UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION
GROUND WATER BRANCH

GROUND-WATER-SUPPLY POSSIBILITIES IN PART OF BEAR LAKE AND CARIBOU COUNTIES, IDAHO

By R. C. Scott

Open-file report. Not reviewed for conformance with stratigraphic nomenclature and editorial standards of the Geological Survey

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Contents

GROUND-WATER-SUPPLY POSSIBILITIES IN PARTS OF BEAR LAKE AND CARIBOU COUNTIES, IDAHO

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Introduction

Ground-water possibilities in parts of Bear Lake and Caribou Counties, Idaho, were studied briefly, with special reference to the vicinities of Dingle and Montpelier and to the availability of ground water for expected industrial developments. The work was part of the ground-water investigations by the Geological Survey in cooperation with the State of Idaho. Most of the factual information herein was obtained from well drillers, farmers, and municipal water engineers. Geological examination was made of apparently favorable areas and water samples were collected from wells at Dingle Station (SW¼ sec. 6, T. 14 S., R. 45 E.) and south of Wardboro (NE¼ sec. 35, T. 13 S., R. 44 E.). The samples were analysed in the laboratory of the State Department of Public Health at Boise. Most of the geologic information contained in this report is from a published report, "Geography, geology, and mineral resources of part of southeastern Idaho," by G. R. Mansfield (U. S. Geol. Survey Prof. Paper 152, 1927). An unpublished report on the ground-water resources of the Soda Springs area, by H. T. Stearns, also is available. Few wells have been drilled in Bear Lake valley, and subsurface geologic conditions can be inferred only from the rock outcrops and structure in nearby mountains.

A small area around Dingle is represented on a map accompanying this report. Places mentioned in the report but not shown on this map appear on county road maps and topographic quadrangle sheets both of which are readily available to the public.

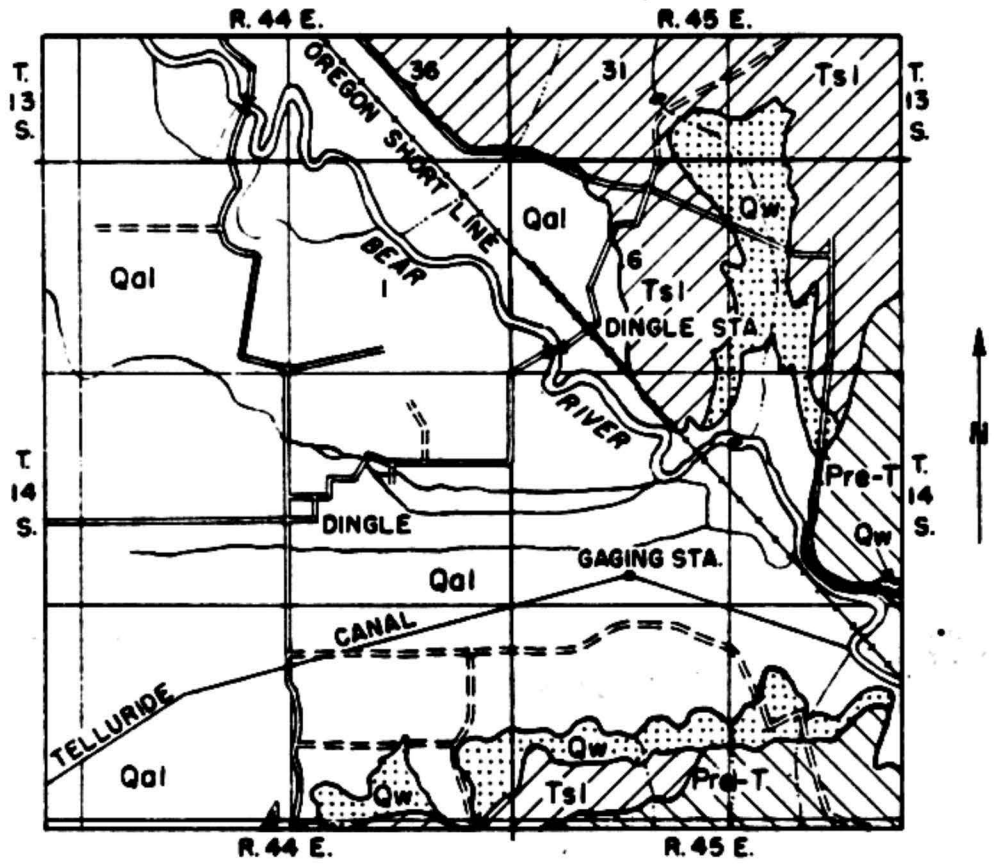
Bear Lake County

Geologic Setting

Bear Lake valley is a broad depression in central Bear Lake County. It intercepts the Bear River valley in the central and northern parts of the county and extends southward from Bear River into Utah. Most of the southern part of the Bear Lake valley is occupied by Bear Lake. North of Bear Lake is the smaller Mud Lake and the Dingle Swamp. The remainder of the valley lowland, except for villages and urban communities, is irrigated farmland. Geologically the valley is a downwarped and faulted depression between strongly folded hills of Cretaceous and older rocks. The folding of these older rocks occurred toward the end of Cretaceous time and culminated with the Bannock overthrust fault. Since Cretaceous time there have been alternate periods of erosion and deposition, often controlled by climatic changes and occasionally interrupted by minor crustal warping and volcanic activity. An abbreviated stratigraphic section of important geologic formations in the Bear Lake valley area is represented in table 1. The distribution of these formations is shown on the accompanying map (p. 4).

TABLE 1. ABBREVIATED SECTION OF LATER GEOLOGIC UNITS IN BEAR LAKE VALLEY, IDAHO

SYSTEM	SERIES	FORMATION AND CHARACTER
QUATERNARY	RECENT	YOUNGER ALLUVIUM. CHIEFLY INTERBEDDED CLAY, SAND, AND GRAVEL. ESTIMATED THICKNESS, 500 TO 800 FT IN BEAR LAKE VALLEY; THIN TONGUES EXTEND UP TRIBUTARY VALLEYS.
		LAKE BEDS. DEPOSITS OF FORMER EXTENSION OF BEAR LAKE. OCCUR IN TERRACES ON SIDES OF MOUNTAINS ADJACENT TO VALLEY. THICKNESS, ABOUT 20 FT.
	PLEISTOCENE	OLDER ALLUVIUM. ALLUVIAL CONES, SLOPE WASH AND TALUS. POORLY SORTED; WELL ROUNDED BOULDERS IN FINE MATRIX. DISSECTED REMNANTS OCCUR ABOVE PRESENT VALLEY BOTTOM IN FOOTHILL VALLEYS. THICKNESS, 0 TO 100 + FT.
	UNCONFORMITY	
TERTIARY	PLIOCENE (?)	SALT LAKE FORMATION. LIGHT-COLORED CONGLOMERATE; COMMONLY ANGULAR OR SUBANGULAR PEBBLES IN A CALCAREOUS WHITE MATRIX. SOME SAND, FINE GRAVEL, AND VOLCANIC MATERIAL. THICKNESS, 0 TO 1,000 ± FT.
	UNCONFORMITY	
	EOCENE	WASATCH FORMATION. RED CONGLOMERATE AND SANDSTONE; CONTAINS BOULDERS OF OLDER METAMORPHIC ROCKS. THICKNESS, 0 - 1,500± FT.
	UNCONFORMITY	
PRE-TERTIARY ROCKS (CRETACEOUS AND OLDER)		BEDROCK FLOOR IN THIS AREA BENEATH THE WATER-BEARING YOUNGER SEDIMENTS. CROP OUT IN FOOTHILLS AND MOUNTAINS.



Generalized geologic map of the vicinity of Dingle, Idaho
(Modified from Mansfield, G. R., Prof. Paper 152., 1927)

1 0 1 MILE

SCALE

Water-Bearing Properties of Formations

Formations older than the Wasatch are not favorable for the occurrence of important aquifers because these formations either are of small areal extent or are low in permeability. The strongly compressed and folded Cretaceous and older rocks ordinarily yield only small amounts of water from joints, other fractures, and fault zones.

Wasatch formation.—The Wasatch formation is chiefly conglomerate and sandstone, which may underlie part of or all the Bear Lake valley. Known occurrences of the formation in this vicinity, however, are sporadic exposures on the flanks of hills adjacent to the valley. The Wasatch probably is not an important potential source of ground water in the Bear Lake valley because, even though the formation may contain permeable aquifers, these probably are too deep to be an economical source of water. Where the Wasatch crops out on nearby hills it may receive appreciable ground-water recharge from precipitation and it may transmit some ground water to younger formations with which it comes in contact.

SALT LAKE FORMATION.—OVERLYING THE WASATCH IS THE SALT LAKE FORMATION, WHICH IN THIS AREA IS CHIEFLY CONGLOMERATE IN A FINE CALCAREOUS WHITE MATRIX; IT CONTAINS ALSO SMALL AMOUNTS OF SANDSTONE AND MARL. BENEATH BEAR LAKE VALLEY THE TOP OF THE SALT LAKE FORMATION MAY BE 400 TO 800 FEET BELOW THE LAND SURFACE. THE FORMATION CROPS OUT EXTENSIVELY IN SURROUNDING FOOTHILLS AND MOUNTAINS, ESPECIALLY IN THE UPLANDS EAST OF MONTPELIER. THE OCCURRENCE OF HIGHLY PRODUCTIVE AQUIFERS IN THE SALT LAKE FORMATION IS UNLIKELY BECAUSE THE GRAVEL IS POORLY SORTED, CONTAINING MUCH FINE SEDIMENT IN THE MATRIX, AND IS MODERATELY TO STRONGLY CEMENTED WITH CALCAREOUS MATERIAL. EXISTING WELLS IN BEAR LAKE COUNTY APPARENTLY DO NOT PENETRATE THE SALT LAKE FORMATION, BUT A NEW WELL IS BEING DRILLED IN THIS FORMATION ABOUT 1⅛ MILES NORTHEAST OF DINGLE STATION. AT THE TIME OF THIS WRITING THE WELL WAS 80 FEET DEEP BUT HAD NOT ENCOUNTERED WATER-BEARING MATERIAL.

Older alluvium.—Older alluvium forms an extensive apron of fluviatile material east of the Bear River in the vicinity of Georgetown. Elsewhere it occurs as dissected remnants in stream valleys. The alluvium, as mapped, includes slope wash and talus, all poorly sorted. Presumably the materials were deposited under humid conditions during the Pleistocene epoch or Ice Age. Deposition of the alluvium probably was affected by glacial Bear Lake, which filled the entire valley and was a temporary local base level. Because the older alluvium is poorly sorted it probably would yield only moderate amounts of water to wells. At Georgetown village the drilled municipal well, 188 feet deep, taps water in older alluvium (see appended log). When tested the well reportedly yielded 94 gpm of water with 52 feet of drawdown. In the vicinity of Dingle small remnants of older alluvium in foothill valleys merge with the younger alluvium in Bear Lake valley. South of Georgetown older alluvium receives recharge from intermittent streams and directly from precipitation, and transmits water to the younger alluvium. In Bear Lake valley older alluvium possibly was removed by erosion or was reworked and deposited with younger alluvium. The older alluvium has not been identified in wells in the Dingle area.

Younger alluvium.—The younger alluvium in Bear Lake valley includes fluviatile deposits and intertongued lake beds. In Bear River valley it consists exclusively of stream deposits which also form the floors of most small stream valleys. In Bear Lake valley the younger alluvium is at least 400 feet thick and may be as much as 800 feet thick at places. The formation is the principal aquifer of the Bear Lake valley, where it consists of alternating beds of clay, sand, and gravel, grading laterally from nearly all clay on the west side of the valley to coarser material, chiefly gravel, along the east side. In the western part of the valley artesian wells penetrate the clayey sequence to depths as great as 200 feet, but few wells have sufficient pressure to flow. From Ovid to south of Bloomington the clayey beds yield as much as 10 gpm of water to domestic wells, but a creamery at Paris is unable to obtain an adequate supply of water from wells. The creamery supplements well water with water from the Paris municipal supply, piped in from mountain springs. On the western side of the valley it seems that only in a small area around Bern would wells yield sufficient water for industrial or other large-scale uses. One irrigation well north of Bern, 232 feet deep, penetrated alternating layers of gravel, gravel and sand, and clay. The well reportedly was test pumped for 5 hours, yielding about 900 gpm with 12 feet of draw-down.

THE CENTRAL PART OF BEAR LAKE VALLEY PROBABLY IS UNDERLAIN MOSTLY BY SAND AT DEPTHS THAT ORDINARILY WOULD BE PENETRATED BY WELLS. AN ABANDONED WELL IN SEC. 20, T. 13 S., R. 44 E., REPORTEDLY WAS ORIGINALLY BETWEEN 300 AND 400 FEET DEEP, TAPPING ARTESIAN WATER IN SO-CALLED QUICKSAND. SAND RAN INTO THE WELL RAPIDLY WHENEVER CLEANING WAS ATTEMPTED BY BAILING, AND THE DRILLER REPORTS THAT THE WELL, WHEN NEW, COULD BE BAILED DRY EASILY. THE WELL WAS ABANDONED BECAUSE OF THE SAND TROUBLE AND PARTIAL COLLAPSE OF THE CASING. PROPERLY CONSTRUCTED WELLS IN THE BEAR LAKE VALLEY PROBABLY WOULD YIELD SUFFICIENT WATER AT LEAST FOR DOMESTIC SUPPLIES. AREAS UNDERLAIN BY EXTENSIVE QUICKSAND AT SHALLOW DEPTH WOULD POSE SPECIAL CONSTRUCTION PROBLEMS FOR WELL DRILLERS AND MIGHT ALSO BE IMPORTANT IN RELATION TO FOUNDATION PROBLEMS FOR HEAVY INDUSTRIAL STRUCTURES REQUIRING STABLE FOUNDATION MATERIALS.

ALONG THE EAST SIDE OF THE BEAR LAKE VALLEY THICK GRAVEL LENSES ARE INTERBEDDED WITH SAND AND CLAY. IN THAT AREA MOST DOMESTIC AND FARM WELLS HAVE 2-INCH PIPES AND SAND POINTS, DRIVEN TO AN AVERAGE DEPTH OF 20 FEET. DRIVEN WELLS GENERALLY PIERCE AN UPPER CLAY BED AND REACH UNDERLYING GRAVEL OR SAND, CONTAINING WHAT IS CALLED LOCALLY THE "SECOND WATER." THE STATIC WATER LEVEL IN THESE WELLS RANGES FROM 10 TO 20 FEET BELOW THE LAND SURFACE AND IS LOWEST IN WINTER. DOMESTIC SUPPLIES FROM WELLS OF THIS TYPE REPORTEDLY ALWAYS ARE ADEQUATE AND WERE NOT APPRECIABLY DIMINISHED BY THE DROUGHT OF 1934, ALTHOUGH THERE WAS INSUFFICIENT SURFACE WATER FOR IRRIGATION.

About 2⅛ miles south of Dingle, northeast of Wardboro, and at the south and west edges of Montpelier, a few drilled domestic wells 40 to 75 feet deep tap the "third water" in gravel underlying that which yields the "second water." An artesian water near the west side of Montpelier flowed when new. In a nearby well the static water level reportedly was 7 to 8 feet below the land surface and there was very little drawdown when the well was tested by bailing. Two drilled wells northeast of Wardboro tap their principal water supply about 50 feet below the surface; artesian pressure raises the water levels in the wells to within 20 feet of the land surface. South of Dingle a well 70 feet deep obtains most of its water from a depth of about 45 feet. The static depth to water is 10 to 15 feet. All owners in the Wardboro area report the ground water to be hard but otherwise good in quality. Most users have water softeners. A dug well 25 feet deep in sec. 6, T. 14 S., R. 45 E., was abandoned after an earthquake in the spring of 1934, reportedly because the water became black and sulfurous. The city of Montpelier has two drilled wells, the smaller and older of which is a standby for emergency use. The larger well, drilled in 1944, is used from May to about October 15 to supplement the main town supply from springs. The well is 300 feet deep and penetrates alternate layers of gravel and clay (see appended log). When new the well was test pumped at 1,300 gpm and the drawdown was 13 feet. Meter charts show that during the pumping season the pumping rate ordinarily is 850 to 1,000 gpm and averages about 900 gpm. The measured depth to water on October 27, 1954, when the pump had been idle for a week, was 58 feet below the top of the casing, or about 63 feet below the land surface.

Quality of Water

Appended (table 2) are results of chemical analyses of water samples collected in 1953 from the Montpelier city wells and in 1954 from two domestic wells near Dingle. The well near Dingle in the SW¼ sec. 6, T. 14 S., R. 45 E., was reported to be 43 feet deep; the well in the NW¼ sec. 35, T. 13 S., R. 44 E., was reported to be about 30 feet deep. Comparison of the shallow water with that from deeper zones in the Montpelier wells suggests that the deeper water is somewhat softer and contains less dissolved solids than the shallow water. The shallow water is almost twice as hard as the deeper water, contains about 75 percent more dissolved solids, and may contain considerably more silica. If these samples are representative of ground water in the Bear Lake Valley, softening is desirable for domestic purposes and softening, perhaps with reduction of silica also, would be almost essential for boiler use. The deeper water would be more satisfactory than the shallow water for use in condensers without pretreatment, although in time it would tend to form scale in condenser tubes. Comparing the long-term expense of treating shallow water with the initial cost of constructing deep wells, it may be found that it would be more economical in the long run to drill deep wells and tap only the water in the deeper zones, where the water is to be used by industrial plants.

In some respects surface water is less desirable than ground water for industrial use, though surface water commonly is less mineralized. Specifically, surface water has the wider temperature range and greater turbidity. A chemical analysis of surface water from Bear River (results appended) indicates that during at least part of the year the surface water would not be much superior, chemically, to ground water for industrial use.

Adequacy of Ground-Water Supply

An important source of recharge to the ground-water reservoir in Bear Lake Valley is infiltration from the Bear River and underflow from Bear River valley. Other sources are direct infiltration of precipitation, infiltration of excess irrigation water large quantities of which are spread on hay meadows, and infiltration from Bear Lake, the Bear Lake Outlet, Dingle Swamp, Mud Lake, and minor tributary streams. Infiltration from the Bear River apparently occurs only in the upper reach of the river, and the loss by upstream infiltration seemingly exceeds natural ground-water discharge to downstream parts of the river only during the nonirrigation season. During the nonirrigation period, October 1, 1946, to April 14, 1947, the reported runoff at Harer in Bear River Valley was 148,250 acre-feet; downstream, at Stewart Dam west of Montpelier, the reported runoff was only 5,890 acre-feet. During this period about 134,280 acre-feet was diverted in the Rainbow Inlet Canal for storage in Bear and Mud Lakes, and about 1,300 acre-feet

WAS DIVERTED IN DINGLE CANAL (SEE IORNS, W. V., 1947, BEAR RIVER HYDROMETRIC DATA, TRI-STATE INVESTIGATIONS: U. S. GEOL. SURVEY). DISREGARDING THE SMALL AMOUNT OF WATER THAT WAS EVAPORATED, AND POSSIBLE MINOR OFF-SEASON DIVERSIONS IN OTHER CANALS, IT SEEMS THAT AT LEAST 6,000 ACRE-FEET OF WATER (ABOUT 46.4 BILLION GALLONS) FILTERED INTO THE GROUND IN THE 9-MILE REACH OF THE RIVER BETWEEN HARER AND STEWART DAM, AND RECHARGED THE GROUND-WATER RESERVOIR.

DURING THE IRRIGATION SEASON OF 1947 (APRIL 15 TO SEPTEMBER 30) THE REPORTED RUNOFF AT HARER WAS 301,065 ACRE-FEET AND THAT BELOW STEWART DAM WAS 9,993 ACRE-FEET, A DIFFERENCE OF ABOUT 291,072 ACRE-FEET. ACCORDING TO RECORDS OF THE BEAR RIVER WATERMASTER ABOUT 69,354 ACRE-FEET WAS DIVERTED IN SEVERAL IRRIGATION CANALS; 229,368 ACRE-FEET WAS DIVERTED IN RAINBOW CANAL, LARGELY FOR TRANSMISSION TO STORAGE IN BEAR LAKE. THE TOTAL OF THESE DIVERSIONS WAS ABOUT 298,722 ACRE-FEET, OR ABOUT 7,650 ACRE-FEET MORE THAN THE DIFFERENCE BETWEEN RUNOFF AT HARER AND AT STEWART DAM. THUS, DURING THE 1947 IRRIGATION SEASON ALLUVIUM IN BEAR LAKE VALLEY DISCHARGED MORE THAN 7,000 ACRE-FEET OF GROUND WATER INTO THE BEAR RIVER. APPENDED IS TABLE 3, SHOWING RUNOFF IN THE BEAR RIVER AT HARER IN THE WATER YEAR 1946-47 (HERE TAKEN ARBITRARILY AS A YEAR OF ORDINARY WATER SUPPLY) AND THE WATER YEAR 1933-34 (A YEAR OF EXTREME DROUGHT). THE AVERAGE DAILY MINIMUM FLOW IN THE RIVER AT HARER DURING AUGUST 1934 WAS ABOUT 71.5 ACRE-FEET (23.3 MILLION GALLONS). MOST OF THIS WATER WAS DIVERTED BELOW HARER FOR IRRIGATION,

BUT DURING THE IRRIGATION SEASON THE DISCHARGE OF STEWART DAM WAS 1 TO 2 CFS (APPROXIMATELY 645,000 TO 1,290,000 GALLONS PER DAY) AND DURING JULY AND AUGUST IT WAS NEVER GREATER THAN 1 CFS.

DURING THE PERIOD OF RECORD THE BEAR RIVER ALWAYS HAS DISCHARGED AT LEAST A SMALL AMOUNT OF WATER EVEN DURING PERIODS OF DROUGHT. WATER LEVELS IN WELLS NEAR THE RIVER REMAINED AT ABOUT NORMAL LEVELS DURING DROUGHT PERIODS — THAT IS, SHALLOW WELLS DID NOT GO DRY AND WATER LEVELS APPARENTLY WERE SUFFICIENTLY HIGH THAT GROUND WATER WAS DISCHARGED INTO THE RIVER CHANNEL AND MAINTAINED MINIMUM SURFACE FLOW. THEREFORE IT IS BELIEVED THAT THE CAPACITY OF THE GROUND-WATER RESERVOIR IS SUFFICIENTLY LARGE AND SOURCES OF RECHARGE ARE SUFFICIENTLY DEPENDABLE TO ASSURE RELIABLE GROUND-WATER SUPPLIES EVEN DURING SEVERE DROUGHT PERIODS. WIDESPREAD HEAVY PUMPING WOULD ALTER THE GROUND-WATER REGIMEN, BUT SUCH PUMPING IS NOT EXPECTED IN THE BEAR LAKE VALLEY IN THE FORESEEABLE FUTURE. SUSTAINED MODERATE TO HEAVY PUMPING IN LOCAL AREAS FROM WELLS THAT TAP IMPORTANT PERMEABLE AQUIFERS UNDOUBTEDLY IS PRACTICABLE. SUCH PUMPING MIGHT LOWER LOCAL WATER LEVELS APPRECIABLY BUT DRASTIC LOWERING IS NOT EXPECTED. PUMPED WELLS NEAR THE RIVER IN THE DINGLE AREA MIGHT INCREASE INFILTRATION LOSS FROM THE RIVER, BUT RETURN OF UNCONSUMED WATER WOULD COMPENSATE PARTLY FOR RIVER DEPLETION.

Apparently the supply of surface water is largely appropriated and used. Availability of a specified quantity of surface water thus would require special study, especially for periods of drought. The problem would be minor for industrial plants making largely nonconsumptive use of water that would be returned to the Bear River. If industrial use were largely nonconsumptive, the river-water supply at Stewart Dam would not be appreciably diminished once the industrial system was filled.

Recovery of Water From Wells

Well construction is an important factor that affects the efficiency with which a well withdraws water from the ground. Wells in unconsolidated material may be driven or they may be drilled by percussion, rotary, or reverse-rotary tools. Rotary drilling generally is faster than percussion drilling, and casing commonly is not installed until drilling is completed. Under some conditions rotary drilling is more expensive than percussion drilling, especially for shallow wells of small diameter. Moreover, where water-bearing zones are thin, fine grained, or under low artesian pressure, ordinary rotary drilling sometimes does not disclose the presence of water-bearing beds. Test drilling in Bear Lake Valley probably could be done effectively with percussion tools and, if carefully done, this would facilitate accurate logging which would be an essential aid to proper well construction.

OTHER DRILLING METHODS MIGHT BE CONSIDERED FOR PRODUCTION WELLS, ALTHOUGH ALL EXISTING WELLS IN BEAR LAKE VALLEY WERE DRILLED WITH PERCUSSION TOOLS. THE COMMONEST CASING IN EXISTING WELLS IS HEAVY PIPE, BUT CALIFORNIA ("STOVE-PIPE") CASING COULD BE USED. WELLS MAY BE EQUIPPED WITH SCREENS OR THE CASING MAY BE PERFORATED BEFORE OR AFTER INSTALLATION, DEPENDING UPON THE CHARACTER OF THE WATER-BEARING MATERIALS, THE YIELD DESIRED, AND OTHER FACTORS. WELL SCREENS PROBABLY WOULD BE ESSENTIAL IN SAND AQUIFERS. ARTIFICIAL GRAVEL PACKING MAY BE NECESSARY AT SOME PLACES.

SUITABLE TYPES OF WELL CONSTRUCTION ARE BEST DETERMINED FOR SPECIFIC AREAS WITH THE AID OF TEST HOLES. PRESUMABLY YIELDS OF AT LEAST SEVERAL HUNDRED GPM WOULD BE REQUIRED FROM EITHER INDUSTRIAL OR IRRIGATION WELLS. IN THE DINGLE AREA SINGLE WELLS MIGHT NOT YIELD THE FULL DESIRED QUANTITY OF WATER FOR SPECIFIC PURPOSES, AND A GROUP OF SEVERAL WELLS MIGHT BE REQUIRED. PERFORMANCES OF OTHER WELLS IN THE AREA SUGGEST THAT PROPERLY CONSTRUCTED WELLS WOULD YIELD INDIVIDUALLY AT LEAST 200 GALLONS A MINUTE. SOME WELLS MAY YIELD CONSIDERABLY MORE. A GROUP OF WELLS OR A WELL FIELD THUS MIGHT BE NEEDED TO DEVELOP 1,000 TO 2,000 GPM, FOR EXAMPLE, FOR A LARGE INDUSTRIAL PLANT. THE MINIMUM SPACING OF WELLS COULD BE DETERMINED ONLY BY APPROPRIATE TESTS BUT PROBABLY WOULD BE IN THE ORDER OF SEVERAL HUNDRED FEET, TO AVOID EXCESSIVE MUTUAL INTERFERENCE.

Potential Industrial Areas

Industrial establishments presumably would prefer locations near the Union Pacific Railroad, the only railroad that serves Bear Lake County. Industries that would ship products chiefly eastward probably would prefer locations at or east of Montpelier, which is a breakpoint for railroad freight tariffs. There are numerous sites along the Bear River and the railroad between Border, and Montpelier, Idaho, that appear to be satisfactory at least for small establishments, and possibly for large ones. The occurrence of ground water in the Bear River valley above Dingle Station, however, is poorly known. Alluvial gravel in the valley contains ground water that apparently is replenished chiefly by underflow from upstream areas. The capacity of the ground-water reservoir appears to be small, and reports of residents indicate that in drought periods many shallow wells "go dry." In the vicinity of Dingle the reservoir is recharged by all underflow from upstream parts of the Bear River valley, as well as from other sources, and the capacity of the ground-water reservoir is large. Hence the Dingle area probably would be considered favorable for industrial establishments. If so, the most favorable area for ground-water supply probably is south of the railroad and west of a north-south line half a mile east of Dingle Station. North of the railroad the water-bearing gravel probably is thin at some locations and local replenishment of ground water by underflow is from a catchment area too small to be perennially reliable. Owing to the lack of specific detailed information about subsurface conditions,

AND THE SCARCITY OF EXISTING WELLS, PROPOSED INDUSTRIAL SITES SHOULD BE EXPLORED BY TEST DRILLING TO DETERMINE LOCAL GROUND-WATER CONDITIONS. FOR SIMPLE LOGGING AND SAMPLING OF FORMATIONS SMALL TEST HOLES (SAY, 4 INCHES IN DIAMETER) MIGHT BE SATISFACTORY. A LARGER DIAMETER GENERALLY WOULD BE DESIRABLE, HOWEVER, BECAUSE IT WOULD ALLOW ROOM FOR REDUCTION OF SCRE IF A HOLE HAD TO BE PARTIALLY CASED BEFORE COMPLETION, AND BECAUSE THE LARGE HOLES COULD BE USED FOR TEST PUMPING AT RATES SUFFICIENTLY HIGH TO GIVE RELIABLE RESULTS. SINGLE TEST WELLS GENERALLY ARE NOT SATISFACTORY FOR AQUIFER TESTS. A SUITABLE ARRANGEMENT WOULD BE TO HAVE ONE 6- OR 8-INCH WELL FOR PUMPING, AND AT LEAST TWO 4- OR 6-INCH WELLS 100 TO 200 FEET DISTANT FROM THE PUMPED WELL, FOR OBSERVATIONS OF WATER-LEVEL CHANGES DURING PUMPING. THE PUMPING RATE SHOULD BE SUFFICIENTLY HIGH TO PRODUCE READILY MEASURABLE DRAWDOWN IN THE OBSERVATION WELLS, AND SHOULD BE OF SUFFICIENT DURATION — PROBABLY NOT LESS THAN 72 HOURS — TO SHOW THE PROBABLE STABLE PUMPING LIFTS AND THE PROBABLE DEGREE OF MUTUAL INTERFERENCE BETWEEN PUMPED WELLS AT A GIVEN SPACING.

Localities such as the Georgetown vicinity do not appear to be favorable for developments that would require a stable moderate to large supply of water from the ground. The area is underlain by older alluvium which, as previously noted, is not very permeable. Geologic materials underlying the alluvium also are unfavorable. The Georgetown vicinity, however, has not been well explored and if it contains industrial sites that are highly desirable in other respects test drilling might be warranted. A favorable area for such drilling would be east of and near the Bear River in sections 11 and 14, T. 11 S., R. 43 E. The appended log of the Georgetown municipal well indicates that most of the material penetrated by the well is poorly sorted gravel and "clay," as is typically the case in the older alluvium. A pumping test when this well was new suggests that the aquifer is capable of yielding only small to moderate amounts of water to wells. Improved well construction might lead to better performance.

Soda Springs Area

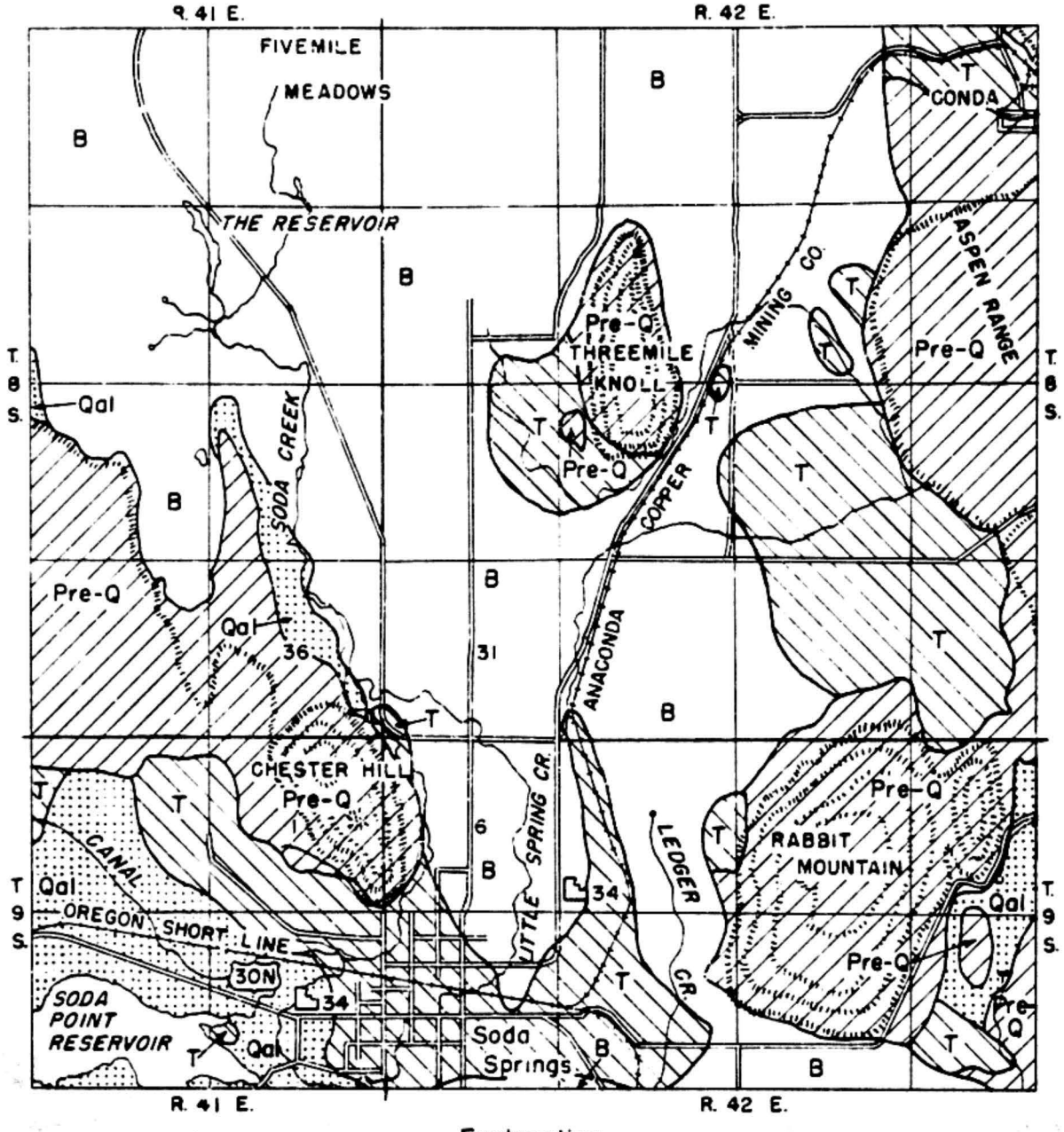
Some industrial development already has occurred in the Soda Springs area, Caribou County, and additional development may be imminent. The valley areas north of Soda Springs (here collectively called the Soda Springs valley) are promising for large ground-water developments. The valley is underlain by Pleistocene basalt, which is highly permeable and is the chief water-bearing rock in the area. The older rocks, which include some metamorphic rocks, are low in hydraulic permeability because they are strongly consolidated. The continuity of potential water-bearing zones in

THE OLDER ROCK IS DISTURBED BY FOLDS AND FAULTS. MUCH OF THE RUNOFF FROM HILLS COMPOSED OF THESE ROCKS SINKS INTO THE BASALT ("LAVA") FIELDS IN THE VALLEYS. EXTENSIVE AREAS OF BASALT AND ALLUVIUM ARE COVERED BY TRAVERTINE (CALCAREOUS SINTER). DEPOSITION OF TRAVERTINE BY THERMAL AND MINERAL SPRINGS PROBABLY OCCURRED THROUGHOUT QUATERNARY TIME AND SOME SPRINGS STILL ARE ADDING TO THEIR CONES. TRAVERTINE THAT OVERLIES AND INTERFINGERS THE BASALT IS THIN-BEDDED AND PROBABLY DOES NOT GREATLY AFFECT THE WATER-BEARING PROPERTIES OF THE BASALT. SOME OF THE ALLUVIAL SAND AND GRAVEL BEDS ARE LOCALLY CEMENTED TO FORM SANDSTONE AND CONGLOMERATE AND PROBABLY ARE POOR AQUIFERS.

MOST OF THE PRECIPITATION DIRECTLY ON THE VALLEY FLOOR ENTERS THE GROUND, RESTORING SOIL MOISTURE OR RECHARGING THE GROUND-WATER RESERVOIR. A LARGE AMOUNT OF RECHARGE IS CONTRIBUTED TO THE BASALT BY INFILTRATION FROM STREAMS AND RESERVOIRS. INFILTRATION LOSS OF WATER FROM BLACKFOOT RESERVOIR IS LARGE AND AT LEAST PART OF THIS WATER RECHARGES THE GROUND-WATER RESERVOIR OF THE SODA SPRINGS AREA. NORTH OF SODA SPRINGS, NEAR BLACKFOOT RESERVOIR, THERE ARE MASSIVE RHYOLITIC OR RELATED VOLCANIC ROCKS HAVING LOW PERMEABILITY. THESE ROCKS WOULD YIELD ONLY A SMALL AMOUNT OF WATER TO WELLS. AROUND THREEMILE KNOLL, ABOUT 3 MILES NORTH OF SODA SPRINGS, AMPLE GROUND WATER PROBABLY COULD BE OBTAINED FROM BASALT BENEATH THE FLAT VALLEY FLOOR. ANOTHER FAVORABLE AREA IS BETWEEN THREEMILE KNOLL, RABBIT MOUNTAIN, AND FOOTHILLS OF THE ASPEN RANGE, A FLAT VALLEY FLOOR CROSSED BY A RAILROAD SPUR TO CONDA, A MINING COMMUNITY OF THE ANACONDA

Copper Co. In that area the depth to water in wells is less than 100 feet. The principal area of the ground-water reservoir is west of Threemile knoll, but the part of the reservoir east of the knoll probably is adequate to sustain heavy pumping. Nevertheless, test drilling and test pumping probably would be prudent before commitment of large plant investments to sites near the railroad spur, as in the eastern halves of secs. 20 and 29, the western halves of secs. 21 and 28, or sec. 32, T. 8 S., R. 42 E. Test holes in this area probably would need be cased only through unconsolidated materials overlying the basalt.

Chemical analyses are not available of water from wells in the Soda Springs area. Water from similar basalt aquifers elsewhere in Idaho commonly is superior in quality to that from sedimentary aquifers. Table 2 includes results of an analysis of water from the municipal well at Conda, in a small valley that is tributary to Soda Springs Valley. Although the water is about the same in hardness as ground water at Montpelier, the sulfate content is much less and the total amount of dissolved solids is about one-third less. It seems likely that ground water in the Soda Springs valley is somewhat better in quality than ground water in the Bear Lake valley.



Explanation

T	Travertine	Qal	Quaternary alluvium
B	Basalt	Pre-Q	Pre-Quaternary Sedimentary and Metamorphic rocks

Generalized geologic map of the vicinity of Soda Springs, Idaho
Based on unpublished map by H.T. Stearns

1 0 1 MILE
SCALE

Explanation of Table 2.

1. Domestic well, SW¼ sec. 6, T. 14 S., R. 45 E. Collected Nov. 1954 1/
2. Domestic well, NW¼ sec. 35, T. 13 S., R. 44 E. Collected Nov. 1954 1/
3. Bear River near Soda Springs, Idaho. Collected Aug. 1947 2/
4. Municipal well, Conda, Idaho. Reported 1953 3/
5. Small municipal well, Montpelier, Idaho. Reported 1953 3/
6. Large municipal well, Montpelier, Idaho. Reported 1953 3/

1/ Analysis by Idaho State Department of Public Health.

2/ Published record, 1952, U. S. Geol. Survey Water-Supply Paper 1102, p. 639.

3/ Published record, 1953, Idaho State Department of Public Health, Division of Environmental Sanitation, A compilation of chemical analyses of community water supplies, May.

TABLE 2. CHEMICAL ANALYSES OF WATER SAMPLES FROM SOUTHEASTERN IDAHO.

(PARTS PER MILLION EXCEPT pH. ANALYSES BY U. S. GEOLOGICAL SURVEY AND IDAHO STATE DEPARTMENT OF PUBLIC HEALTH.)

	1	2	3	4	5	6
TOTAL DISSOLVED SOLIDS	642	536	477	296	362	356
ALKALINITY AS $CaCO_3$						
CARBONATE	0	0	0	0	0	0
BICARBONATE	258	282	382	248	216	284
TOTAL HARDNESS AS $CaCO_3$	414	354	372	260	270	284
NONCARBONATE HARDNESS AS $CaCO_3$	156	72	60	-	-	-
Ca	92	80	42	71	66	73
Mg	45	38	65	20	26	25
SO_4	108	72	75	25	85	71
Cl	57	49	49	4	5	5
NO_3	5.7	3.5	2.5	-	.2	.6
NH_3	0	0	-	-	.0	.0
SiO_2	19	27	14	-	17	14
Na + K	19	34	41	10	-	-
Fe	.02	.0	-	.03	.01	.01
F	.05	.15	-	.4	.15	.1
PO_4	.04	.05	-	.1	.0	.0
pH	7.2	7.3	-	7.1	7.4	7.3

TABLE 3. RUNOFF IN THE BEAR RIVER AT HARER, IDAHO

(FROM PUBLISHED RECORDS OF THE U. S. GEOLOGICAL SURVEY)

MONTH	1946–1947		1933–1934	
	ACRE-FEET	MILLION GALLONS PER DAY (AVERAGE)	ACRE-FEET	MILLION GALLONS PER DAY (AVERAGE)
OCTOBER	14,670	154.2	10,440	109.9
NOVEMBER	14,500	157.5	9,720	105.6
DECEMBER	16,260	170.9	8,300	87.2
JANUARY	11,150	117.2	8,990	94.5
FEBRUARY	14,190	165.1	10,390	120.9
MARCH	55,780	586.3	11,120	116.9
APRIL	45,710	496.5	5,910	64.2
MAY	97,280	1,022.5	2,810	29.5
JUNE	103,600	1,125.3	2,860	31.1
JULY	40,780	428.7	2,390	25.1
AUGUST	21,400	224.9	2,220	23.3
SEPTEMBER	16,200	176.0	2,800	30.4
TOTAL FOR WATER YEAR	451,500		77,950	

Logs of Wells

Municipal Well, Georgetown, Idaho

(Log from municipal records, city of Georgetown)

Drilled by J. H. Petersen, Wood Cross, Utah, 1938.

Formation	Depth (feet)	Thickness (feet)
Soil	2	2
Clay	16	14
Coarse gravel and boulders	25	9
Layers of gravel, clay and fine sand; no water	48	23
White gravel and "lime" boulders	52	4
White sand; show of water	55	3
Clay	72	17
Coarse gravel; contains some water. Two feet of gravel yielded about 50 gpm. Water rose to 55 feet below surface	74	2
Gravel; no water	78	4
Clay; water from 72-foot level broke in	99	21
Gravel; some water	102	3
Clay; water from 72 foot level still breaking in	106	4
Coarse gravel; no water	115	9
Fine sand (quicksand)	120	5
Coarse gravel; no water	146	26
Clay	150	4
Sand; contains water, which rose to 65 feet below surface	161	11
Coarse cemented gravel, interbedded with clay	163	2
Fine gravel interbedded with clay	168	5
Fine sand interbedded with clay	185	17
Pea gravel; contains water, which rose to 60 feet below surface	188	3

Set 15-stage 6 in. turbine pump to depth of 112 feet; tested and surged for 24 hours; produced 94 gpm with 52 feet of drawdown; 1350 rpm on the pump.

LARGE MUNICIPAL WELL, MONTPELIER, IDAHO

(FROM RECORDS OF THE CITY ENGINEER, MONTPELIER, IDAHO)

FORMATION	DEPTH (FEET)	THICKNESS (FEET)
SOIL	6	6
COARSE GRAVEL	50	44
GRAVEL; WATER ROSE 20 FT. IN CASING	64	14
GRAVEL AND CLAY	100	36
COARSE GRAVEL	150	50
FINE GRAVEL	190	40
CLAY	201	11
FINE GRAVEL	222	21
CLAY	232	10
FINE GRAVEL	300	68

CASED 300 FEET WITH 16 INCH CASING. LOWER 50 FEET PERFORATED WITH ABOUT 300 HOLES.