

**TABLE 2**  
**Groundwater Availability And Development Potential Of The Major Aquifers**  
**In The Bighorn & Wind River Basins, Wyoming<sup>1</sup>**

Major Aquifer	Geologic Unit	Thickness (ft)	Lithologic Character	Hydrologic Character <sup>2</sup>	General Water Quality	Availability / Development Potential <sup>3</sup>
Quaternary Aquifer	Flood-plain alluvium and glacial outwash, terrace gravel deposits, glacial moraine, lacustrine deposits.	0-100+	Unconsolidated silt, sand, gravel, and boulders. Present along and adjoining major stream channels & tributaries. Terraces 50-300' above present stream levels	Yields > 200 gpm possible, especially where induced recharge from diverted irrigation water occurs. Yields range from <50 to 1,600 gpm throughout Bighorn Basin, and ranges from 1 to > 1,000 gpm in Wind River Basin. Terraces are topographically high and often drained by seeps and springs along an escarpment.  Specific Capacity: 0.1-300 gpm/ft Permeability: 1,000-4,400 gpd/ft <sup>2</sup> Transmissivity: 200-80,000 gpd/ft	Total dissolved solids concentrations range from 141 to 11,100 mg/l, depending upon the type of deposit ground water was obtained from.	Excellent potential for the installation of moderate to high capacity wells in the various Quaternary units in the planning area. Surface water treatment requirements generally apply.
Wind River Aquifer	Wind River Formation	250-1,030	Variegated siltstone, shale, claystone, and argillaceous sandstone with interbedded fine-grained sandstone, arkose, and arkosic sandstone. Tuffaceous and bentonitic mudstone lenses in upper 500 feet. Unit exposed throughout Wind River Basin.	Yields water to wells and springs throughout Wind River Basin. Yields range between 0.1 to 3,000 gpm. Locally contains artesian zones with sufficient head to produce 200 gpm. Principal source of domestic and stock water on and near Wind River Indian Reservation. Principal source of industrial water in southern part of Wind River Basin.  Specific Capacity: 0.04-23 gpm/ft	Water qualities are highly variable with total dissolved solids ranging from 100 to 5,110 mg/l. High variability in water quality due to highly variable lithology, permeability, and recharge conditions.	Historically this aquifer has been extensively developed for municipal, domestic, industrial, and agricultural purposes in the Wind River Basin. High yield potential in areas not previously developed, particularly in the western portion of the basin. Wide variations in water quality locally will constrain its type of use.
Willwood Aquifer	Willwood Formation	0-8,000	Highly variable, "red-banded" sub arkose sandstone interbedded with siltstone, mudstone, and locally conglomerate discontinuous sandstone lenses. Unit exposed in the central Bighorn Basin.	Yields from discontinuous sandstones generally between 5-30 gpm throughout the central Bighorn Basin; yields as large as 120 gpm have been reported.  Specific Capacity: 0.01-8.50 gpm/ft	Total dissolved solids concentrations generally exceed 1,000 mg/l and are usually reported in the range from 750 to 2,000 mg/l.	Low yield potential for stock and domestic purposes in the Bighorn Basin. Primarily developed for water supply along the Greybull River and Emblem Bench. Can be difficult to obtain adequate domestic supply.
Fort Union/Lance Aquifer	Fort Union Formation	0-8,000	Basal, cliff-forming sandstone and conglomerate, overlain by interbedded claystone, sandstone, siltstone and minor coal.	Conglomerate and sandstone units yield water to wells. Highly productive and permeable where fractured. Water is semi-confined to confined with sufficient head to produce 10 gpm. Yields generally <20 gpm throughout Bighorn basin, but up to 30 gpm have been reported. Basal part of unit is considered a regional confining layer. Upper part of unit contains complex series of permeable and confining layers.  Specific Capacity: 0.016-3.0 gpm/ft	Water qualities are poor with total dissolved solids greater than 1,000 mg/l. Total dissolved solids concentrations increase to 20,500 mg/l in basin interiors.	Development not as extensive as in overlying Willwood Fm. Historically has been developed for stock and domestic use along recharge areas. Low yield potential in areas where the unit could be economically drilled for additional stock and domestic uses.
Fort Union/Lance Aquifer (Continued)	Lance Formation	0-6,000	Massive to thin bedded sandstone, poorly sorted shale pebble conglomerate, grades upward to carbonaceous shale, siltstone, with thin lenses of bentonite and coarse-grained sandstone. Thin coal lenses in uppermost part of unit.	Wells generally completed in Fort Union and Lance. Unit is highly productive and permeable in Bighorn Basin (yields range between 1 to 100 gpm).  Specific Capacity: 0.8-13.3 gpm/ft	Total dissolved solids concentrations less than 1,000 mg/l may be encountered along recharge areas, but increase basinward.	Historically has been developed for stock and domestic use along recharge areas. Low yield potential in areas where the unit could be economically drilled for additional stock and domestic uses.

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Mesaverde Aquifer	Mesaverde Formation	550-2,000	Upper: very fine to coarse grain, massive to cross-bedded, friable sandstone. Few shale, claystone, and carbonaceous shale interbeds.  Middle: interbedded carbonaceous shale, siltstone, and sandstone. Some lenticular coal beds up to 13 feet thick.  Basal: very fine to medium grain, irregularly bedded to massive sandstone.	Mesaverde water wells primarily located in southwest and southeast parts of Bighorn basin yielding <20 gpm (5-10 gpm on the average) although yields up to 300 gpm have been reported in the planning area. Artesian flows reported from several petroleum test wells in Wind River Basin.  Specific Capacity: 0.2-3.8 gpm/ft	Water qualities poor with total dissolved solids usually greater than 1,500 mg/l.	Moderate yield potential in areas where permeability has been enhanced through fracturing. Suitable for use other than stock is uncertain based on limited water quality data.
Frontier Aquifer	Frontier Formation	450-1,045	Alternating sequence of sandstone and shale.  Sandstone: fine to medium grain, thin bedded to massive, locally glauconitic.  Shale: fissile, silty and sandy, locally carbonaceous.	Upper 2/3 of unit is regional aquifer; lower 1/3 of unit is confining layer. Water is under confined conditions with sufficient head to produce flows of 12 to 25 gpm at selected petroleum test wells. Yields 0.5 to 150 gpm to shallow stock and domestic wells.  Specific Capacity: 0.1-65pm/ft Porosity: 10-26% Permeability: 0-1.4 gpd/ft <sup>2</sup> Transmissivity: 0-45,000 gpd/ft	Water qualities highly variable and range from less than 500 to about 14,000 mg/l total dissolved solids.	Good source of ground water for shallow stock and domestic wells near recharge areas.
Muddy Aquifer	Muddy Sandstone	20-75	Sandstone, poorly to well sorted, fine to medium grain, salt and pepper sandstone. Grades locally to siltstone and sandy shale.	Oil and water-bearing unit. Water is under confined conditions with sufficient head to produce flows of 1 to 20 gpm at selected petroleum test wells.	Water qualities are poor with total dissolved solids generally greater than 1,500 mg/l. Total dissolved solids concentrations as low as 599 mg/l have been reported in Hot Springs County.	Low yield and generally poor water quality associated with oil production generally limit the usefulness of this aquifer.
Cloverly Aquifer	Cloverly Formation	85-470	Composed of three units, upper sandstone, middle shale, and a lower lenticular conglomeratic sandstone.	Permeable and productive upper and basal sandstones. Water is under artesian conditions with sufficient head to produce flows of 1 to 25 gpm at selected petroleum test wells. Yields 5-20 gpm to various wells.  Specific Capacity: 0.02-4 gpm/ft Porosity: 7-15% Permeability: up to 2.2 gpd/ft <sup>2</sup> Transmissivity: 0-50 gpd/ft	Water qualities are generally less than 1,000 mg/l where the formation crops out and is intensely faulted or fractured. Total dissolved solids range from 450 to 30,000 mg/l.	Low to moderate yield potential from upper and basal sandstones. Local water qualities will affect potential uses.
Sundance/Nugget Aquifer	Sundance Formation	150-570	Upper: fine to coarse grain glauconitic sandstone with few thin shale and fossiliferous limestone interbeds.  Basal: siltstone and sandstone; grade downward to oolitic limestone, dolomite, and chert pebble conglomerate.	Large intergranular permeability in sandstone and chert lenses. Yields water to shallow stock and domestic well along outcrops (1 to 25 gpm). Water is under confined conditions. Selected petroleum test wells yield flows of 25 to 50 gpm.	Water qualities are good along outcrops with total dissolved solids less than 500 mg/l. Water qualities deteriorate basinward with total dissolved solids greater than 2,000 mg/l.	Low yield potential renders this aquifer suitable primarily for domestic and stock use in areas where suitable water qualities can be obtained.

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Sundance/Nugget Aquifer (Continued)	Nugget Sandstone	0-400	Upper: sandstone, fine to medium grain, calcite and silica cement, and large scale cross beds.  Basal: calcareous siltstone and mudstone, thin limestone, and thin to massive, very-fine grain sandstone.	Good intergranular permeability. Saturated conditions reported for numerous petroleum test wells throughout Wind River Basin only. Water is under confined conditions. Yields on Wind River Indian Reservation range from 10-90 gpm.  Specific Capacity: 3.3-8.2 gpm/ft	Insufficient data exists to meaningfully quantify water qualities.	Low yield potential renders this aquifer suitable primarily for domestic and stock use in areas where suitable water qualities can be obtained.
Phosphoria Aquifer	Phosphoria Formation (Park City Formation) (Goose Egg Formation)	100-350	Interbedded dense limestone, dolomite, nonresistant siltstone and fine grain sandstone. Grades eastward to dominantly limestone, dolomite, and calcareous shale. In eastern Bighorn Basin, contains red shale and siltstone interbedded with limestone and gypsum beds.	Complex series of permeable sandstones and impermeable limestone, dolomite, and siltstone. Highly productive where fractured. Well and spring yields range up to 1,000 gpm.  Porosity: 2-24% Permeability: <0.1-1.4 gpd/ft <sup>2</sup> Transmissivity: <0.5-40 gpd/ft	Water qualities near recharge areas are generally good with total dissolved solids less than 1,000 mg/l. However, sodium sulfate type water with total dissolved solids concentrations ranging up to 44,339 mg/l are typical of the deeper basin areas.	Significant yield potential in areas where permeability has been enhanced through fracturing; however, water quality may not be suitable for all purposes, particularly municipal and domestic supply.
Tensleep Aquifer	Tensleep Sandstone	57-600	Tan to white, massive, crossbedded sandstone. Lower part more dolomitic with interbedded carbonate beds. Primary intergranular porosity and secondary fracture porosity present.	Artesian wells often flow at the surface with yields commonly 50 to 250 gpm. Good intergranular permeability, excellent permeabilities where fractured. Generally saturated throughout the planning area. Water is under confined conditions with sufficient head to produce flows of 1 to several hundred gpm from selected wells. Tremendous oil reservoir within basin interiors.  Specific Capacity: 0.2-5 gpm/ft Porosity: 3-27% Permeability: 0.02-15 gpd/ft <sup>2</sup> Transmissivity: <1-3,000 gpd/ft	Water qualities along outcrops are good with calcium bicarbonate type water having total dissolved solids less than 500 mg/l. Water quality degrades basinward with total dissolved solids commonly exceeding 2,000 mg/l, and as high as 10,727 mg/l due to dissolution of anhydrite and halite from sandstone matrix.	Historically has been a major source of water used for stock and domestic purposes, but has also been developed for industrial and municipal public supply purposes. Generally does not yield sufficient water quantities for irrigation. Moderate to large yields from this aquifer may be encountered in areas of either intergranular or fracture permeability. Water quality generally suitable for most uses.
Tensleep Aquifer	Amsden Formation	0-400	Upper: complex sequence of nonresistant shale, dense dolomite, thin cherty limestone, and thin, resistant, fine grain sandstone. Red shale above basal unit.  Basal: Darwin Sandstone Member, sandstone, fine to medium grain, cross-bedded to massive, friable, and porous.	Part of Tensleep or Madison Aquifer. Darwin sandstone: permeable along joints and partings between bedding surfaces. Excellent permeabilities where fractured. Water is confined. Well yields range between 1 to several hundred gpm.  Porosity: 10%±	Insufficient evidence to characterize, but good water quality from Darwin Sandstone where developed with Madison Limestone near Ten Sleep, Wyoming.	Low to moderate yields available from the lower Darwin Sandstone member.
Madison Aquifer	Madison Limestone	200-880	Massive crystalline limestone and dolomite with siltstone and shale zones, cherty in places. Breccia filled paleokarst in upper part and a second breccia zone in middle. Secondary porosity due to solution along joints and fractures.	Poor permeabilities except where fractured. Some saturated caverns. Water-bearing throughout the planning area. Water is confined. Well yields in the planning area range from 1 to 14,000 gpm.  Specific Capacity: 0.1-673 gpm/ft Porosity: 10-21% Permeability: 0.4-16 gpd/ft <sup>2</sup> Transmissivity: 6.7-14,200 gpd/ft; 30,000 gpd/ft or more where highly fractured	Water qualities are good along outcrop areas. Calcium bicarbonate type water with total dissolved solids concentrations less than 500 mg/l is typically found in wells and springs near recharge area. Sodium sulfate type water with total dissolved solids concentrations as high as 4,303 mg/l is typical of basin interior water.	Highest yielding aquifer in the planning area with excellent water qualities. Significant yields from this aquifer can be expected where the permeability has been enhanced through fracturing and cavern development. Historically has been a major source of water for municipal, irrigation, agricultural, domestic, commercial, and industrial purposes in the planning

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Madison Aquifer	Bighorn Dolomite	0-450	Massive to thin-bedded dolomite and dolomite limestone. Fine-grained massive sandstone at the base (Lander Sandstone Member). Porosity primarily do to fracturing and solution. Contains cavernous zones near outcrop areas.	Basal part of Madison Aquifer. Produces artesian water from joints, fractures, and caves. Basal sandstones are permeable. Yields water to numerous springs along Wind River Mountains and several wells in Bighorn Basin. Yields range from 1 to 1,200 gpm.  Specific Capacity: 0.1-5.2 gpm/ft  Porosity: 13%±	Limited and sparse data are available exclusively for this unit. Total dissolved solids concentrations in recharge areas are typically less than 250 mg/l, but concentrations as high as 3,440 mg/l have been reported in Hot Springs County.	area.  Generally developed along with the Madison Limestone, ground water from this aquifer has been used for municipal, domestic, and irrigation purposes. Significant yield potential in areas where permeability have enhanced through fracturing and cavern development. Suitable water qualities for most purposes.
Flathead Aquifer	Flathead Sandstone	0-500	Sandstone, fine to medium grain, resistant; grades downward to conglomerate and arkose. Interbedded shale in upper part.	Permeable along partings between bedding planes, faults, fractures and joints. Small interstitial permeabilities. Water is semi-confined to confined. Produces water under very high artesian pressures and yields from 1 to 3,000 gpm have been reported for stock, domestic, and irrigation wells.  Specific Capacity: 0.52-3.4 gpm/ft  Transmissivity: 700-2,400 gpd/ft	Excellent water qualities toward recharge areas; total dissolved solids generally less than 500 mg/l, but are known to increase to at least 4,150 mg/l in the southern Bighorn Basin. Sodium-chloride and sodium-sulfate type waters typify basin interior waters.	Significant yield potential in undeveloped areas where the intergranular permeability has been enhanced along bed partings and fractures. Historically ground water from this aquifer has been developed for irrigation, stock, and domestic purposes. Water qualities suitable for various purposes depending upon local conditions. Not easily developed due to drilling depths and caving of the overlying Gros Ventre Formation during drilling.

<sup>1</sup> Modified from Cox (1976), Libra and others (1981), Richter (1981), Jarvis (1986), Susong and others (1993), Plafcan and others (1993), Plafcan and Ogle (1994), and Daddow (1996).

<sup>2</sup> Reported yields may reflect development needs rather than aquifer capability, and higher yields may sometimes be expected along with increased drawdown. Reported transmissivities or permeabilities may be for wells completed in more than one aquifer, or only part of a single aquifer. Reported ranges include varying amounts of data.

<sup>3</sup> Actual development potential will require site specific office and field investigations to define aquifer capability and constraints unique to each project and site.