine and basin-fill deposits; these deposits probably developed after the basin filled with lacustrine and marginal lacustrine sediments, allowing ephemeral streams to reestablish across the surface; they were incised as the streams cut through the natural dam; 0 to 30 feet (0-9 m) thick.

Mixed Alluvial, Colluvial, and Eolian Deposits

Qafc **Young alluvial-fan and colluvial deposits (Holocene to upper Pleistocene)** -- Reddish-brown, poorly stratified, poorly sorted, coarse- to fine-grained sand and pebble to cobble gravel with silt and scattered boulders; clasts are angular to subangular and locally derived; deposited by debris flows and sheet wash at decrease in slopes and at mouths of small ephemeral channels that flow into Virgin River valley and major tributaries; mostly graded to and partially mantle Qath and Qats alluvial deposits, and commonly includes small secondary fans (not mapped separately) inset into main deposit that are graded to the active or modern channel; commonly interfingers with and covers alluvial stream deposits; forms most surfaces cultivated and built on by communities of Rockville and Springdale; in many areas debris flows have surged across these surfaces in historical times, sometimes causing considerable damage to buildings and roads; 0 to 30 feet (0-9 m) thick.

Qafco **Middle-level alluvial-fan and colluvial deposits (lower Holocene to upper Pleistocene)** -- Similar to Qafc deposits described above, except deposits are graded to older alluvial surfaces (Qat3 and Qat4), are incised by modern stream channels, and are no longer accumulating sediment; deposited by debris flows issuing from small side canyons; thickness probably less than 20 feet (6 m).

Qac **Mixed alluvium and colluvium (Holocene to upper Pleistocene)** -- Poorly to moderately sorted, poorly stratified sand, silt, and clay with scattered subangular to angular boulders, cobbles, and pebbles; brown to gray; deposited in minor drainages and topographic depressions primarily by ephemeral streams, slope wash, and creep processes; includes mix of alluvial materials carried down drainages and colluvial

materials derived from adjacent slopes; may be dissected up to about 20 feet (6 m) by modern ephemeral stream channels; thickness less than 30 feet (9 m).

Qaco **Older mixed alluvium and colluvium (lower Holocene to upper Pleistocene)** -- Similar to mixed alluvium and colluvium (Qac) described above, but deeply dissected by ephemeral stream channels.

Qae **Mixed alluvial and eolian deposits (Holocene to upper Pleistocene)** -- Locally derived, moderately to moderately well-sorted, mostly silt, clay, and fine sand with scattered lenses of subangular to angular gravel; deposited in shallow topographic depressions and on broad gentle slopes by slope wash and wind; includes small fans and colluvium from adjacent slopes; 0 to 20 feet (0-6 m) thick.

Qea **Mixed eolian and alluvial deposits (Holocene to upper Pleistocene)** -- Well-sorted, pale-reddish-brown to pale-yellowish-gray, windblown sand locally redeposited by alluvial processes; locally includes minor alluvial gravel; covers broad, gently sloping surfaces; deposits are relatively old and stable and are isolated from most erosion, allowing eolian sediments to gradually accumulate; scattered incisions through the deposits reveal stage II to IV pedogenic carbonate soil; generally less than 20 feet (6 m) thick.

Eolian and Residual Deposits

Qes **Eolian sand (Holocene to upper Pleistocene)** -- Well-sorted, pale-yellowish-gray to pale-reddish-gray, mostly fine-grained, windblown sand deposited in sheets, mounds, and dunes; derived primarily from the Navajo Sandstone; locally includes minor residual weathered rock from underlying unit; 0 to 20 feet (0-6 m) thick.

Qer **Mixed eolian and residual deposits (Holocene to upper Pleistocene)** -- Pale reddish-orange, windblown, well-sorted, mostly fine-grained sand with scattered to common angular to subrounded, residual sandstone blocks derived from the Navajo Sandstone; locally includes minor alluvial sand; occurs as sheets, mounds, and poorly formed dunes in shallow topographic depressions and on gently sloping surfaces mostly on Navajo Sandstone; 0 to 20 feet (0-6 m) thick.

Qre **Mixed fine-grained residual and eolian deposits (Holocene to upper Pleistocene)** -- Reddish-brown to pale-yellowish-gray, residual silt and fine sand with scattered subangular gravel deposited on flat surfaces eroded on lower part of Co-op Creek Limestone Member of the Carmel Formation; partly reworked by eolian processes; deposited by wind and as residual accumulation on weathered slopes; one small exposure on Altar of Sacrifice in northeast part of quadrangle; 0 to 10 feet (0-3 m) thick.

Colluvial, Mass-Movement, and Related Deposits

Qc **Colluvium (Holocene to upper Pleistocene)** -- Poorly sorted, nonstratified sand and silt with subangular to angular mostly sandstone blocks; color and clast composition vary with parent material; deposited primarily by creep and slope wash on moderate slopes; locally includes talus and alluvial deposits; generally less than 20 feet (6 m) thick.

Qmt **Talus (Holocene to upper Pleistocene)** -- Primarily very poorly sorted, coarse, angular blocks on steep slopes; fine-grained interstitial component varies from abundant to absent; composed of blocks derived from immediately upslope ledges and cliffs; locally contains small landslide and slump masses and boulders with diameters exceeding 30 feet (9 m); mantles steep slopes beneath cliffs and ledges; locally includes undifferentiated colluvium; commonly grades downslope into colluvial and other deposits; generally 15 feet thick (4.5 m) or less, locally up to 30 feet (9 m) thick.

Qmts **Talus sand (Holocene to upper Pleistocene)** -- Cone-shaped deposits of sand commonly mantling talus, colluvium, and other slope-forming units; locally contains small landslide and slump masses and boulders with diameters exceeding 30 feet (9 m); sand was mostly derived from eroding bare sandstone exposed upslope; locally concentrated by wind; up to 20 feet (6 m) thick.

Qmsh **Historical undifferentiated mass-movement slide and slump deposits (Historical)** -- Masses of rock and unconsolidated material that have undergone translational and/or rotational downslope movement; include zones of highly disturbed material, especially at landslide toes where movement is characterized by earth flow; typically associated with low-strength bentonitic mudstone and claystone in the Petrified Forest Member of the Chinle Formation and the Kayenta Formation; landslide features such as scarps and slide blocks are morphologically distinct; historical age documented by disturbed vegetation and open fractures; deposits may deflect stream flow; vary greatly in thickness, but most are estimated to be less than 50 feet (15 m) thick.

Qmsy **Younger undifferentiated mass-movement slide and slump deposits (Holocene to upper Pleistocene)** -- Masses of rock and unconsolidated material that have undergone translational and/or rotational downslope movement; bedrock strata within the blocks are commonly tilted and shattered; individual blocks may be as much as several hundred feet long; slip surfaces commonly develop in the clays of the Petrified Forest Member of the Chinle Formation and in silt and clay units in the Kayenta Formation; similar in character and occurrence to Qmsh, but landslide features such as scarps and slide blocks are morphologically less distinct as the result of weathering and erosion; locally includes deposits with historical movement; probably formed mostly during wet climatic regimes in the Pleistocene, but continue to move near springs and other wet areas, and where undercut or oversteepened by stream erosion or human activity; vary greatly in thickness, but most are probably less than 50 feet (15 m) thick.

Qmso **Older undifferentiated mass-movement slide and slump deposits (lower Holocene to Pleistocene)** -- Similar to Qmsy deposits but forms isolated mounds and erosional remnants of once larger landslide masses; locally may be more than 300 feet (90 m) thick.

Qmsc, Qms(n)
Undifferentiated landslide complex (Holocene to Pleistocene) -- Large complex mass of slump, slide, and earthflow deposits; forms large hummocky mounds and hills; includes older, younger, and historical landslide deposits; locally reactivated with historical movement along and upslope from incised channels; large mostly intact blocks of Navajo Sandstone mapped as Qms(n); 0 to 200 feet (0-60 m) thick.

Qms(b) **Collapsed blocks of basalt (lower Holocene to upper Pleistocene?)** -- Large blocks of Crater Hill basalt flow that collapsed and slid after softer underlying sedimentary rocks were eroded out by streams; age poorly constrained.

Qmcp1, Qmcp2, Qmcp3
Older mass-movement, colluvial, and alluvial pediment-mantle deposits (lower Holocene to Pleistocene) -- Remnants of poorly sorted rock-fall, small slump block and landslide, colluvial, and generally minor alluvial-fan debris that mantle and armor gently sloping, pediment-like benches cut across bedrock; consist of angular and subangular, up to house-sized boulders to fine-grained sand, and lesser amounts of silt and clay derived from local cliffs and ledges; color is dependent on source formations; materials become coarser upslope; preserved as remnants that form inclined benches near steep bedrock slopes at high levels; these benches may be either remnants of much larger surfaces that were graded to the ancestral Virgin River, which, at the time of deposition, must have been up to several hundred feet above its present position or, are the remnants of sloping erosional surfaces mantled and protected from erosion by the coarse deposits and were not graded to the river; mapped deposits locally include aprons of colluvium derived from the pediment-mantle deposits; as much as 30 feet (9 m) thick; graded to several levels that project up to 700 feet (210 m) above the modern river channel; here divided into low-level

(Qmcp1, in which the inclined surface projects less than about 100 feet [30 m] above the river), middle-level (Qmcp2, about 100 to 200 feet [30-60 m]), and high-level (Qmcp3, 200 to 700 feet [60-180 m]) deposits.

Lacustrine and Basin-Fill Deposits

Qlbc **Lacustrine and basin-fill deposits of Coal Pits Wash (upper Pleistocene)** -- Well-sorted, pale-yellowish-brown, to pale-reddish-brown, thin-bedded to laminated, planar-bedded clay, silt, sand, and marl; locally with soft-sediment slump features; form remnants draped across older alluvial, mass-movement, and bedrock deposits; locally as much as 150 feet (45 m) thick; coarser grained in distal areas where grades into alluvial and colluvial deposits; deposits rest directly on a basaltic ash in some areas; lake formed by basalt flow that filled Coal Pits Wash (north-central part of quadrangle) and impinged against older landslide deposits; estimated at about 100,000 years old; 0 to 150 feet (0-45 m) thick.

Qlg **Lacustrine and basin-fill deposits of ancestral Lake Grafton (upper Pleistocene)** -- Pale-gray, pale-yellowish-brown, and medium-greenish-gray, planar, thin-bedded to laminated clay, silt, sand, and marl; deposited directly on a basaltic ash; deposited in a large lake that formed behind a basalt dam formed by flows from the Crater Hill eruption that dammed the Virgin River; the lake extended upriver into the southern part of Zion Canyon; only one small exposure in NE1/4 section 3, T. 42 S., R. 11W.; about 60 feet (20 m) thick, though base is poorly exposed; estimated at about 100,000 years old.

Qbc, Qbcc, Qbca, Qbcr

Basaltic flows, cinders, ash, and rafted block of Crater Hill (upper(?) Pleistocene) -- Medium-gray (fresh surfaces), weathering to dark-brownish-gray to dark-brownish-black, olivine basalt to trachybasalt (table 1); vesicular to dense; locally jointed; forms prominent cinder cone with a large mound of cinders (Qbcc) that may have been deposited by a directed plume eruption or wind drift; basaltic ash (Qbca) is preserved in several areas to the northeast of the cone, and one locality to the southeast; upper surface of flows (Qbc) generally has large arcuate flow ridges and locally a large rafted and tilted block (Qbcr) once considered a separate cinder cone and vent (Nielson, 1977); strongly weathered upper surface mostly covered by eolian and alluvial deposits; rubbly base where exposed; flow is typically 40 to 80 feet (12-24 m) thick, but locally up to 400 feet (120 m) thick where it ponded in Virgin River and ancestral Coal Pits Wash channels; base is about 125 feet (38 m) above modern river channel (appears higher along State Highway 9 because the cliff face exposes a higher level of the dish-shaped flow); caps broad sloping bench in north-central part of quadrangle; estimated at 100,000 years old.

JURASSIC

Carmel Formation

Jccl **Lower unit of Co-op Creek Limestone Member** -- In quadrangle, only lowermost part of lower unit is preserved as an inaccessible outcrop at the top of The West Temple; description is based on exposures in adjacent quadrangles. Mostly thinly laminated to thin-bedded, pale-yellowish-gray weathering, calcareous shale and platy limestone; local rip-up clast conglomerate at the base; limestone is mostly micritic, but some beds are oolitic and sandy; has minor thin-bedded dolomite and sandstone; has locally abundant fossils, including pelecypods, gastropods, and crinoid columnals; *Pentacrinus asteriscus*, a Middle Jurassic crinoid, is common in some of the limestone beds; forms low, sloping, vegetated cap on top of the Temple Cap Formation; deposited in a marine (shallow sea) environment; probably less than 60 feet (18 m) preserved.

J-2 unconformity

Temple Cap Formation -- forms inaccessible outcrops capping Towers of the Virgin in northeast part of quadrangle; descriptions based on exposures in adjacent quadrangles.

Jtw **White Throne Member** -- Very light-gray to pale-orange, cliff-forming sandstone resembling the white Navajo Sandstone; consists of fine-grained, well-sorted, cross-bedded sandstone; has high-angle tabular-planar or wedge-planar cross-beds in sets as much as 20 feet (6 m) thick; deposited in an eolian environment; thickness varies due to unconformity at top; upper contact is sharp and marked by a reddish zone at the base of the Co-op Creek Limestone Member of the Carmel Formation; estimated at 80 to 100 feet (24-30 m) thick; thins westward.

Jts **Sinawava Member** -- Interbedded, fine-grained sandstone, silty sandstone, and mudstone; generally forms prominent reddish-brown to dark-red vegetated bench or ledgy slope; locally forms recessed cliff between the White Throne Member and the white Navajo Sandstone; red color locally streaks the white Navajo cliffs below; interfingers with the White Throne Member at the top; deposited in coastal sabkha and tidal-flat environments; estimated at 100 to 140 feet (30-42 m) thick; thins eastward.

J-1 unconformity

Jn **Navajo Sandstone** -- (undivided on cross section only) Massive, cliff-forming, cross-bedded, locally highly jointed sandstone; forms spectacular sheer cliffs, deep canyons, and impressive spires, promontories, and monoliths; consists mostly of well-sorted, fine- to medium-grained, quartzose sandstone; bedding consists of high-angle large-scale cross-bedding in tabular-planar, wedge-planar, or trough-shaped sets 10 to 45 feet or more (3-14+ m) thick; ironstone bands and concretions locally common; deposited in a vast eolian coastal to inland erg (dune field) environment with prevailing winds principally from the north; lower 200 to 400 feet (60-120 m) consists of a transitional interval with planar bedding, evaporite mineral casts, crinkly or wavy bedding, load structures (typically a few inches in amplitude), and bioturbation indicative of a coastal sabkha environment; upper contact is an unconformity that makes a sharp break below the slope of the red Sinawava Member; divided into three generalized non-stratigraphic units based on color and weathering habit; 1,800 to 2,200 feet (550-670 m) thick.

Jnw **White Navajo** -- Upper part of Navajo Sandstone; very pale-gray, yellowish-gray, orangish-gray, to white because of alteration, remobilization, and bleaching of limonitic and hematitic (iron-bearing) cement; generally forms a massive cliff; includes upper 400 to 800 feet (120-240 m) of the formation in Zion National Park.

Jnp **Pink Navajo** -- Middle part of Navajo Sandstone; generally less resistant than the white Navajo above and brown Navajo below; forms benches, steep slopes, and cliffs; pale-reddish-brown color is more uniform than in units above and below due to more uniformly dispersed hematitic (iron-bearing) cement; locally contains dark green cement (possibly celadonite - an iron-bearing micaceous mineral), and ironstone bands, concretions, and cement; 400 to 1,000 feet (120-300 m) thick.

Jnb **Brown Navajo** -- Lower part of the Navajo Sandstone; upper contact is at the top of a dark-brown, irregular and undulating band overlain by a broad light-colored band; generally forms a massive cliff; roughly correlative with the lower transitional beds of the Navajo; 400 to 600 feet (120-180 m) thick.

Jk **Kayenta Formation (entire formation in areas where Lamb Point Tongue of Navajo Sandstone not mapped, and on cross section; lower part (main body) in areas where Lamb Point and Tenney Canyon Tongues mapped separately)** -- Moderate to dark reddish-brown siltstone and sandstone similar to that described for the Tenney Canyon Tongue; contains 20 to 30 percent sandstone ledges in the Zion National Park area; forms steep ledgy slope grading up to ledgy cliffs at top; upper

contact gradational over a few feet but placed at top of slope- or ledgy cliff-forming, thin- to medium-bedded sandstone with siltstone partings, and at base of laterally continuous, thick- to massive-bedded, cliff-forming sandstone; deposited in an area of little relief near a terrestrial-marine transition zone alternating between mudflats and fluvial environments; locally has thin to medium ledgy sandstone beds similar to Springdale Sandstone in lower part; entire formation is between 550 and 700 feet (170-210 m) thick; lower part below the Lamb Point Tongue is about 290 to 400 feet (88-120 m) thick.

Jkt **Tenney Canyon Tongue of Kayenta Formation** -- Upper part of Kayenta Formation in areas where Lamp Point Tongue is present; lenticular beds of pale-reddish-brown to moderate reddish-orange siltstone and very fine-grained sandstone; minor claystone and limestone; forms a steep slope grading up to ledgy cliffs at top; 140 to 315 feet (43-96 m) thick where separated from the main body.

Jnl **Lamb Point Tongue of Navajo Sandstone** -- Mostly reddish-brown, fine- to very fine-grained, well-sorted, quartzose sandstone; prominently jointed; forms a vertical ledge in the upper one-third of the Kayenta Formation; strongly cross-bedded; contains scattered thin lenses of flat-bedded, pale-reddish-brown siltstone and claystone similar to Kayenta Formation beds; upper contact placed at top of thick, laterally consistent ledge interval; locally contains a 1-foot-thick (30 cm) bed of limestone near the top; deposited in an eolian erg and sabkha environment; thins and pinches out to west in the quadrangle; 0 to 60 feet (0-18 m) thick.

Moenave Formation

Jms **Springdale Sandstone Member of Moenave Formation** -- Mostly pale-reddish-purple to pale-reddish-brown, moderately sorted, very fine- to medium-grained, medium- to thick-bedded, cross-bedded sandstone; locally contains intraformational conglomerate consisting of rounded chips of mudstone and siltstone in a sandstone matrix; has large lenticular and wedge-shaped, low-angle, medium- to large-scale cross-bedding; secondary color banding that varies from concordant to discordant with cross-bedding is common in the sandstone; generally forms a vertical to irregular ledgy cliff; upper contact with Kayenta Formation is generally sharp and even; deposited in a fluvial environment of constantly shifting stream channels; 90 to 150 feet (27-46 m) thick.

Jmw **Whitmore Point Member of Moenave Formation** -- Grayish-red, pale-reddish-brown, and pale-greeenish-gray siltstone, fine-grained sandstone and claystone; sandstone beds are similar to sandstone in Springdale Sandstone; siltstone is commonly thin bedded to laminated in lenticular or wedge-shaped beds; claystone is generally flat-bedded; slope forming; the upper contact of the member is generally sharp but irregular where scoured by the overlying Springdale; locally contains fish scales and bone fragments; deposited in low-energy lacustrine and fluvial environments; about 60 to 85 feet (18-26 m) thick.

Jmd **Dinosaur Canyon Member of Moenave Formation** -- Uniformly colored, moderate to dark reddish-orange to pale-reddish-brown, thin-bedded siltstone, very fine-grained sandstone, and claystone; near the base, contains a minor amount of conglomerate similar to beds in underlying Petrifed Forest Member of Chinle Formation; forms an irregular slope slightly steeper than that of the Whitmore Point; the upper part is marked by a series of more resistant sandstone beds that help define the contact with the Whitmore Point Member above; commonly ripple-marked or mud-cracked; deposited on a broad, low, stream-meander floodplain that was locally shallowly flooded by water (fluvial mudflat); about 150 to 270 feet (46-82 m) thick.

J-0 unconformity

TRIASSIC

Chinle Formation

TRcp **Petrified Forest Member of Chinle Formation** -- Brightly variegated, light-brownish-gray, pale-greenish-gray, to grayish-purple, smectitic shale, siltstone, claystone, sandstone, and pebble to small cobble conglomerate; weathers as badlands; prone to landsliding; contains locally abundant fossilized wood; mostly slope-forming; upper contact is an erosional surface with only slight relief; contains locally prominent, thick, resistant sandstone and conglomerate ledges in lower and middle parts of unit; deposited in lacustrine, floodplain, and braided-stream environment; about 400 to 500 feet (120-150 m) thick.

TRcs **Shinarump Conglomerate Member of Chinle Formation** -- Interbedded, medium- to coarse-grained sandstone, pebbly sandstone, and pebble conglomerate; locally with silty sandstone, claystone, and smectitic claystone interbeds; locally contains abundant fossilized wood; forms resistant ledges to cliffs; clasts are mostly black, gray, tan, and white chert and quartzite; locally heavily stained by iron-manganese oxides, forming "picture stone"; upper contact varies from sharp to gradational; deposited in fluvial environment; about 60 to 135 feet (18-41 m) thick.

unconformity

TRm **Moenkopi Formation, undivided** -- Shown on cross section only; about 1,700 feet (520 m) thick.

TRmu **Upper red member of Moenkopi Formation** -- Moderate- to dark-reddish-brown, very fine- to fine-grained sandstone, siltstone, and mudstone; mostly thin bedded and evenly stratified with a few thick beds that form resistant ledges; common ripple marks and planar, low-angle, and climbing-ripple cross-stratification; common secondary gypsum in thin beds and as cross-cutting veinlets increasing downward; sharp, locally deeply incised erosional upper contact; deposited in tidal-flat environment; 200 to 280 feet (60-85m) thick.

TRms **Shnabkaib Member of Moenkopi Formation** -- Banded, light-gray to pale-red "bacon-striped," gypsiferous siltstone, bedded gypsum, mudstone, and calcareous mudstone; with thin interbeds of pale-brownish-gray dolomite, and moderate-reddish-brown siltstone; mostly nonresistant with thin resistant layers that form ledges; gypsum common as secondary cavity filling and cross-cutting veins; parts weather to a thick punky gypsiferous soil; upper contact placed at change from grayish mudstone to uniform reddish-brown siltstone and mudstone; deposited in shallow-marine to tidal-flat environment; total member is probably about 400 feet (120 m) thick.

TRmm **Middle red member of Moenkopi Formation** -- Interbedded, laminated to thin-bedded, moderate reddish-brown to moderate-reddish-orange siltstone, mudstone, and very fine-grained sandstone; white to greenish-gray gypsum beds and veins are common, especially in the lower part; upper contact is conformable and gradational and corresponds to the base of the first thick gypsum bed; deposited in tidal-flat environment; about 400 to 450 feet (120-140 m) thick.

unconformity

PERMIAN

P **Permian strata, undifferentiated** -- Shown in cross section only; includes Kaibab, Toroweap, and Queantoweap Formations; probably about 3,000 feet (600 m) thick beneath quadrangle.

Appendix B
Well Logs

Form 113—5M—12-60

Examined 6-18-71 V.F.O.
Recorded: B. C. 6-18-71 V.F.O. T. P. V.F.O.
Inspection Sheet 6-18-71 B.M.
Copied 6-18-71 B.M.

REPORT OF WELL DRILLER
STATE OF UTAH

Application No. 35548
Change # A 6036 (41-585)
Coordinate No. (C-41-10) 28bdb

GENERAL STATEMENT: Report of well driller is hereby made and filed with the State Engineer, in accordance with the laws of Utah. (This report shall be filed with the State Engineer within 30 days after the completion or abandonment of the well. Failure to file such reports constitutes a misdemeanor.)

(1) WELL OWNER:
Name City of Springdale
Address Springdale, Utah

(2) LOCATION OF WELL:
County Wash. Ground Water Basin (leave blank)
North 71072 feet, East 1944.42 feet from W4 Corner
of Section 28, T. 41 S, R. 10 W SLBM (strike out words not needed)

(3) NATURE OF WORK (check): New Well ☐ Replacement Well ☒ Deepening ☐ Repair ☐ Abandon ☐
If abandonment, describe material and procedure:

(4) NATURE OF USE (check):
Domestic ☐ Industrial ☐ Municipal ☒ Stockwater ☐
Irrigation ☐ Mining ☐ Other ☐ Test Well ☐

(5) TYPE OF CONSTRUCTION (check):
Rotary ☐ Dug ☐ Jetted ☐
Cable ☒ Driven ☐ Bored ☐

(6) CASING SCHEDULE: Threaded ☐ Welded ☒
16 " Diam. from 0 feet to 100 feet Gage .250
" Diam. from feet to feet Gage
" Diam. from feet to feet Gage
New ☒ Reject ☐ Used ☐

(7) PERFORATIONS: Perforated? Yes ☒ No ☐
Type of perforator used Mills
Size of perforations 3/8 inches by 3 inches
30 perforations from 23 feet to 83 feet
perforations from feet to feet
perforations from feet to feet
perforations from feet to feet
perforations from feet to feet

(8) SCREENS: Well screen installed? Yes ☐ No ☒
Manufacturer's Name
Type Model No.
Diam. Slot size Set from ft. to
Diam. Slot size Set from ft. to

(9) CONSTRUCTION:
Was well gravel packed? Yes ☐ No ☒ Size of gravel:
Gravel placed from feet to feet
Was a surface seal provided? Yes ☐ No ☒
To what depth? feet
Material used in seal:
Did any strata contain unusable water? Yes ☐ No ☐
Type of water: Depth of strata
Method of sealing strata off:
Was surface casing used? Yes ☐ No ☒
Was it cemented in place? Yes ☐ No ☐

(10) WATER LEVELS:
Static level 26 feet below land surface Date 2/26/71
Artesian pressure feet above land surface Date

LOG RECEIVED
RECEIVED MAY 25 1971 WATER RIGHTS CLEARANCE

(11) FLOWING WELL:
Controlled by (check) Valve ☐
Cap ☐ Plug ☐ No Control ☐
Does well leak around casing? Yes ☐ No ☐

(12) WELL TESTS: Drawdown is the distance in feet the water level is lowered below static level.
Was a pump test made? Yes ☐ No ☒ If so, by whom?
Yield: gal./min. with feet drawdown after hours
" " " " " "
" " " " " "
Bailer test gal./min. with feet drawdown after hours
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? No ☐ Yes ☐

(13) WELL LOG: Diameter of well 16 inches
Depth drilled 100 feet. Depth of completed well 100 feet.

NOTE: Place an "X" in the space or combination of spaces needed to designate the material or combination of materials encountered in each depth interval. Under REMARKS make any desirable notes as to occurrence of water and the color, size, nature, etc., of material encountered in each depth interval. Use additional sheet if needed.

DEPTH From	DEPTH To	Clay	Silt	Sand	Gravel	Cobbles	Boulders	Hardpan	Conglomerate	Bedrock	Other	REMARKS
0	10			X								sandy loam
10	38			X	X							
38	68				X							
68	70	X			X							
70	84				X							
84	100	X										

Work started Feb. 18, 19 71 Completed Feb. 26, 19 71

(14) PUMP:
Manufacturer's Name H. P.
Type:
Depth to pump or bowles feet

Well Driller's Statement:
This well was drilled under my supervision, and this report is true to the best of my knowledge and belief.
Name Boyd Bradshaw Well Drilling (Person, firm, or corporation) (Type or print)
Address Hurricane, Utah 84737
(Signed) Boyd C. Bradshaw (Well Driller)
License No. 114 Date May 24, 1971

USE OTHER SIDE FOR ADDITIONAL REMARKS

OOER

Recorded: B. C. ... T. B. ...
Inspection Sheet ...
Copied ...

REPORT OF WELL DRILLER
STATE OF UTAH

Application No. 38420
Claim No. ...
Coordinate No. (C-41-10)29 dda

GENERAL STATEMENT: Report of well driller is hereby made and filed with the State Engineer, in accordance with the laws of Utah. (This report shall be filed with the State Engineer within 30 days after the completion or abandonment of the well. Failure to file such reports constitutes a misdemeanor.)

(Test Well #2) Ite dated 12/14/77 a

(1) WELL OWNER:
Name Town of Springdale
Address Utah

(2) LOCATION OF WELL:
County Wash Ground Water Basin (leave blank)
North/South 100 feet, East/West 1360 feet from E 1/4 Corner
of Section 29 T 41 S, R 10 W SLBM (strike out words not needed)

(3) NATURE OF WORK (check): New Well ☑
Replacement Well ☐ Deepening ☐ Repair ☐ Abandon ☐
If abandonment, describe material and procedure: ...

(4) NATURE OF USE (check):
Domestic ☐ Industrial ☐ Municipal ☐ Stockwater ☐
Irrigation ☐ Mining ☐ Other ☐ Test Well ☑

(5) TYPE OF CONSTRUCTION (check):
Rotary ☑ Dug ☐ Jetted ☐
Cable ☑ Driven ☐ Bored ☐

(6) CASING SCHEDULE: Threaded ☐ Welded ☑
12 " Diam. from 0 feet to 35 feet Gage .360
8 " Diam. from 0 feet to 385 feet Gage .375
" Diam. from ... feet to ... feet Gage ...
New ☑ Reject ☐ Used ☐

(7) PERFORATIONS: Perforated? Yes ☑ No ☐
Type of perforator used Mills
Size of perforations 1/4 inches by 3 inches
1200 perforations from 280 feet to 380 feet
perforations from ... feet to ... feet
perforations from ... feet to ... feet
perforations from ... feet to ... feet
perforations from ... feet to ... feet

(8) SCREENS: Well screen installed? Yes ☐ No ☑
Manufacturer's Name ...
Type ... Model No. ...
Diam. ... Slot size ... Set from ... ft. to ...
Diam. ... Slot size ... Set from ... ft. to ...

(9) CONSTRUCTION:
Was well gravel packed? Yes ☐ No ☑ Size of gravel: ...
Gravel placed from ... feet to ... feet
Was a surface seal provided? Yes ☑ No ☐
To what depth? 40 feet
Material used in seal: Grout
Did any strata contain unusable water? Yes ☐ No ☐
Type of water: ... Depth of strata ...
Method of sealing strata off: ...
Was surface casing used? Yes ☑ No ☐
Was it cemented in place? Yes ☑ No ☐

(10) WATER LEVELS:
Static level 128 feet below land surface Date 3-22-78
Artesian pressure ... feet above land surface Date ...

LOG RECEIVED: RECEIVED APR 17 1978 State Engineer CEDAR CITY

(11) FLOWING WELL:
Controlled by (check) Valve ☐
Cap ☐ Plug ☐ No Control ☐
Does well leak around casing? Yes ☐ No ☐

(12) WELL TESTS: Drawdown is the distance in feet the water level is lowered below static level.
Was a pump test made? Yes ☑ No ☐ If no, by whom? ...
Yield 60 gal./min. with 75 feet drawdown after 30 hours
... gal./min. with ... feet drawdown after ... hours
Bailer test ... gal./min. with ... feet drawdown after ... hours
Artesian flow ... g.p.m. Date ...
Temperature of water ... Was a chemical analysis made? No ☒ Yes ☐

(13) WELL LOG: Diameter of well 8 inches
Depth drilled 385 feet. Depth of completed well 385 feet.

NOTE: Place an "X" in the space or combination of spaces needed to designate the material or combination of materials encountered in each depth interval. Under REMARKS make any desirable notes as to occurrence of water and the color, size, nature, etc., of material encountered in each depth interval. Use additional sheet if needed.

DEPTH From	DEPTH To	Clay	Silt	Sand	Gravel	Cobbles	Boulders	Boulders	Conglomerate	Bedrock	Other	REMARKS
0	30	X				X						
30	275	X										Schinley Brown & White Sandstone
275	377	X		X	X							Schinerump
377	385	X										Redish Brown Mancopie

Work started Jan. 1 1978 Completed Mar. 24 1978

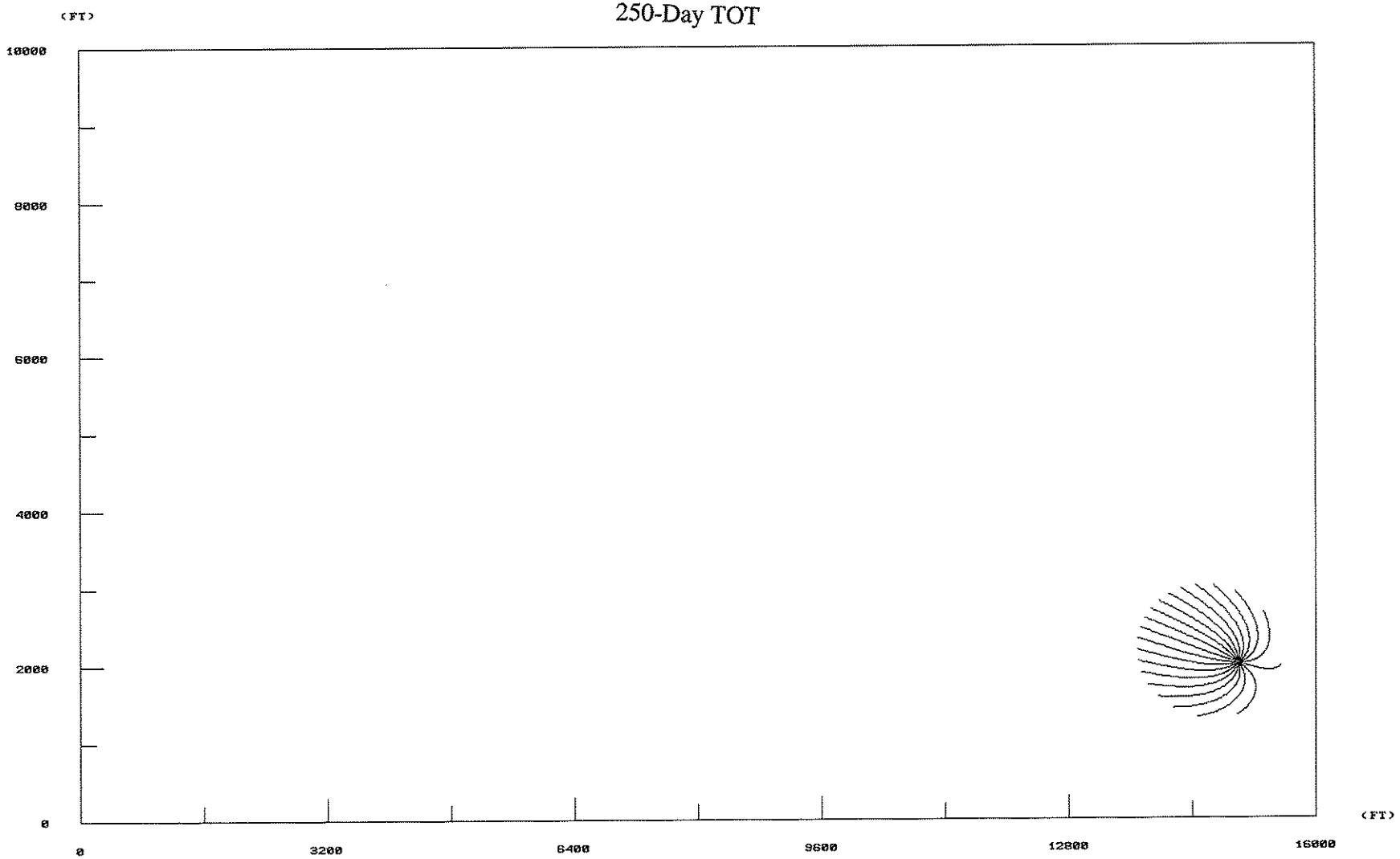
(14) PUMP:
Manufacturer's Name ... H. P. ...
Type: ...
Depth to pump or bowls ... feet

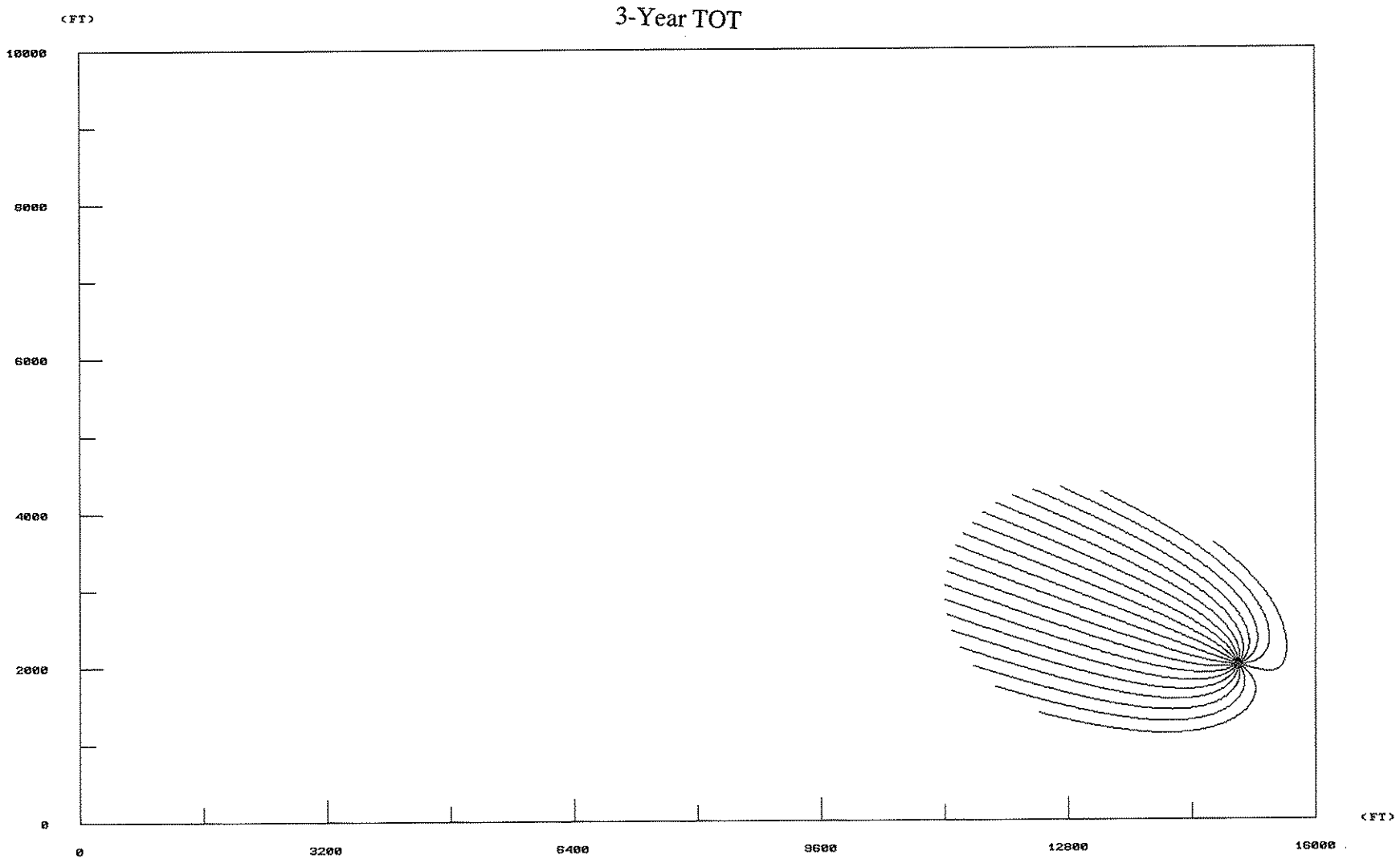
Well Driller's Statement:
This well was drilled under my supervision, and this report is true to the best of my knowledge and belief.
Name Anzalone Pumps Drilling Co. (Person, firm, or corporation) (Type or print)
Address Beryl Utah
(Signed) ... (Well Driller)
License No. 27 Date March 24 1978

USE OTHER SIDE FOR ADDITIONAL REMARKS

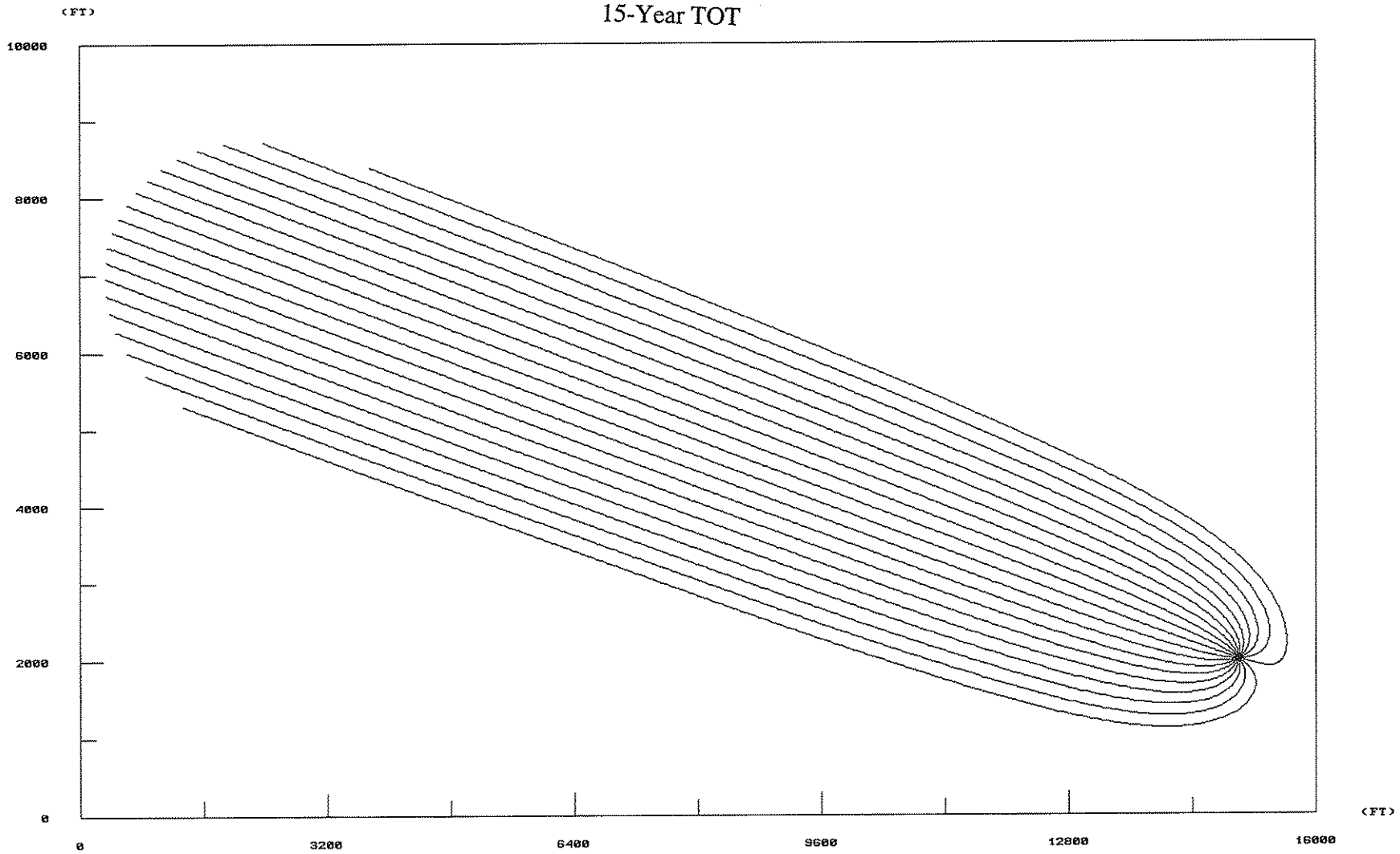
Appendix C
Output from WHPA Models

250-Day TOT




3-Year TOT
(FT)
10000
8000
6000
4000
2000
0
0
3200
6400
9600
12800
16000
(FT)

15-Year TOT



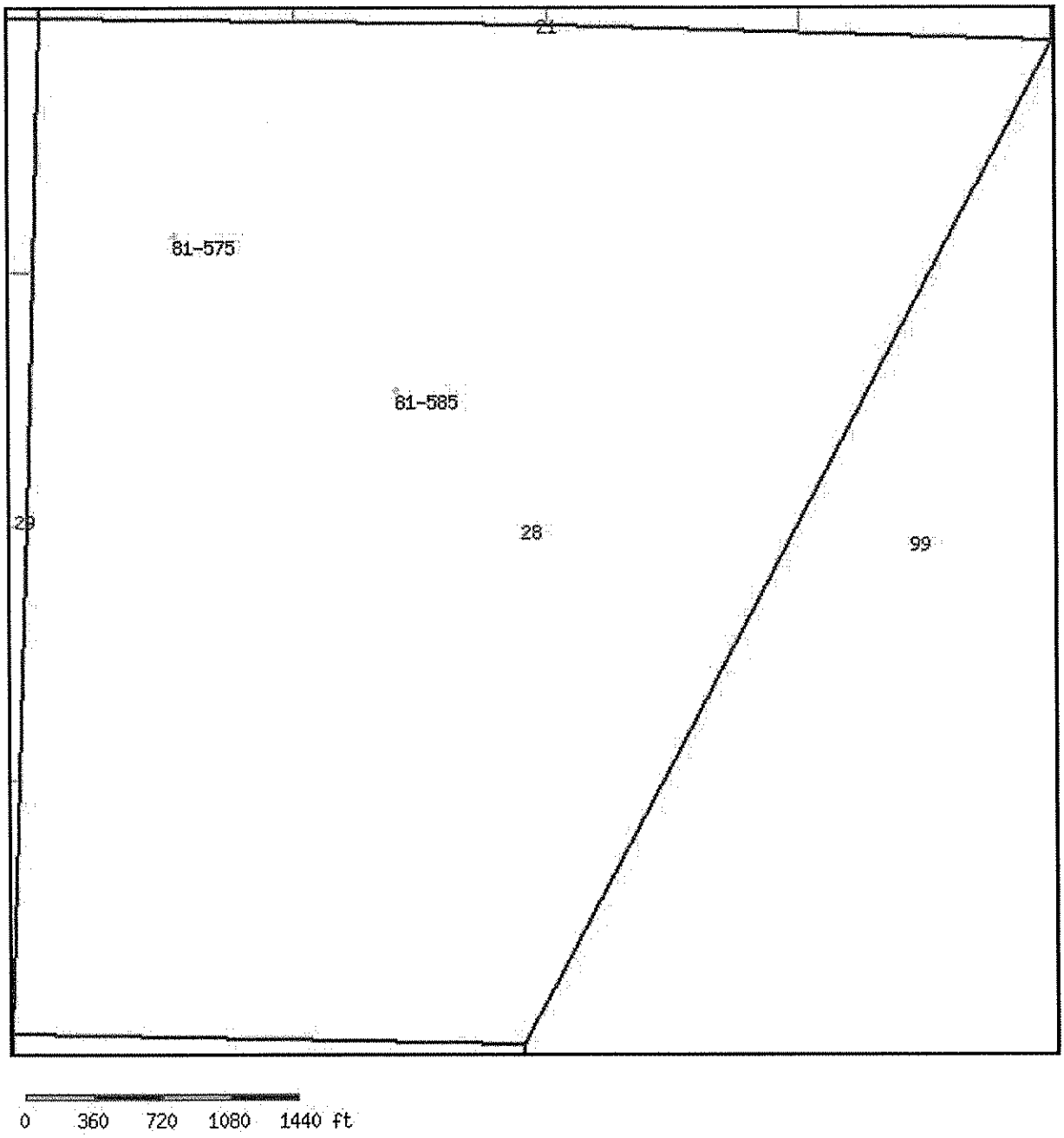
Appendix D
Water Rights Search Results

Utah Division of Water Rights

Output Listing

Version: 2009.05.06.00 Rundate: 05/28/2010 03:11 PM

Search of Section 28, Township 41S, Range 10W, SL b&m Criteria:wrtypes=W,C,E podtypes=S,U,D,Sp,P,R,T status=U,A,P usetypes=all



Water Rights

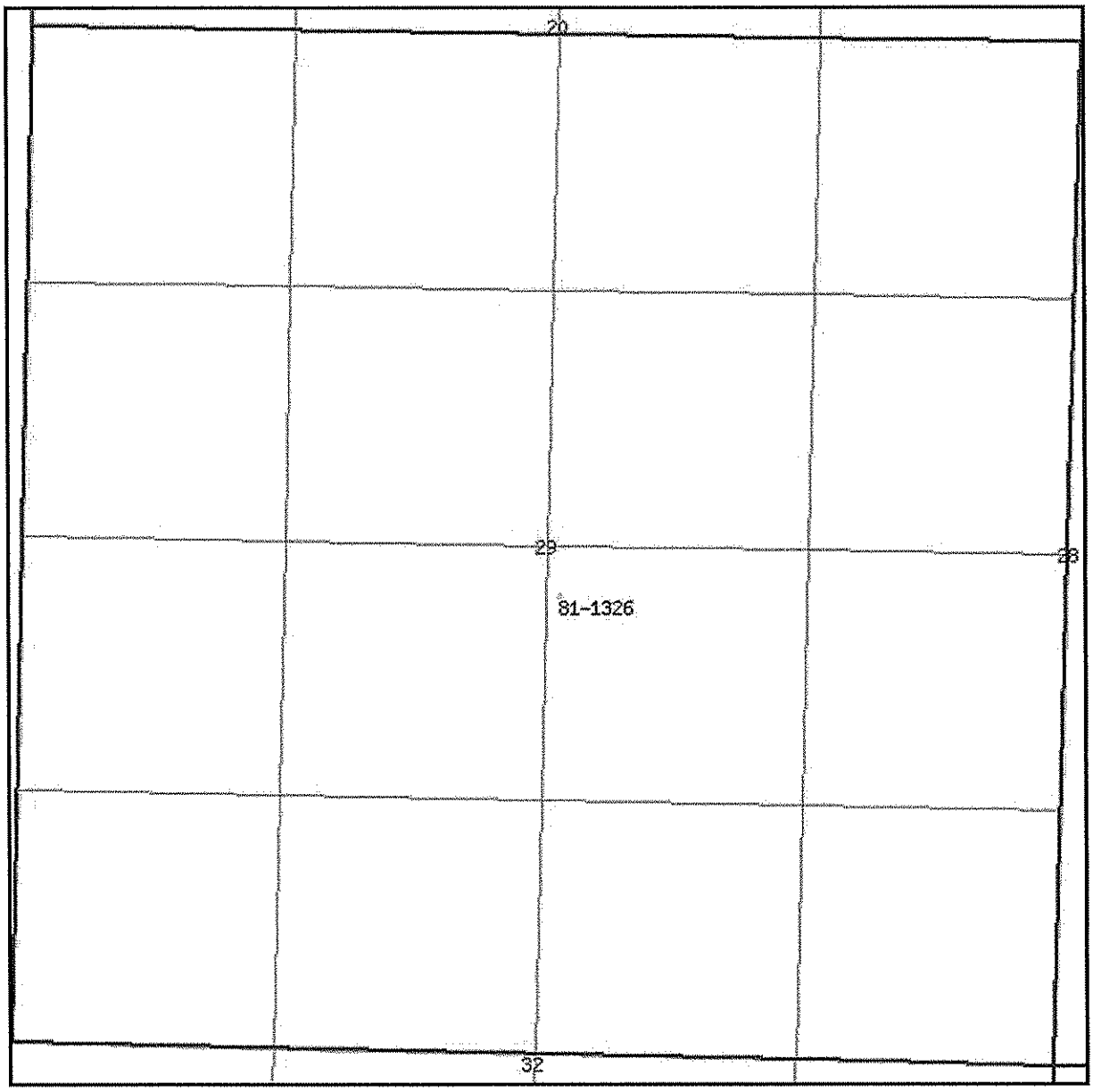
WR Number	Diversion Type/Location	Well Log	Status	Priority	Uses	CFS	ACFT	Owner Name
81-575	Underground		P	19630706 D		0.000	0.450	JAMES M. AND JUDYTHE D ROBERTS
	N1530 E775 W4 28 41S 10W SL							JOINT TENANTS
81-585	Underground	well info	P	19630421 M		0.330	0.000	SPRINGDALE TOWN CORPORATION
	N711 E1944 W4 28 41S 10W SL							SPRINGDALE UT 84767

Utah Division of Water Rights

Output Listing

Version: 2009.05.06.00 Rundate: 05/28/2010 03:13 PM

Search of Section 29, Township 41S, Range 10W, SL b&m Criteria:wrtypes=W,C,E podtypes=S,U,D,Sp,P,R,T status=U,A,P usetypes=all



Water Rights

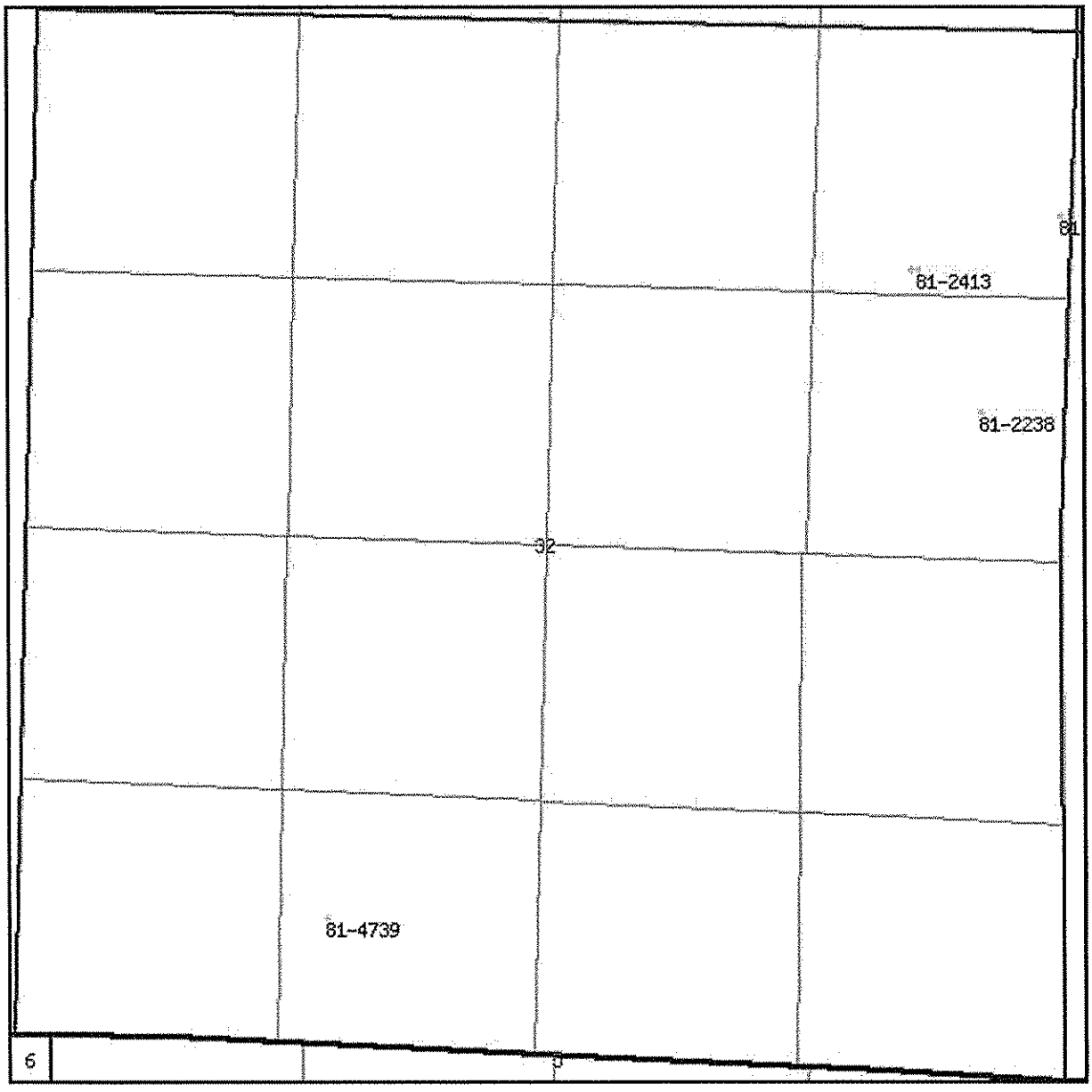
WR Number	Diversion Type/Location	Well Log	Status	Priority	Uses	CFS	ACFT	Owner Name
81-1326	Underground S222 W2650 E4 29 41S 10W SL	well info	P	19630421	M	0.145	0.000	SPRINGDALE TOWN CORPORATION SPRINGDALE UT 84767

Utah Division of Water Rights

Output Listing

Version: 2009.05.06.00 Rundate: 05/28/2010 03:15 PM

Search of Section 32, Township 41S, Range 10W, SL b&m Criteria:wrtypes=W,C,E podtypes=S,U,D,Sp,P,R,T status=U,A,P usetypes=all



Water Rights

WR Number	Diversion Type/Location	Well Log	Status	Priority	Uses	CFS	ACFT	Owner Name
81-1120	Surface		P	1862	IS	3.090	1015.714	TOWN OF ROCKVILLE
	N606 E1631 SW 32 41S 10W SL							ROCKVILLE UT 84763
81-1135	Surface		P	18800000	I	0.270	73.500	DONALD E. DEMILLE
	N606 E1631 SW 32 41S 10W SL							P. O. BOX
81-1146	Surface		P	18630000	I	1.300	358.500	HALL AND GRAFTON IRRIGATI(COMPANY
	N606 E1631 SW 32 41S 10W SL							P. O. BOX
81-1147	Surface		P	18650000	I	1.420	391.000	HALL AND GRAFTON IRRIGATI(COMPANY
	N606 E1631 SW 32 41S 10W SL							P. O. BOX
81-1623	Underground		P	19510907	DI	0.000	2.000	HUBERT S. & FLORA E. REED
	N753 W473 E4 32 41S 10W SL							P. O. BOX 1229
81-216	Surface		P	19470224	IO	0.200	0.000	ZION PARK RESORT LIMITED PARTNERSHIP
	S1245 W875 NE 32 41S 10W SL							C/O SCOTT THORNTON, WESTEI STATES MANANGEMENT CO.
81-2238	Underground		P	19510907	I	0.000	1.000	HUBERT S. & FLORA E. REED
	N753 W473 E4 32 41S 10W SL							P. O. BOX 1229
81-2413	Surface		P	19630421	M	0.525	0.000	SPRINGDALE TOWN CORPORATION
	S1245 W843 NE 32 41S 10W SL							SPRINGDALE UT 84767
81-349	Underground		P	19570511	IO	0.089	0.000	ERIS S. WILLIAMS
	S965 W90 NE 32 41S 10W SL							P. O. BOX 184
81-4739	Surface		P	1862	I	0.750	206.432	ROCKVILLE TOWN DITCH COMPANY
	N606 E1631 SW 32 41S 10W SL							PO BOX 630158

Appendix E
Checklist of Potential Contamination Sources

Checklist of Potential Contamination Sources
Hummingbird Well
Town of Springdale

Source #	Potential Contamination Source	Within Zone One	Within Zone Two	Within Zone Three	Within Zone Four
1	Active and abandoned wells	None	None	None	None
2	Agricultural pesticide, herbicide and fertilizer storage, use, filling and mixing	None	None	None	None
3	Airport maintenance and fueling sites	None	None	None	None
4	Animal feeding operations with more than ten units	None	None	None	None
5	Animal watering troughs located near unfenced wells and springs that attract livestock	None	None	None	None
6	Auto washes	None	None	None	None
7	Beauty salons	None	None	None	None
8	Boat builder and refinishers	None	None	None	None
9	Chemical reclamation facilities	None	None	None	None
10	Chemigation wells	None	None	None	None
11	Churches, schools, hotels, restaurants, tourist shops, theaters and city facilities	None	5	3	2
12	Concrete, asphalt, tar and coal companies	None	None	None	None
13	Dry cleaners	None	None	None	None
14	Farm dump sites	None	None	None	None
15	Farm maintenance garages	None	None	None	None
16	Feed lots	None	None	None	None
17	Food processors, meat packers and slaughter houses	None	None	None	None
18	Fuel and oil distributors and storers	None	1	None	None
19	Furniture strippers, painters, finishers and appliance repairers	None	None	None	None
20	Grave yards, golf courses, parks and nurseries	None	None	1	None
21	Heating oil storers	None	None	None	None
22	Industrial manufacturers: chemicals, pesticides, paper and leather products, textiles, rubber, plastic, fiberglass, silicone, glass, pharmaceutical and electrical equipment, etc.	None	None	None	None
23	Industrial waste disposal/improvement areas and municipal wastewater treatment plants, landfills, dumps and transfer stations	None	None	None	None
24	Junk and salvage yards	None	None	None	None
25	Laundromats	None	None	None	None
26	Machine shops, metal platers, heat treaters, smelters, annealers and descalers	None	None	None	None
27	Manure piles	None	None	None	None
28	Medical, dental and veterinarian offices	None	None	1	None
29	Mortuaries	None	None	None	None
30	Mining operations	None	None	None	None
31	Muffler shops	None	None	None	None

Checklist of Potential Contamination Sources
Hummingbird Well
Town of Springdale

Source #	Potential Contamination Source	Within Zone One	Within Zone Two	Within Zone Three	Within Zone Four
32	Pesticide and herbicide storers and retailers	None	None	None	None
33	Photo processors	None	None	None	None
34	Print shops	None	None	None	None
35	Radiological mining operations	None	None	None	None
36	Railroad yards	None	None	None	None
37	Research laboratories	None	None	None	None
38	Residential pesticide, herbicide and fertilizer storage, use, filling and mixing areas	None	15	2	None
39	Residential underground storage tanks	None	None	None	None
40	Roads, highways, and freeways	None	Fig. 1	Fig. 1	Fig. 1
41	Salt and sand-salt piles	None	None	None	None
42	Sand and gravel mining operations	None	None	None	None
43	School vehicle maintenance barns	None	None	None	None
44	Sewer lines	None	Fig. 1	Fig. 1	Fig. 1
45	Single-family septic tank/drain-field systems	None	None	None	None
46	Sites of reported spills	None	None	None	None
47	Small engine repair shops	None	None	None	None
48	Storm water impoundment sites and snow dumps	None	None	None	None
49	Subdivisions using subsurface wastewater disposal systems (large and individual septic tank/drain-field systems)	None	None	None	None
50	Submersible pumps used to pump wells	1	None	None	None
51	Taxi cab maintenance garages	None	None	None	None
52	Tire shops	None	None	None	None
53	Toxic chemical and oil pipelines	None	None	None	None
54	Vehicle chemical supply storers and retailers	None	None	None	None
55	Vehicle dealerships	None	None	None	None
56	Vehicle quick lubes	None	None	None	None
57	Vehicle rental shops	None	None	None	None
58	Vehicle repair, body shops and rust proofers	None	None	None	None
59	Vehicle service stations and terminals	None	None	None	None
60	Wood preservers	None	None	None	None

Appendix F
UST List

6/1/2010

Facility ID	Location Name	Location Address	Location City	Location Zip	Location County	Owner Name	Owner Address	Owner City	Owner State	Owner Zip	Owner Phone	Total Tanks	Closed Tanks
6000697	FLYING J #05101 ST. GEORGE	2841 S 60 E	SAINT GEORGE	84790	WASHINGTON	FLYING J INC	333 W CENTER ST	NORTH SALT LAKE	UT	84054	(801) 296-7716	5	0
6000780	ST GEORGE SEWER PLANT	3780 S 1550 W	SAINT GEORGE	84790	WASHINGTON	CITY OF ST GEORGE	931 E RED HILLS PARKWAY	SAINT GEORGE	UT	84770	(435) 634-5904	1	1
6000732	FABULOUS FREDDYS CAR WASH	134 S 1300 E (RIVER RD)	SAINT GEORGE	84790	WASHINGTON	FABULOUS FREDDY'S CARWASH	10091 PARK RUN DR STE 110	LAS VEGAS	NV	89145	(435) 652-4566	3	0
6000777	MAVERIK #370	2078 E RIVERSIDE DR	SAINT GEORGE	84790	WASHINGTON	MAVERIK COUNTRY STORES INC.	880 W CENTER STREET	NORTH SALT LAKE	UT	84054	(801) 335-3860	4	0
6000342	BLOOMINGTON MARKET	141 W BRIGHAM RD	SAINT GEORGE	84790	WASHINGTON	YOUNKER LAND & DEVELOPMENT LLC	141 W BRIGHAM RD	SAINT GEORGE	UT	84790	(435) 229-7529	3	0
6000775	FORT PIERCE SINCLAIR	3795 S RIVER RD	SAINT GEORGE	84790	WASHINGTON	PRICE HILL DEVELOPMENT	675 N 1300 E	SAINT GEORGE	UT	84770	(435) 673-9421	5	0
6000798	OLD AIRPORT	OLT AIRPORT SE OF SAINT GEORGE	SAINT GEORGE	84790	WASHINGTON	CITY OF ST GEORGE	931 E RED HILLS PARKWAY	SAINT GEORGE	UT	84770	(435) 634-5904	1	1
6000311	ANDRUS TRANSPORTATION	3185 E DESERET DR N	SAINT GEORGE	84790	WASHINGTON	ANDRUS TRANSPORTATION INC	3185 E DESERET DR	SAINT GEORGE	UT	84790	(435) 673-1566	1	0
6000751	MIRASTAR #62040	2610 S PIONEER STREET	SAINT GEORGE	84790	WASHINGTON	TESORO REFINING & MARKETING CO	3450 S 344TH WAY STE 201	AUBURN	WA	98001	(253) 896-8700	3	0
6000750	QUALITY EXCAVATION	1472 E 3950 S	SAINT GEORGE	84790	WASHINGTON	QUALITY EXCAVATION	1472 E 3950 S	SAINT GEORGE	UT	84790	(435) 634-0111	3	0
6000377	DUTCHMANS SINCLAIR	2300 W SANTA CLARA DR	SANTA CLARA	84765	WASHINGTON	NICK FREI	2300 W SANTA CLARA DR	SANTA CLARA	UT	84765	(435) 628-8482	3	0
6000306	FAA-SHIVWITS RMLR QVJ	SHIVWITS	SANTA CLARA	84765	WASHINGTON	FAA SALT LAKE SMO SAFETY OFFICE	2150 W 700 N BUILDING 1	SALT LAKE CITY	UT	84116	(801) 320-2059	1	1
6000691	LIGHTFOOTS SANTA CLARA	2275 W SANTA CLARA DR	SANTA CLARA	84765	WASHINGTON	LIGHTFOOTS INC	PO BOX 380200	IVINS	UT	84738	(206) 679-8814	3	0
6000046	JENKINS OIL CO. INC.	2753 W SANTA CLARA DR	SANTA CLARA	84765	WASHINGTON	JENKINS OIL	PO BOX 1356	CEDAR CITY	UT	84721	4355864819	3	3
6000531	SPRINGDALE CHEVRON	1593 ZION PARK BLVD	SPRINGDALE	84767	WASHINGTON	ZION ENROUTE LLC	1593 ZION PARK BLVD	SPRINGDALE	UT	84767	(435) 772-3677	5	2
6000400	SPRINGDALE TEXACO	445 ZION PARK BLVD	SPRINGDALE	84767	WASHINGTON	JOANNA ADAMSON	1490 AMBASSADOR WAY	SALT LAKE CITY	UT	84108	(801) 582-5112	4	4
6000261	CANYON TIRE & FOOD MART	962 ZION PARK BLVD	SPRINGDALE	84767	WASHINGTON	JERRY HATCH	962 ZION PARK BLVD	SPRINGDALE	UT	84767	(435) 772-3963	6	3
6000260	ZION CANYON EXXON	1130 ZION PARK BLVD	SPRINGDALE	84767	WASHINGTON	ZION PARK RESORT INC	2159 S 700 E STE 200	SALT LAKE CITY	UT	84106	(801) 467-3600	4	4
6000658	ZION NATIONAL PARK	ZION NATIONAL PARK	SPRINGDALE	84767	WASHINGTON	NATIONAL PARK SERVICE	PO BOX 925	SPRINGDALE	UT	84767	(435) 772-3256	7	5
6000415	TOQUERVILLE MERCANTILE	176 N TOQUER BLVD	TOQUERVILLE	84774	WASHINGTON	REUBEN CLINGER	BOX 117	TOQUERVILLE	UT	84774	(435) 635-4756	2	2
6000131	SPANISH TRAIL SUPPLY	21 S MAIN ST	VEYO	84782	WASHINGTON	SPANISH TRAIL SUPPLY COMPANY LLC	21 S MAIN STREET	VEYO	UT	84782	(435) 668-7505	4	1
6000378	VEYO MERC	13 N MAIN ST	VEYO	84782	WASHINGTON	VEYO LAND & LIVESTOCK LLC	175 W 400 N	VEYO	UT	84782	(435) 574-3330	6	6
6000202	RED CLIFFS SINCLAIR	880 W RED CLIFFS DR	WASHINGTON	84780	WASHINGTON	HARDY ENTERPRISES INC	598 W 2600 S	BOUNTIFUL	UT	84010	(801) 298-1180	3	0
6000352	OLD TOWN & COUNTRY	471 W TELEGRAPH ST	WASHINGTON	84780	WASHINGTON	OLD TOWN & COUNTRY	471 WEST TELEGRAPH RD	WASHINGTON	UT	84780	(801) 368-6788	6	3
6000343	WASHINGTON SERVICE	214 W TELEGRAPH ST	WASHINGTON	84780	WASHINGTON	WASHINGTON SERVICE	214 W TELEGRAPH	WASHINGTON	UT	84780	(435) 673-1472	2	2
6000714	SERVICE STATION INC. TEXACO	1036 W MIDDLETON DR	WASHINGTON	84780	WASHINGTON	EUGENE E HAFEN	1036 W MIDDLETON DRIVE	WASHINGTON	UT	84780	(435) 656-8032	3	0
6000170	RIVERBEND EXPRESS	1391 W REDLEDGE RD	WASHINGTON	84780	WASHINGTON	NORMAN HOWARD	P O BOX 890	WASHINGTON	UT	84780	(435) 634-9800	4	2
6000655	HARTS GAS & FOOD	260 S GREEN SPRING DR	WASHINGTON	84780	WASHINGTON	HARTS GAS AND FOOD LLC	P O BOX 418	AMERICAN FORK	UT	84003	(801) 756-9681	3	0
6000796	MAVERIK #390	980 N HOODOO WAY	WASHINGTON	84780	WASHINGTON	MAVERIK COUNTRY STORES INC.	880 W CENTER STREET	NORTH SALT LAKE	UT	84054	(801) 335-3860	4	0
6000749	MIRASTAR #62041	675 W TELEGRAPH ST	WASHINGTON	84780	WASHINGTON	TESORO REFINING & MARKETING CO	3450 S 344TH WAY STE 201	AUBURN	WA	98001	(253) 896-8700	3	0
6000209	FREEWAY CHEVRON # 208910 (OLD TRI-MART #1063)	990 BUENA VISTA BLVD	WASHINGTON	84780	WASHINGTON	DARREL L. ANDERSON	990 BUENA VISTA BLVD	WASHINGTON	UT	84780	(435) 673-3675	8	4
6000330	FIRST STOP TESORO	195 E TELEGRAPH ST	WASHINGTON	84780	WASHINGTON	DARREL L. ANDERSON	1820 W 5870 N	SAINT GEORGE	UT	84770	(435) 673-6677	3	0
6000128	U.S.WEST 671564	100 S 200 W	WASHINGTON	84780	WASHINGTON	QWEST COMMUNICATIONS	250 BELL PLAZA STE 1601	SALT LAKE CITY	UT	84111	(801) 237-3006	1	1

Appendix G
Fact Sheets

Partnership for the Environment

Utah Department of Environmental Quality

Household Hazardous Waste Fact Sheet

What is Household Hazardous Waste?

Many hazardous products and chemicals such as cleaners, oils and pesticides are used in the home every day. When discarded, these products are called household hazardous waste (HHW). HHWs are discarded materials and products that are ignitable, corrosive, reactive, toxic or otherwise listed as hazardous by the EPA. Products used and disposed of by a typical residence may contain more than 100 hazardous substances including:

- Batteries
- Cleaners
- Cosmetics
- Fluorescent light bulbs
- Glues
- Heating oil
- Insecticides and pesticides
- Ink
- Medicines
- Motor oil and automotive supplies
- Paints, thinners, stains and varnishes
- Polishes
- Swimming pool chemicals
- Smoke detectors
- Thermometers
- Fuel

HHW is a Serious Threat

The U.S. Environmental Protection Agency estimates the average American household generates 20 pounds of HHW each year. As much as 100 pounds of HHW can accumulate in the home and remain there until the resident moves or undertakes a thorough "spring cleaning."

Since the chemicals found in HHW can cause soil and groundwater contamination, generate hazardous emissions at landfills and disrupt water treatment plants, it is important to dispose of HHW properly. Many solid waste treatment facilities are currently required to screen for HHW to avoid operating under restrictive hazardous waste laws. Furthermore, many communities may be required to establish a HHW collection program in order to qualify for permits to manage storm water.

Safe Handling Tips

The best way to handle household hazardous materials is to completely use the product before disposing of the container. If this is not possible, then the next alternative is to return unused portions to your community household hazardous waste clean-up day. Keep products in their original package with all labels intact. If the container is leaking, place it in a thick plastic bag. Pack the products in a plastic-lined cardboard box to prevent leaks and breakage.

Household hazardous waste clean-up days are for household wastes only. No industrial or commercial wastes and no containers larger than five gallons are accepted. Explosives, radioactive

material and medical wastes are also unacceptable.

HHW can be dangerous to people and pets who come in contact with them. HHW can endanger water supplies, damage sewage treatment systems, and cause other environmental damage. Only use the products as directed. **DO NOT:**

- Flush HHWs down the toilet
- Pour HHWs down the sink
- Pour HHWs down a storm drain
- Pour HHWs on the ground

Contact your local health department or the Division of Solid and Hazardous Waste to determine whether your community has a household hazardous waste collection program.

Identify HHW

Reduce the amount of potentially hazardous products in your home and eliminate what you throw away by following these easy steps:

1. **Before you buy:**

- Read the labels and be aware of what they mean.
- Look for these words on labels; they tell you what products may need special handling or disposal.

Caution	Flammable
Combustible	Poison
Corrosive	Toxic
Danger	Volatile
Explosive	Warning

- Select a product best suited for the job.
- Buy only what you can use entirely.

2. **After you buy:**

- Read label precautions and follow directions for safe use.
- Recycle/dispose of empty containers properly.
- Share what you can't use with friends or neighbors.
- Store properly.
- Use recommended amounts; more is not necessarily better.
- Use the child-resistant closures and keep them on tightly.

For More Information, Contact:

Division of Solid & Hazardous Waste - (801) 538 - 6170
Division of Drinking Water, Source Protection Program - (801) 536-4200
Environmental Hotline - 1-800-458-0145
Sonja Wallace, Pollution Prevention Coordinator - (801) 536-4477

Partnership for the Environment

Utah Department of Environmental Quality

Fertilizer Fact Sheet

What Are The Potential Hazards?

Fertilizer applied to plants during crop, lawn, and garden maintenance may leach into the ground water and cause contamination. The main constituent in fertilizer is usually nitrogen. If the nitrate level of drinking water is too high, infants, up to the age of six months, can develop a fatal disease called blue baby syndrome (methemoglobenemia). Drinking water that contains 10 milligrams of nitrate-nitrogen per liter of water exceeds the drinking water standard and should not be used, especially for infant formula. Proper storage, application, and watering procedures should be included in fertilizer best management practices to prevent contamination of ground water.

Storing Fertilizers

The less fertilizer you buy, the less you will have to store. Therefore, only purchase the amount and kind of fertilizer that you need.

- Fertilizer should be stored in locked, dry cabinets.
- Keep fertilizer and pesticides on separate shelves.
- Don't store fertilizer with combustibles, such as gasoline or kerosine, because of explosion hazards.

Application Precautions

The chemical in fertilizer that can most easily pollute ground water is a form of nitrogen called nitrate. Nitrate moves readily in soil to the ground water strata. The best way to prevent the movement of nitrate into the ground water is to apply no more nitrogen than the crops, grass, garden plants, shrubs, or trees can use during the time that the plants are growing.

- Calibrate your spreader and sprayer to keep from applying too much fertilizer.
- Load fertilizer spreaders on the driveway or other hard surfaces so any spills can easily be swept up. Fertilizer that spills should be swept up and applied to the lawn or garden at the right time and amount. This allows the fertilizer to grow plants instead of washing off into the storm drain system and ultimately contaminating nearby streams and lakes.
- If you are using liquid fertilizer on your turf, add fertilizer to the spray tank while on the lawn. This way, if you spill the fertilizer, it will be used by the plants and not run off into the storm drain system.
- Do not spray or apply fertilizer near irrigation wells. Wells are conduits to the ground water.

Application Rates For Lawns

Utah State University's Extension Service recommends the following for Utah lawns: "It is important to fertilize on a regular basis every four to six weeks to maintain an attractive lawn. Begin

when lawns start to green in the spring, mid to late April. Earlier applications may cause a lawn to become greener faster, but may also increase spring disease problems. Summer applications of nitrogen fertilizer will not burn lawns, if you apply them to dry grass and water immediately. Fall applications are important for good winter cold tolerance, extended fall color, and fast spring green-up. A complete fertilizer containing nitrogen, phosphorus and potassium should be applied in the fall every three to four years. This will prepare the lawn for winter conditions and allow the phosphorus to penetrate into the root zone by the next growing season.

For a well-kept lawn in Utah, apply 1 pound of available nitrogen per 1,000 square feet each four to six weeks throughout the growing season. The following chart indicates how much of various fertilizer will supply one pound of nitrogen."

%N on Label	Pounds of Fertilizer Per 1000 Square Feet
12-15	7-8
18-21	5-5 ½
24-28	3 ½-4
30-34	3-3½
45-46	2-2 ¼

Types of Plants

One of the best ways to protect your ground water is to use plants that are drought-tolerant and that are adapted to your area. Drought-tolerant or low-water-use plants can continue to survive once they are established, even during times of little rainfall. Because you do not have to water these plants, there is less chance that nitrate and pesticides will be carried with the water through the soil and into the ground water.

If low-water-use plants are not practical, then try to use medium water use plants. Water these plants only when they begin to show drought stress. Some plants will wilt when they are drought-stressed, while other plants will show marginal leaf burn.

Watering

Over-watering plants can cause excess water to move through the soil. This water can flush fertilizer away from the root zone of your plants and into the ground water. The best way to avoid over-watering is simply to measure how much you are adding. Contact your county Extension Service to determine the best way to calculate how much water your plants need and how to measure the amount you are applying.

For More Information, Contact:

Division of Drinking Water, Source Protection Program - (801) 536-4200
Department of Agriculture - (801) 538-7100
Environmental Hotline - 1-800-458-0145
Sonja Wallace, Pollution Prevention Coordinator - (801) 536-4477

Partnership for the Environment

Utah Department of Environmental Quality

Pesticides Fact Sheet

What Are The Potential Hazards?

Pesticides applied to plants during crop, lawn, and garden maintenance may leach into the ground water and cause contamination. Proper storage, mixing, application, spill cleanup, watering, and disposal procedures should be included in pesticide best management practices.

Storing Pesticides

The fewer pesticides you buy, the fewer you will have to store. Therefore, only purchase the amount and kind of pesticide that is needed. Pesticides should always be stored in sound, properly labeled, original containers. ***Sound containers are the first defense against spills and leaks.***

- Ensure that there are no holes, tears, or weak seams in the containers and that the label is readable.
- Pesticides should be stored in locked, dry cabinets.
- Be sure to store dry products above liquids to prevent wetting from spills.
- Storage and mixing areas should not be located near floor drains of any kind.
- Storage facilities should have secondary containment, such as a berm or dike, which will hold spills or leaks at:
    1. 10% of the total volume of the containers, or
    2. 110% of the volume of the largest container, whichever is larger.

Mixing Pesticides

- Mix pesticides on an impermeable surface, such as concrete, so any spills will be contained.
- Mix only the amount that you will use:
    1. Measure the total square feet you intend to treat.
    2. Read the label on the pesticide container and follow the instructions. (These are often given in terms of amount of pesticide to use per thousand square feet.)
    3. By properly measuring and calculating, there should be little or no pesticide left in the spray tank when the job is finished and it will be applied at the recommended rate.

Applying Pesticides

Pesticides are used to kill or control weeds (herbicides), insects (insecticides) and fungi (fungicides) that attack plants. Some of these pesticides can move through the soil and into the ground water. Guidelines for the safe use of pesticides are listed below:

- Be willing to accept a low level of weed, insect, and plant disease infestation.

- Use pesticides only when absolutely necessary.
- Identify pests correctly. Use the proper pesticides.
- Read and follow the directions printed on the container labels. Remember, *the label is the law.*
- Calibrate your spreader and sprayer to keep from applying too much pesticide.
- Do not spray or apply pesticides near irrigation wells. Wells are conduits to the ground water.
- Do not spray or apply pesticides near your walks and driveway. This prevents them from washing off into the storm drain system.

Cleaning Up Spills

- Dry formulated pesticide spills should be swept up and applied to crops, lawns, and gardens at the rate specified on the label.
- Liquid pesticide spills should be soaked up using absorbent material (such as, soil, sawdust, and cat litter). The contaminated absorbent material should then be put in a sealed container and taken to a household hazardous waste collection site.

Watering

Over-watering your plants can cause excess water to move through the soil. This water can carry pesticides that can contaminate the ground water. The best way to avoid over-watering is simply to measure how much you are adding. Contact your county Extension Service to determine the best way to calculate how much water your plants need and how to measure the amount you are applying.

Disposing of Pesticides

If the pesticide was properly measured and mixed, there should be little or no spray left in the tank. The little that may be left can be safely sprayed over the area that was treated until it is gone. Disposal of "empty" pesticide containers and unused pesticides should be handled as follows:

- If you are using liquid pesticides, rinse the container three times. Be sure to pour the rinsing into your sprayer and not down a drain or onto the ground. Containers which have been emptied and rinsed can be discarded in the trash.
- Unused pesticides in their original containers can be recycled at household hazardous waste collection sites.

For More Information, Contact:

Division of Drinking Water, Source Protection Program - (801) 536-4200
Department of Agriculture - (801) 538-7100
Environmental Hotline - 1-800-458-0145
Sonja Wallace, Pollution Prevention Coordinator - (801) 536-4477