BEULAH
LEVEL I WATER SUPPLY STUDY
EXECUTIVE SUMMARY

NOVEMBER 2003

SUBMITTED TO
WYOMING WATER DEVELOPMENT COMMISSION
AND
THE COMMUNITY OF BEULAH, WYOMING

PREPARED BY
WESTON ENGINEERING, INC.
WITH ASSISTANCE FROM
ENTECH, INC.
EXECUTIVE SUMMARY

for

BEULAH LEVEL I
WATER SUPPLY STUDY

Prepared for:
Wyoming Water Development Commission

Submitted by:
WESTON
GROUNDWATER ENGINEERING

in association with
EnTech, Inc.
Consulting Engineers
Sheridan, Wyoming
EXECUTIVE SUMMARY

BEULAH LEVEL I WATER SUPPLY STUDY

INTRODUCTION

The Community of Beulah is located in Crook County in northeastern Wyoming. Beulah is a residential community with an elevation of approximately 3,512 feet. It is located approximately two miles west of the Wyoming-South Dakota state line on Interstate-90 (I-90).

Most of the residents of the Community of Beulah are self-employed, retired or commute to Spearfish, South Dakota and coal mines of the Powder River Basin where they are employed. In addition, a small number of people are employed in the agricultural business.

The Weston Engineering, Inc. (WESTON) project team consists of WESTON personnel and their subconsultant, EnTech, Inc. The purpose of this Beulah Level I Water Supply Study is to determine a service area for Beulah; conduct a geologic and hydrologic investigation of a potential water supply source; conduct a well siting study; develop a conceptual design for a supply well and appurtenances, treatment, storage, transmission, and distribution system; estimate costs for the project; and determine the monthly cost per user for financing and operating the system.

SERVICE AREA

The WESTON Team began the process of determining the Community of Beulah Water Supply service area by reviewing land ownership records at the Crook County Assessor's Office and identifying the number of current dwellings in the Beulah area. All landowners located within a three-mile radius of the Beulah Town Plat were identified and a survey developed by WESTON was mailed to these landowners. Based on the locations of those who positively responded to the survey and the high costs of extending service to remote points of use the service area was established as the area depicted in Figure 1.

As depicted in Figure 1, Beulah Land Estates (BLE) has been included within the Beulah water supply service area. BLE is currently serviced by an independent water supply and distribution system, but may require development of a second water supply well in the future. Population and water demand scenarios for this study were thus developed both with and without BLE. Of the 32 lots in the BLE subdivision, only three currently have dwellings.

PRESENT AND FUTURE WATER NEEDS

For water system planning purposes, the population of the service area has been projected 20 years into the future, to the year 2023. The Wyoming Department of Administration and
Information (DAI), Economic Analysis Division estimates a one percent annual growth rate for Crook County. However, to account for the increased potential for growth due to dependence on the energy and tourism industries in the area, WESTON applied a 1.5 percent annual population growth rate to the current estimated population of Beulah (64) for the purposes of this study.

The maximum average daily water consumption for the present estimated population of 64 (not including BLE) is estimated to be 70,166 gallons, requiring a source capacity of 49 gpm. The maximum daily water consumption including BLE is 79,166 gallons, requiring a source capacity of 55 gpm.

The 20-year projected population of the Beulah area (not including BLE) is 86 persons with a projected maximum daily water consumption of 94,395 gallons, requiring a source capacity of 66 gpm. The 20-year projected population, including BLE, is 164 persons with a projected maximum daily water consumption rate of 172,395 gallons, requiring a source capacity of 120 gpm.

WELL SITING STUDY

Structural Setting

The Community of Beulah is located in the northern Black Hills of South Dakota and Wyoming on the extreme eastern margin of the Powder River Basin. The Black Hills Uplift is a doubly plunging anticline that was formed during the Laramie Orogeny approximately 60 to 65 million years ago. Most of the rocks that form the core of the Black Hills Uplift are composed of high-grade Proterozoic metasedimentary rocks, which were intruded by a large body of relatively undeformed granite. These Precambrian rocks, which were uplifted and eroded over a long period of time, were overlain by Paleozoic Era limestones and sandstones followed by deposition of the red beds, sandstones, and black shales of the Mesozoic Era. All of these rocks were uplifted during the Laramide Orogeny.

Hydrostratigraphy

The Minnelusa and Madison Aquifers have been identified as the aquifers of concern for this study. Although Feathers and others (1980) defined the Madison Aquifer system as all of the saturated and permeable rocks in the Paleozoic section below the Opechee Shale, the discussion in this report is limited to the Minnelusa and Madison aquifers. The Minnelusa and Madison aquifers are distinct in the Beulah area, based on significant differences in shut-in pressures and water quality between the two aquifers. Based on an analysis of available water quality data, the Madison Aquifer was identified as the best target for development of a municipal water supply source for Beulah.

Madison Aquifer. The Madison Aquifer consists of the saturated and permeable parts of the Madison Limestone. The porosity of the Madison Aquifer results from: (1) solution enlarged voids
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BEULAH LEVEL I WATER SUPPLY PROJECT

and fractures, (2) intercrystalline porosity in the limestones and dolomites, and (3) fracturing. Regionally extensive karst resulted from penecontemporaneous and later widespread post-depositional erosion and dissolution of the Madison Limestone. In general, most cavern development is in the upper third of the unit. Where fractured and cavernous zones are saturated in the Madison Limestone, they will yield large quantities of water to wells penetrating them. The Madison Aquifer is the source of supply for many municipalities in the area surrounding Beulah, including a well recently completed for the Town of Moorcroft (WESTON, 2002), which is located approximately 40 miles southwest of Beulah. The Madison Aquifer also supplies the nearby towns of Sundance, Alladin, and Hulett.

Transmissivities in the Madison Aquifer generally vary from 1,000 to 60,000 gpd/ft, but may exceed 300,000 gpd/ft locally (Feathers and others, 1980). Specific capacities range from 0.5 to over 50 gpm/ft of drawdown and yields generally vary from 600 to 1,200 gpm, but may be higher. The effective transmissivity of the Madison Aquifer in the vicinity of the Moorcroft Madison well, which yields approximately 600 gpm, was estimated to be 10,600 gpd/ft, as determined from long-term pumping tests (WESTON, 2002).

The quality of water in the Madison Aquifer is fair, with Total Dissolved Solids (TDS) values less than 1,000 mg/L in the samples where it was analyzed. However, water in the Madison Aquifer is generally hard and may require treatment to reduce hardness. In addition, sulfate at concentrations of 250 mg/L or greater tends to have a laxative effect on those not accustomed to such levels. However, the sulfate tends to lose effect after a short period of constant exposure to the water.

Well Siting Criteria and Proposed Locations

WESTON believes the most important criteria in siting any well is the hydrogeologic setting. Whereas most wells are sited out of convenience and in close proximity to points of use, WESTON has learned that maximizing the potential of the well to produce significant quantities of high quality water is the most important criterion. Unfortunately, there are no promising geologic structural targets within the Beulah study area. Because no promising geologic structures have been identified within the Beulah study area, the well sites proposed in this study were selected because they afforded the greatest convenience with respect to proximity to proposed infrastructure and land ownership. Land ownership and access issues were also considered in the selection process.

Well Site 1. Site 1 is located on the easterly side of the Community of Beulah, northwesterly from the State Line Station. The projected top of the Madison Aquifer at this location is approximately 950 feet and the projected depth to the base of the Madison Limestone at this location is approximately 1,550 feet. The land at this site is owned by Mr. Dale Bell, who has indicated his willingness to allow a well to be drilled and constructed on his property. Mobilization of equipment and materials to the drilling site should be relatively easy at this location. Well Site
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1 is located directly across U.S. 14 northwest of the State Line Station. It is estimated that a tie-in from the well site to the nearest proposed pipeline along U.S. 14 would be less than 500 feet.

Well Site 2. Site 2 is located in the Community of Beulah, north of I-90 and just east of the Community Center. The projected top of the Madison Aquifer at this location is approximately 925 feet and the projected depth to the base of the Madison Limestone at this location is approximately 1,525 feet. The land at this site is owned by Crook County. The Crook County Commissioners have indicated their willingness to allow a well to be drilled and completed at this location at no charge to the Community of Beulah. Mobilization of equipment and materials to the drilling site should be relatively easy at this location. This site lies in the heart of Beulah and is located within 150 feet of the proposed pipeline along U.S. 14 included in all of the alternatives developed for this study.

CONCEPTUAL DESIGN AND COST ESTIMATES

Conceptual Design of Water Supply

Figure 2 is a preliminary design diagram for an exploration well completed in the Madison Limestone at Beulah. It is predicted that the top of the Madison Limestone will be encountered at a depth of approximately 950 feet below ground surface (bgs) and the base of Madison Limestone will be encountered at approximately 1,550 feet bgs at either site. Based on the data from existing wells in the area, a well completed in the Madison Aquifer at either site will flow at the ground surface. As shown in Figure 2, a well at either site is designed to be completed with casing and cement grout across the formations overlying the Madison Aquifer in order to minimize intrusion of poor quality groundwater, as well as to prevent corrosion of the steel casing. The selected well will also be designed with an open borehole within the Madison Aquifer.

Conceptual Design Of Storage And Distribution System

Three water supply system alternatives were developed for this water supply study. Alternative A incorporates a well located near the State Line Station and a water storage tank northwest of BLE. This alternative would provide water service to BLE. Alternative B utilizes a well located near the community hall and a standpipe storage tank near the State Line Station. Alternative C proposes drilling a well near the community hall and constructing a standard water tank south of I-90 near County Road 108. Neither Alternative B or C includes providing water service to BLE.

Alternatives A and C, which vary significantly in the approach to developing a public water supply system, were selected for further consideration in this study. Figures 3 and 4 depict the individual components of Alternatives A and C, respectively.
DESIGN DETAILS

- 8-INCH GATE VALVE
- 200 PSI PRESSURE GAUGE
- 0 - 75 FEET: 10 3/4-INCH STEEL SURFACE CASING
- +1.0 - 950 FEET: 7 5/8-INCH O.D. STEEL CASING, 26.40 POUNDS PER FOOT
- TYPE G OR H CEMENT GROUT FOR BOTTOM 300 FEET, REMAINDER TO BE "LIGHT" CEMENT GROUT
- 75 - 950 FEET: 9 7/8-INCH DIAMETER BOREHOLE
- GUIDE SHOE
- 950 - 1,550 FEET: 6 3/4-INCH OPEN BOREHOLE

NOTE: DEPTHS AND LENGTHS OF WELL APPURTENANCES ARE DIAGRAMMATIC ONLY. FINAL DESIGN TO BE DETERMINED BY THE ENGINEER.

- ESTIMATED 68 PSI SHUT-IN PRESSURE (157 FEET OF HEAD)
- NOTE: CENTRALIZERS SHALL BE PLACED EVERY 200 FEET.

T.D. = 1,550 FEET
NOT TO SCALE

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BEULAH LEVEL I WATER SUPPLY STUDY
SITE 1 EXPLORATION WELL
PRELIMINARY DESIGN DIAGRAM
FIGURE 2
FIG. 3

PROPOSED 125,000 GALLON TANK
GROUNDF ELEVATION = 3700'
OVERFLOW ELEVATION = 3724'

PROPOSED 8" TRANSMISSION MAIN
EXISTING 4" LINES TO REMAIN IN USE

PROPOSED SERVICE AREA BOUNDARY

BEULAH LAND ESTATES BOUNDARY

PROPOSED 10" TRANSMISSION MAIN

RED WATER ROAD (CR 108)

PROPOSED 8" DISTRIBUTION MAINS

PROPOSED WELL SITE 1 LOCATION

Beulah

EnsTech, Inc.
Consulting Engineers

WESTON

FIG. 3
PROJECTED COSTS AND ECONOMIC ANALYSIS

Conceptual Level Cost Estimates

The conceptual level cost estimate for capital components of Alternatives A and C, the two alternatives selected for further consideration, are $1,390,360 and $1,269,574, respectively. Tables 1 and 2 summarize the estimated costs requiring debt service from a Level III project for Alternatives A and C, respectively. The total project cost shown for each alternative assumes a 50 percent grant and 50 percent loan from the WWDC. The current interest rate for WWDC loans is 6.0 percent over a period of 30 years.

TABLE 1

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<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
<th>COST</th>
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<tr>
<td>1</td>
<td>Eligible Level III Costs (Table V-6)</td>
<td>$930,607</td>
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<td>2</td>
<td>Beulah Exploration Well Equipment (Table V-4)</td>
<td>$75,835</td>
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<td>3</td>
<td>Beulah Exploration Well Purchase (Table V-2)</td>
<td>$64,559</td>
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<td>4</td>
<td>WWDC Grant (50 Percent of Items 1 and 2)</td>
<td>$503,221</td>
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<td>5</td>
<td>Level III Balance</td>
<td>$567,780</td>
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<td>6</td>
<td>Non-Eligible Costs (Table V-6)</td>
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<td>TOTAL</td>
<td>$763,180</td>
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Water Customer Costs for Alternative A

EDU Costs. The cost for construction, operation, and maintenance of the Beulah Exploration Well and the Level III Project, financed with a 30-year loan, is projected to produce a monthly water rate of $122.98, expressed as dollars per month per EDU, assuming the BLE is not included under the alternative. If BLE is included, the projected monthly water rate is $77.35.
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TABLE 2

ESTIMATED COSTS REQUIRING DEBT SERVICE FROM LEVEL III PROJECT
ALTERNATIVE C

<table>
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<th>ITEM</th>
<th>DESCRIPTION</th>
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<td>Eligible Level III Costs (Table V-8)</td>
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<td>2</td>
<td>Beulah Exploration Well Equipment (Table V-4)</td>
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<td>3</td>
<td>Beulah Exploration Well Purchase (Table V-3)</td>
<td>$64,584</td>
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<td>4</td>
<td>WWDC Grant (50 Percent of Items 1 and 2)</td>
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<td>5</td>
<td>Level III Balance</td>
<td>$499,637</td>
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<td>6</td>
<td>Non-Eligible Costs (Table V-8)</td>
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<td><strong>TOTAL</strong></td>
<td><strong>$713,537</strong></td>
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**Per Tap Costs.** The average monthly per tap cost for the construction, operation, and maintenance of the Beulah Exploration Well and the Level III Project, financed with a 30-year loan, is projected to be $166.76 without BLE and $92.64 with BLE.

**Water Customer Costs for Alternative C**

**EDU Costs.** The cost for construction, operation, and maintenance of the Beulah Exploration Well and the Level III Project, financed with a 30 year loan, is projected to produce a monthly water rate of $117.44, expressed as dollars per month per EDU.

**Per Tap Costs.** The average monthly per tap cost for the construction, operation, and maintenance of the Beulah Exploration Well and the Level III Project, financed with a 30-year loan, is projected to be $159.25.

**CONCLUSIONS**

Based on the advantages and disadvantages of each of the alternatives considered, as well as the estimated costs of construction, the recommended alternative if BLE participates in a Beulah
community water system is Alternative A. If BLE elects not to participate in the Beulah community water system, then Alternative C is the preferred alternative.

If the residents within the proposed service area are interested in pursuing construction of a public water supply system, a water district must be formed. With a successful application to the WWDC, an exploration well could be drilled, constructed, and tested during completion of a Level II water supply project. The results of the exploration well program will be used to refine the conceptual design of the water system and to develop more accurate conceptual-level cost estimates. If the exploration well yields sufficient quantities of water and the community agrees to pursue construction of the water system, then an application for a Level III water supply project can be made to the WWDC for final design and construction of the water system.