Hydrogeologic Analysis of the Water Supply for Franklin, Franklin County, Idaho

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Information Circular 57
ISBN 1-55765-111-6
2005

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SUMMARY

Franklin, the oldest incorporated community in Idaho, lies along the east side of Cache Valley in the Bear River drainage. This town of approximately 640 residents acquires its domestic water from springs and wells along the western front of the Bear River mountain range. Some of the springs contain particulate contaminants, forcing the community to either treat the water or develop a new ground-water source. Scientists with the Idaho Water Resources Research Institute's "Technical Assistance for Rural Ground Water Development Within Idaho" project have completed a hydrogeologic study of the Franklin area and recommends the following options:

- Abandon the contaminated springs or install an adequate treatment system.
- Drill a new well to replace water lost by decommissioning the contaminated springs. A site is defined east of town for a preliminary test well (Plate 1).
- Consider drilling an additional well near the existing municipal wells.

Proterozoic-, Paleozoic- and Tertiary-age sedimentary strata form the bedrock under Cache Valley near Franklin. A diverse assemblage of unconsolidated sediments lies above these older rocks. The sediments include gravel deposited from ancient streams and mud from Pleistocene Lake Bonneville. Lake Bonneville formed in western Utah, eastern Nevada, and southern Idaho approximately 12,00 to 15,000 years ago when the in-flow by glacial melt-water exceeded the outflow by evaporation from the internally drained Great Basin.

Extensive deposits of mud and silt that accumulated on the former lake floor impede the flow of ground water in the Franklin area. Well-test data show low yields of ground water from the lacustrine (lake) mud and the older bedrock. Higher yields occur in the gravel deposits that reside above the bedrock and below the Bonneville lakebed sediments. Geological fieldwork and interpretation of aerial photographs from the project area defined the distribution of these gravels. An analysis of precipitation that falls in nearby drainage basins shows that the Oxkiller drainage, located immediately east of town, may provide adequate recharge into these gravels. The proposed well is designed to test this sequence of gravel.

Particulates contaminate Crooked Spring, one of Franklin's primary water sources. The contamination results from surface water mixing with subsurface water. Further work on the spring cannot eliminate the contamination; therefore, this source should be abandoned or the water treated. Dowdell and Kingsford springs, the other spring-water sources, continually provide clean water, so they should be maintained. Since the town already uses two wells that penetrate fractured Tertiary bedrock, a new well drilled nearby in the same fracture system should provide a similar quantity of water as the other wells.

INTRODUCTION

Franklin, a town of 640 residents, lies along the front of the Bear River Mountain Range in Cache Valley (Figure 1). This report summarizes results of a study by the IWRRI Technical Assistance for Rural Ground Water Development Within Idaho project to advise Franklin on its problems with the domestic water supply. Domestic water is acquired from three springs and two wells in the foothills east of town. One of the primary sources, Crooked Spring, has had chronic water quality problems during the past few years. The spring was redeveloped recently to remedy the problems, but this work failed and the spring remains contaminated. IWRRI scientists studied the hydrogeology of the existing water supplies and determined additional sources of ground water.

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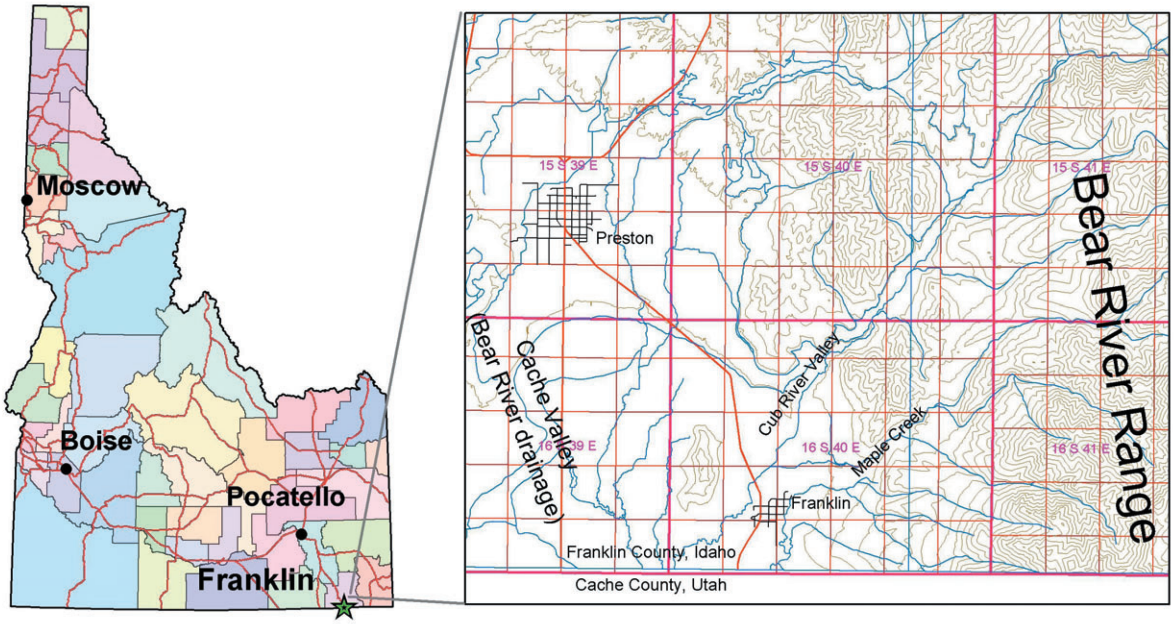

Figure 1. Location map of the Franklin project area, Franklin County, Idaho.

STATEMENT OF PROBLEM

One of the community's primary water supplies, Crooked Spring, contains particulate contaminants. The chronically poor water quality has prompted the Idaho Department of Environmental Quality (DEQ) to require the community to either treat the water or decommission the spring. Regardless of the decision on this spring, Franklin will likely need additional water for its expanding population. From 1990 to 2000, the local population grew 34 percent (U.S. Census Bureau, March, 2001).

OBJECTIVES

This study provides a hydrogeologic assessment of the ground-water systems from which Franklin acquires domestic water. The assessment will help identify a source of water to replace Crooked Spring. It also provides the technical information not generally available that will enable the town to develop a sustainable, additional source of water.

GENERAL GROUND-WATER CONCEPTS

The main points in understanding the ground-water system for Franklin include the composition of the subsurface rocks that make up the water source or aquifer, the locations of recharge and discharge areas for the aquifer, and the long-term sustainability of the aquifer.

Ground water collects and moves between individual grains of sand and gravel and through cracks and fractures in solid rocks. One of the keys to exploiting a ground-water resource is locating a zone where the spaces between grains or fractures are large and interconnected. In such a saturated zone, called an aquifer, water in the subsurface moves under the force of gravity from higher elevations (recharge areas) to lower elevations (discharge areas). Typical discharge areas include springs, streams, and lakes. Most recharge comes from precipitation (rain and snow) that infiltrates the ground. Some recharge occurs from streams and lakes at elevations higher than the ground water. Generally, ground water moves down gradient less than 10 feet per day.

Understanding subsurface geology improves our knowledge of ground-water systems. Aquifers occur where ancient streams deposited sand or gravel or where an extensive network of fractures cut solid rock. Geologists study aquifers and ground-water flow patterns by mapping surface rock outcrops and reviewing the drillers' logs of material penetrated by wells. This leads to identifying the potential areas for well construction and the recharge areas critical for good water quality and sustainability.

Sustainable development requires that ground-water use be less than aquifer recharge. Removing water from wells results in some water level decline in the ground and an associated reduction in natural discharge.

Characterizing natural ground-water discharge from springs and seeps, estimating the discharge of interconnected streams, and defining the quantity and location of annual aquifer recharge provide the fundamental data for sustainable ground-water exploitation.

REGIONAL GEOLOGY

The geological structure, including the type of rocks and the distribution of faults, considerably influences the distribution, quantity, and availability of ground water in the Franklin area.

Rocks primarily of sedimentary strata were deposited in shallow marine water during Precambrian and lower Paleozoic time. The originally flat-lying strata were compressed and transported eastward during Mesozoic time, forming the Idaho-Wyoming overthrust belt. The waning stages of this deformation exposed the section in early Tertiary time to an extensive period of erosion. Modern-day drainage patterns and the distribution of valleys and mountains were largely established during this period of erosion.

Bear River starts in the Uinta Mountains of Utah and flows north into Wyoming, west into Idaho, and then south into the Great Salt Lake. This convoluted course resulted from bedrock controls imposed by complexly folded and faulted sedimentary strata of the Idaho-Wyoming overthrust belt. Rocks within this belt have regional-scale, north-south oriented folds. Many types of faults cut the folded strata; some, called thrust faults, place older rocks above younger, and others, called normal faults, place younger strata above older rocks.

Normal faults, the youngest in the area, cut all of the earlier features and help to form the landscape visible in much of southeastern Idaho. These faults formed primarily during development of the Basin and Range, an extensional tectonic province covering much of the central-west and southwest part of North America. Franklin and the Cache Valley lie within the Idaho-Wyoming overthrust belt in the northern part of the Basin and Range geologic province.

PROJECT AREA GEOLOGY

Exposures of Proterozoic- and Paleozoic-age sedimentary rocks in the Bear River Mountains and west of Franklin on Little Mountain indicate that these strata underlie Tertiary and Quaternary sediments in the study area. The section consists of Proterozoic- and Cambrian-age Brigham Quartzite and lower Paleozoic-age limestone, dolomite, and sandstone. According to mapping by Oriel and Platt (1980), Eocene-age sedimentary rocks of the Salt Lake Formation accumulated above the deformed and deeply eroded pre-Tertiary strata in a shallow, inland sea. Following deposition of the Salt Lake Formation, erosion formed a regionally extensive accumulation of gravel. Young faults cut this sequence and formed isolated, gravel-capped benches and terraces. The terrace gravels now occur as erosional remnants along the margins of valleys throughout the area. Unconsolidated sediments, primarily of glaciolacustrine and fluvial origin, accumulated above the older strata at elevations less than 5,100 feet.

STRATIGRAPHY

The geologic map of the study area (Plate 1), constructed from field mapping, interpretations of aerial photographs, and data from Oriel and Platt (1983), shows the distribution of sedimentary units. The following section discusses the sedimentary strata near Franklin that influence ground-water flow.

Precambrian and Cambrian Brigham Quartzite

The Brigham Quartzite forms the oldest strata exposed in the Bear River Mountain Range and underlies most of the upper parts of the drainage basins east of Franklin. The unit consists primarily of silicified quartz sandstone with local pebble conglomerate lenses. It forms bold, resistant outcrops, though locally it shows pervasive, strong fracturing.

Limestone and dolomite strata, discussed below, form most of the higher elevation areas in the Bear River Range, where the largest amount of precipitation occurs. Ground water flowing through this section to lower elevations would likely equilibrate chemically to the carbonate-rich strata before entering the Brigham Quartzite. Geochemical analyses of water samples (Table 1; Figure 2) collected from springs in the Brigham Quartzite along the east side of the Bear River Range show low levels of Ca and Mg concentration, suggesting that ground water in the Brigham results principally from locally derived precipitation, not from a regional ground-water flow system. If applicable at Franklin, this interpretation suggests that the Brigham Quartzite is not a good target for well development.

Table 1. Chemistry of water from springs in the Brigham Quartzite.

Sample Number	Water Temp (F°)	Alkalinity	Ca (Mg/l)	Mg (Mg/l)	K (Mg/l)	Si (Mg/l)	Na (Mg/l)	Sulfate (Mg/l)
1	60		Not analyzed					
2	65	29	6.6	1.7	1.6	1.05	3.4	<2.00
3	50	14	5.3	1.2	0.7	6.68	2.2	2.52
4	65	16	6.1	1.2	0.7	6.71	2.3	2.46
5	55	18	4.8	1	0.6	6.17	1.9	<2.00
6	58	37	9.9	2.4	0.7	10.8	3	3.09

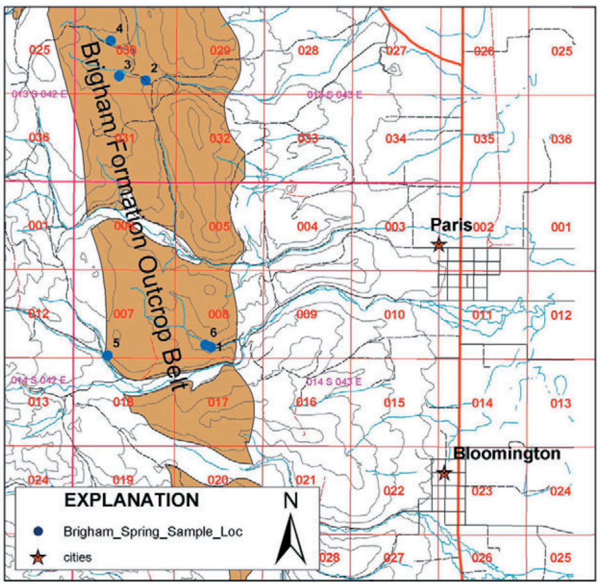

Figure 2. Location map of samples collected from springs in the Brigham Quartzite.

Paleozoic Carbonate Strata

Strata younger than the Brigham Quartzite that occur on Little Mountain west of Franklin include Paleozoic-age limestone and quartzite (Plate 1). These strata do not occur in the Bear River Range near Franklin, so are not important with respect to ground-water systems utilized by the community.

Tertiary Salt Lake Formation

Tertiary-age sedimentary rocks of the Salt Lake Formation overlie the Brigham Quartzite (Oriel and Platt, 1980). These strata include a diverse assemblage of siltstone, sandstone, limestone, and conglomerate that lies above an erosional surface on the older rocks. The strata occur along the lower part of the Bear River Range front and underlie the Cache Valley near Franklin. A north-south normal fault juxtaposes Salt Lake strata near Franklin against the Brigham Quartzite along the Bear River range front (Plate 1).

Most of the wells developed in bedrock near Franklin penetrate siltstone and claystone of the Salt Lake Formation. Water yield from these wells varies widely. Most show yields of 5 to 20 gallons per minute, though a few produce over 200 gpm. Generally, the higher yielding wells are along or near faults, suggesting that fault-induced fractures play a critical role in the higher flow rates. Conversely, this suggests that wells developed in unfractured Salt Lake strata will typically yield low flow rates.

Tertiary and Quaternary Unconsolidated Sediments

Several different types and ages of unconsolidated sediments occur above rocks of the Salt Lake Formation and provide water to many wells in the Franklin area. Most wells in the Cache Valley near Franklin take water from the unconsolidated material, whereas wells within and near the mountains get water from strata of the Salt Lake Formation (Plate 1).

Terrace gravel. Deposits of coarse-grained terrace gravel accumulated during an extensive period of erosion that followed deposition of the Salt Lake Formation. This once regionally extensive gravel unit has been eroded away in many areas because of uplift and faulting. Remnants of the gravel unit now cap ridges near Franklin and form a large dissected alluvial fan at the base of Oxkiller Canyon (Plate 1). The gravel deposits formed earlier than the Glacial Lake Bonneville sediments, so they underlie these extensive clay-rich strata. As such, a hole drilled in the Cub River Valley near Franklin would penetrate the glacial lake sediments and then intersect the gravel before penetrating the Salt Lake Formation.

Wells developed in the gravel section can show yields of 350 gpm or greater. Table 2 shows two examples of such wells. Regionally, numerous springs emanate from the terrace gravels. These data indicate that the gravels carry abundant ground water where hydrologically connected to a recharge area. The large gravel fan in the lower Oxkiller drainage immediately east of Franklin represents such an occurrence. Surface runoff from precipitation in upper Oxkiller Creek recharges this fan (Plates 1 and 2).

Table 2. Example of water yields from wells developed in terrace gravels.

Owner	Location	Well Depth (feet)	Yield (gpm)
Fairview Water District	SE¼NE¼ sec. 8, T. 16 S., R. 40 E.	354	350
Boyd Hanson	SW¼SE¼ sec. 27, T. 16 S. R. 40 E.	200	365

Bonneville and Provo Formations. The predecessor to the Great Salt Lake, ancient Lake Bonneville, occupied much of the Great Basin during Pleistocene time. It formed because glacial melt water and precipitation accumulated faster than what could evaporate from the internally drained area. Lake Bonneville reached a maximum elevation of about 5,100 feet before it breached Red Rock Pass and flowed into the Snake River Plain. The breach drained the lake to an elevation of about 4,800 feet, where it resided for an extended period. The 5,100-foot-elevation high-water stand is referred to as the Bonneville level, and the 4,800-foot elevation is called the Provo level. Geologic features such as shorelines and sediments deposited from the lake use these same names. Unlithified sediments deposited during the Bonneville level high-water stand are named the Bonneville Formation, and similarly for the Provo Formation (Plate 1). Both formations consist primarily of clay-rich sediment, though sand- and gravel-bearing deltas, fed by mountain streams, propagated into the clay-rich sediments.

Clay-rich sediments of the Bonneville and Provo Formations severely impede or preclude ground-water flow. Wells that penetrate these sediments generally derive water from gravel below the clay-rich sediments or from interlayered deltaic sand and gravel beds. Many of the wells in Cache Valley show an artesian head, suggesting that the aquifer underlying the lacustrine clay beds is confined.

STRUCTURE

Faults help to form the landscape visible from Franklin and influence the elevation of the bedrock surface below unconsolidated valley-filling sediments. Two primary fault orientations occur in the study area: north-northeast faults and west-northwest faults. Both sets cut all strata except those deposited from Pleistocene Lake Bonneville. Fault displacement has exposed the older terrace gravel deposits to increased erosion, greatly modifying their distribution and thickness. This relationship indicates that the last movement occurred before Lake Bonneville sedimentation, approximately 12,000 to 15,000 years ago.

North-Northeast Faults

North-northeast faults form the eastern side of Cache Valley by displacing strata down to the west. The largest of this fault set, located approximately 3.5 miles east of Franklin, separates Brigham Quartzite within the Bear River Range from strata of the Salt Lake Formation exposed along the range front (Plate 1). A parallel structure lies between Franklin and the Oxkiller fan. This structure, inferred from differential depths to bedrock in drill holes, separates relatively thick accumulations of unconsolidated sediments below the valley floor from thinner accumulations along the range front.

West-Northwest Faults

The west-northwest set of faults drops strata down to the south (Plate 1). Outcrops of these faults exposed east of Franklin show extensive fracturing, particularly in the Brigham Quartzite. A west-northwest fault in Oxkiller Canyon, herein named the Oxkiller fault (Plate 1), cuts through the terrace gravels east of Elk Meadows subdivision and places gravels south of the fault against strata of the Salt Lake Formation on the north.

REGIONAL HYDROGEOLOGY

The rocks and unconsolidated sediments discussed above and the structural controls imposed by faulting provide the geologic framework in which ground water occurs in the Franklin area.

Water table contours derived from static water levels in wells and perennial streams in Cache Valley (Plate 2) show two sources that contribute water to the area near Franklin. Some ground-water flows south along the axes of the valleys of Cub and Bear rivers. Ground water also results from the infiltration of precipitation in the Bear River Mountains to the east. The relative proportion of water from each source depends on the location in the valley; Franklin probably derives its water primarily from the easterly mountainous source area. The generalized water table map constructed from static water levels in approximately 80 wells (Plate 2) shows that ground water along the range front generally flows from east to west.

PROJECT AREA HYDROGEOLOGY

Two types of material provide ground water to wells in the Franklin area: the sedimentary strata of the Salt Lake Formation and the overlying unconsolidated material. Lacustrine clay beds deposited from Lake Bonneville generally produce little water.

GROUND-WATER FLOW SYSTEMS IN CONSOLIDATED ROCKS

Wells in the Franklin area that intersect bedrock penetrate strata of the Tertiary Salt Lake Formation. Well tests from these strata generally show low to moderate yields of 5 to 20 gpm, probably the result of low permeability through the clay-rich strata. A few wells, however, have flow rates over 200 gpm. These wells are generally near fault traces, suggesting that fractures concentrated along faults may foster increased water flow.

Brigham Quartzite underlies the drainage basins east of Franklin. A lack of moderate- to high-volume springs in these strata and the water chemistry indicating primarily local recharge suggest that much of the precipitation falling on these drainage basins probably runs off as surface water rather than infiltrating. The runoff flows down gradient and recharges unconsolidated-sediment aquifers at lower elevations. Clearly, the larger drainage basins provide the greatest amount of recharge. Plate 2 shows the outline of these basins and the quantity of annual precipitation (modified from Daly and Taylor, 2001). Based on these amounts, Deep Creek and Oxkiller Canyon provide the largest quantity of recharge in the area logistically most accessible to Franklin.

GROUND-WATER FLOW SYSTEMS IN UNCONSOLIDATED SEDIMENTS

Clay-rich strata deposited from Glacial Lake Bonneville dominate the unconsolidated sediments in the Cache Valley near Franklin. Wells developed in the lake sediments typically have low yields and are probably inadequate for most water uses. Artesian heads commonly occur in wells that penetrate the base of the clay beds, suggesting that the clay-rich strata confine the underlying aquifer. Isolated gravelly and sandy lenses within the clay-rich lakebeds show higher flow rates and probably represent the best potential strata within the Lake Bonneville sequence to host a productive aquifer. Locating such strata, however, could only be accomplished by trial and error.

The terrace gravel unit is older than the Lake Bonneville sediments, so it probably underlies the clays throughout much of the Cub River Valley. Wells developed in this gravel sequence generally show yields of greater than 200 gpm (Table 2). One well near the mouth of Cub River Canyon developed in these gravels yields 350 gpm. These data suggest the unit can produce high yields where the gravels are connected to a recharge zone. The following discussion pertains to a uniquely large accumulation of terrace gravel east of Franklin in the lower Oxkiller drainage basin.

Oxkiller Fan Ground-Water System

The terrace-gravel fan at the mouth of Oxkiller Creek likely contains a ground-water system that can be developed (Plate 1). A west-northwest trending fault cuts the gravel fan and places gravel on the fault's south side against strata of the Salt Lake Formation on the north. The bedrock floor beneath the down-dropped gravel is deepest near the fault. Viewed in cross section (Plate 1, Section BB'), the bedrock profile creates an asymmetric "V" shape, with the bottom of the V nearest the fault. Water enters the gravel fan from the upper part of the drainage basin and then may preferentially flow through the deeper gravels along the south side of the fault. Water following this path will continue down gradient into the Cub River basin under the clay beds of Lake Bonneville. A hole drilled into the fan gravels south of the fault should intersect this flow path.

HYDROTHERMAL WATER SYSTEMS

Several wells in the Cub River Valley reportedly contain sulfurous or iron-rich water. Some, like Franklin's old well, contain geothermal water. The geothermal water probably emanates from faults that cut the sedimentary rock units and then mixes with the cold ground water below Lake Bonneville sediments.

ANALYSIS OF WELLS AND SPRINGS

Franklin Wells

The town of Franklin operates two wells in the Maple Creek drainage (Plate 1). Well 1 is 244 feet deep and cased to 39 feet. It collars in glacial gravel deposits and then penetrates strata of the Salt Lake Formation. This well yields 136 gpm. Well 2 is 285 feet deep, cased to 285 feet, and perforated from 100 to 120 feet and from 178 to 285 feet. It penetrates rocks similar to Well 1 and was pump-tested at 185 gpm (Idaho Department of Water Resources records; Sunrise, 1999a). These two wells provide water to the town; Well 3, located approximately 200 feet away, remains undeveloped. Well 3 is 305 feet deep, cased to 305 feet, and perforated from 205 to 305 feet. The yield of well 3 reported by the driller's log was 225 gpm with 135 feet of drawdown after 5 hours of pumping. Measured yields from these wells are abnormally high relative to others completed in correlative strata. The well logs indicate that water-producing zones are strongly fractured. The fractures may have resulted from movement along the west-northwest fault that follows Deep Creek. The pump test of Well 3 showed a yield higher than test results from the two adjacent wells. We do not know why Wells 1 and 2 were developed rather than Well 3.

Franklin's old well is located along lower Maple Creek, approximately 1 mile northeast of town. This well was drilled to 377 feet and cased to 366 feet. The pump test indicates the well can produce approximately 100 gpm (Sunrise, 1999b). It is not used because it produces geothermal water; a 1978 pump test records a temperature of 74°F from a depth of 120 feet.

Dowdell Spring Ground-Water System

Dowdell Spring is northwest of High Creek in Cache County, Utah. The spring emanates from an early Tertiary terrace gravel sequence (Plate 1, unit *Tc*) that underlies Lake Bonneville sediments. The spring maintains a constant flow rate of approximately 70 gpm throughout the year (Sunrise, 1999c). The recharge area for the ground-water system feeding Dowdell Spring appears to be from an irrigated area rather than from the Bear River Mountains. Irrigation water is diverted from High Creek and flows in a canal constructed on the terrace gravel approximately 1,000 feet upslope from Dowdell Spring. Two factors may impact the long-term viability of this spring: agricultural practices in the recharge area that alter the water chemistry, and drought that shortens the irrigation season and thereby reduces the volume of water flowing through the spring. Otherwise, the historical water quality and constant flow rate from the spring suggest that it will likely remain a dependable source of water.

Kingsford Spring Ground-Water System

Kingsford Spring emanates from unconsolidated gravel in the South Canyon drainage (Plate 1) and flows at approximately 20 gpm. The gravel, originally deposited by a glacier, consists of a mixture of fine- and coarse-grained material. A dye test completed in 1971 (Haws, 1971; Appendix XI, Sunrise, 2002) indicates that High Creek, 6,000 feet to the south, is the source of water for Kingsford Spring. The dye, placed in High Creek at an elevation of approximately 5,200 feet, appeared in Kingsford Spring at an elevation of 5,050 feet 11 days later. This represents an unusually fast rate of 26.5 feet per hour over a horizontal distance of about 7,000 feet. The report on this study does not indicate if base-line data were collected before the test. Results, therefore, may have been misinterpreted owing to a misidentification of naturally occurring substances for the dye. It is highly unlikely for ground water to travel at 26.5 feet per hour through poorly fractured bedrock while dropping relatively little in elevation. Recharge for the ground-water system feeding the spring probably occurs higher in the South Creek drainage. Historical water analyses show that agricultural practices in South Canyon do not influence the quality of Kingsford Spring water (DEQ southeast district office personnel, oral commun.). Other development such as road construction may impact the water quality, so the spring should be monitored.

Crooked Spring Ground-Water System

Crooked Creek, a high-gradient mountain stream, flows into Maple Creek upstream from the municipal wells (Figure 3). A thin mantle of gravel overlies bedrock along the deeply incised stream channel for most of its length. Surface and ground water are closely interconnected within the drainage. As gravels thicken in the drainage, surface water infiltrates and mixes with the ground water. Where gravels thin, ground water reemerges as surface water and mixes with the stream. Crooked Spring exemplifies this process. The close interconnection of the springs with ground water and surface water make using the spring as a municipal source essentially the same as using water directly from the creek. There is no way to develop the spring differently to improve it as a water supply source.

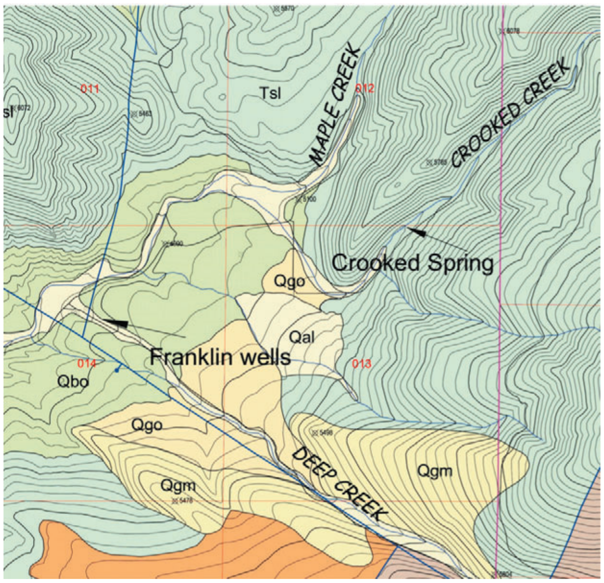

Figure 3. Location of Crooked Spring relative to the Franklin wells.

RESULTS

The town of Franklin derives its water supply from two wells and three springs. A combination of bacterial contamination in some of the springs, inefficient production from the wells, and population growth will require the community to consider developing alternative water sources. Exploration targets include aquifers in bedrock and in overlying, unconsolidated sediments. In choosing a new target, the following two factors are primary:

- the availability of a suitable supply of good quality water, and
- the proximity to existing electrical lines and pipelines.

Bedrock targets near existing electrical lines and pipelines are restricted to the Tertiary Salt Lake Formation on the basis of surface rock exposures and drill logs. Test data from existing wells that penetrate these strata show a range of production levels, though most produce less than 20 gpm. Rock exposures indicate that these strata are composed primarily of clay-rich siltstone, which likely explains the low flow rates. Higher flow rates may occur locally owing to interbedded sandy lenses or areas of increased fracture density along faults. Franklin wells 1 and 2 provide examples of this; exposures of a fault that follows Deep Creek show extensive fracturing along the trace of the structure. Though not exposed at the wells, drill logs indicate increased fracturing in the water-bearing zones. An exploration target in these strata near wells that show higher flow rates, such as the Franklin wells, would increase the odds of developing a better well. Concentrated zones of fracturing or the distribution of sandy lenses in the Salt Lake Formation elsewhere would be difficult to locate owing to the extensive cover of Lake Bonneville sediments.

Potential ground-water targets occur in unconsolidated gravel as well. Considerations for such targets include (1) an adequate thickness of gravel to host the ground water and (2) adequate, continuous recharge. The springs used by Franklin define three types of gravel occurrences in the area. Crooked Spring occurs in a thin mantle of young gravels that line the deeply incised stream drainage. Kingsford Spring emanates from gravel deposited directly by a glacier. Dowdell Spring occurs in a thick accumulation of old terrace gravel.

Terrace gravels, such as those in which Dowdell Spring occurs, show the greatest possibility of hosting a quality aquifer. Relevant factors include adequate thickness, good recharge, and evidence of good transmissivity. A large accumulation of terrace gravel occurs east of Franklin, in the lower Oxkiller drainage basin, and represents the best possible target in these types of strata. These gravels appear to be hydrologically connected to the upper part of the drainage, which would probably furnish continuous recharge. A west-northwest fault that follows Oxkiller Creek may funnel ground water through the thickest section of gravel along the trace of the structure.

Two other types of gravel host ground water in the Franklin area but are not considered targets: glacially derived till and stream-deposited gravels. The glacial gravels would likely provide low flow rates owing to a high interstitial clay content, and ground water traveling in shallow stream gravels is prone to interact with surface water as shown by Crooked Springs.

CONCLUSIONS AND RECOMMENDATIONS

The town of Franklin should abandon Crooked Spring or install an adequate treatment system. This source cannot supply consistent contaminant-free water, regardless of the type and quality of spring development, without properly treating the water.

If Crooked Spring is abandoned, Franklin will need a new well to replace it. Plate 1 shows the location of a proposed new well designed to test unconsolidated terrace gravels in the lower Oxkiller drainage basin. If the test well proves successful, a new production well should be drilled deep enough to intersect rocks of the Salt Lake Formation and be completed with an engineered screen. The community should select a qualified driller with experience in difficult drilling conditions and installing well screens.

Well 3 is close enough to Wells 1 and 2 that, if developed, it could interfere with production from these existing wells. Instead, Franklin should consider drilling another well along the Deep Creek fault southeast of Wells 1 and 2. Plate 1 shows a proposed location for a test well where potential interference should not be a problem. Additional geologic mapping would refine this target by placing the hole within fractured rock along the fault.

Dowdell and Kingsford springs should be maintained as primary sources of water. The town must recognize, however, that shortened irrigation seasons due to drought may impact the volume of water that flows through Dowdell Spring. Land use upstream from Kingsford Spring should be monitored because changes in land use may adversely affect the quality of water that recharges the spring.

ACKNOWLEDGMENTS

This work was funded through grant number X97008601 from the U.S. Environmental Protection Agency (Region 10) to the Idaho Water Resources Research Institute at the University of Idaho. We thank the representatives of Franklin for their contributions and the Idaho Geological Survey for providing peer reviews and publishing this work.

The authors are alone responsible for the interpretations expressed in this document. These do not necessarily reflect those of the University of Idaho and IWRRI, the U.S. Environmental Protection Agency, or any other institution. Rather, they are observations shaped by our experiences in the field, study of the scientific and technical literature, and discussions with colleagues and the representatives of Franklin.

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