

Table III-24
Summary of Ground Water Availability/Development Potential of Major Aquifer Systems, Central and Eastern Flanks of the Powder River Structural Basin

Major Aquifer System	Geologic Unit	Thickness (Feet)	Lithologic Character	Hydrological Character ^{a,b}	General Water Quality	Availability/Development Potential ^c	Remarks
Quaternary Alluvial Aquifer System	Alluvium and Terrace Deposits	0-100+	Clay rich sandy silt, silt, sand and gravel; unconsolidated and interbedded; present along most streams. Thickness generally less than 50 feet but may be thicker. Coarser deposits in valleys of the Belle Fourche and the Cheyenne Rivers. Alluvium overlying formations of Tertiary age is generally fine to medium grained in central part of basin. (Hodson, Pearl and Druze, 1971)	Yield of 1000 gpm possible, often through induced recharge. Terraces topographically high and often drained. Specific capacity, 0.3-18 gpm/ft; porosity, 28-45%; permeability, 0.1-1100 gpd/ft ² ; transmissivity, 15-64000 gpd/ft; specific yield, 2-39%. Coarser deposits have better aquifer properties.	TDS content generally range from about 100 to >4000 mg/l, and chemical characteristics of water differ geographically. Chemical type and mineralization of the water can be expected to vary depending on underlying rock types and the nature and degree of interconnection with underlying bedrock aquifers as well as surface water. Moderate to high mineralization tolerable for stock and domestic use. Suitability for irrigation generally limited to salt tolerant crops. Water in the alluvium in Black Hills generally is better quality than central part of basin. (Hodson, Pearl and Druze, 1971).	Historical source for domestic and stock uses. Production has ranged from 1 to 900 gpm. Ground water development potential generally better in coarse-grained deposits and poorer in fine-grained materials. Yields in the high end of the above range might be possible to optimally located and properly designed wells if induced infiltration from surface water can be tolerated (Belle Fourche, Cheyenne and Niobrara River Basins). Potential source for irrigation, municipal / public and industrial sources where more than 40 feet of saturated well sorted sand and gravel are present.	Quaternary alluvial aquifers generally in hydraulic connection with all bedrock aquifers in outcrop areas and also with surface waters. Alluvial aquifers in larger valleys provide hydraulic interconnection between otherwise hydraulically isolated bedrock aquifers (Whitcomb, 1965). Alluvial aquifers also serve as interchange point and storage for ground water in the hydrologic cycle (Davis and Rechar, 1977). (Davis, 1976). Induced recharge from surface waters is probable in areas of extensive development.
Middle Tertiary Aquifer	Arkaree Formation	0-500 (southeast only)	Tuffaceous sandstone, fine-grained with silty zones, coarse sand lenses and concretionary zones.	Yields up to 1000 gpm; specific capacity up to 232 gpm/ft; porosity, 5-24%; permeability <1-300 gpd/ft ² ; transmissivity up to 77,000 gpd/ft.	TDS content of water ranges from 261 to 535 mg/l. Composition mainly Calcium Bicarbonate (Whitcomb, 1965). Median TDS content in samples from 12 wells in Niobrara County 321 mg/l (Larson, 1984).	Historical source for municipal / public, industrial, domestic, stock and irrigation supply with tested production ranging as high as 195 to 730 gpm (Whitcomb, 1965). Yields of 1000 gpm might be possible to optimally located and properly designed wells.	Water level data available from two observation wells located east and south east of Lusk in Niobrara County (32-62-05-baa01), (32-62-32-bbb01). Water levels have shown approximately 6 to 13 feet decline in the water levels in the aquifer since the 1970s with possibly some stabilization and slight recovery since early to mid 1990s (USGS, 2001).
Fort Union / Wasatch Aquifer System	Wasatch Formation	up to 1600	Fine- to coarse-grained lenticular sandstones interbedded with shale and coal, coarser in south.	Yields generally <15 gpm, locally flowing wells exist. Yields historically could be expected to range from 10 to 50 gpm in the north part of the basin with the possibility of higher yields up to 500 gpm in the south part of the basin (Hodson, Pearl and Druze, 1973). Specific capacity, 0.10-14 gpm/ft (Hodson, Pearl and Druze, 1973); porosity, 28-30%; permeability, 0.01-65 gpd/ft ² ; transmissivity, average 500 gpd/ft range 1-4000 gpd/ft.	TDS content of waters is variable and ranges from <200 to > 8000 mg/l (Hodson, Pearl and Druze, 1973). Sodium Sulfate and Sodium Bicarbonate are general dominate water types. Major ion composition varies with depth and shows more Sodium and Bicarbonate content with depth. Radium 226 + 228 may be of concern near uranium deposits.	Historical source for municipal / public, domestic and stock supply. Yields ranging from 10 to 50 gpm in the north part of the basin can be expected with the possibility of higher yields up to 500 gpm in the south part of the basin (Hodson, Pearl and Druze, 1973).	Water level data available from two observation wells located in Campbell County (50-72-21-abo01), (42-71-35-aaa01) and one observation well in Converse County (37-70-10-abb01). Water levels in the aquifer have shown about a 40 feet rise between 1983 and 2000 in Gillette and about a 40 to 50 feet decline south east of Wright in Campbell County. Water levels in the aquifer in northwest Converse County have shown a rise of about 7 feet between 1988 and 1999 after a decline of about 6 feet between 1986 and 1988. (USGS, 2001)

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Fort Union/Wasatch Aquifer System (continued)	Fort Union Formation	1100-2270	Sandstone, fine- to medium-grained, lenticular, interbedded with siltstone, coal and shale. Middle part may be shaler in north, upper part siltier in south. "Clinker" associated with coal outcrops.	Flowing yields of 1-60 gpm where confined. Pumped yields up to 250 gpm with several hundred feet of drawdown. Specific capacity, 0.1-2 gpm/ft; permeability, 0.01-100 gpd/ft ² ; transmissivity, 1-5000 gpd/ft. Coal and clinker generally have better aquifer properties than sandstones. Locally clinker transmissivity up to 3,000,000 gpd/ft. Anisotropy and leaky confining layers are common.	TDS content and major ion composition of Fort Union Formation waters as above. Water co-produced with coal bed methane is predominantly Sodium Bicarbonate type with TDS content and SAR (32 samples), 270 - 1170 mg/l (mean of 653 mg/l) and 5.7 - 12 (mean of 7.85) respectively (Rice, Ellis & Bullock, 2000). BLM Wyodak-EIS assumed average TDS concentration of 764 mg/l (USDIBLM, 1999). High radionuclide content of concern in areas near uranium ore zones.	Historical source for municipal/public, domestic and stock supply. Maximum expected yields of about 130 to 150 gpm (Hodson, Pearl and Druse, 1973), (Wester-Warstein and Privateley Owned Water Systems and Water Users Associations in Campbell County. City of Gillette mixes Fort Union Formation water with that from the Madison and Fox Hills/Lance system for municipal/public water supply. Total of 5285 Coal Bed Methane wells permitted with WSEO in planning area as of 12/31/00. Maximum, minimum and mean depths, and range of actual yields listed on permits were 138 -5507 (mean 772) feet below ground surface (bgs), and 1 - 120 (mean 27) gpm respectively. Range of depths to main water bearing zone listed on WSEO Permits were 124 - 1558 (mean 124) feet bgs. BLM Wyodak EIS assumed average expected water production to be 12 gpm over the estimated 12 year life of each CBM well (USDIBLM, 1999). BLM Wyodak Drainage EA assumed average water production for each CBM well to be 11.1 gpm (USDIBLM, 2000).	Source for approximately 14 municipal and public water supply systems including the City of Gillette and adjacent Districts, Joint Powers Boards and Privately Owned Water Systems and Water Users Associations in Campbell County. City of Gillette mixes Fort Union Formation water with that from the Madison and Fox Hills/Lance system for municipal/public water supply. Total of 5285 Coal Bed Methane wells permitted with WSEO in planning area as of 12/31/00. Maximum, minimum and mean depths, and range of actual yields listed on permits were 138 -5507 (mean 772) feet below ground surface (bgs), and 1 - 120 (mean 27) gpm respectively. Range of depths to main water bearing zone listed on WSEO Permits were 124 - 1558 (mean 124) feet bgs. BLM Wyodak EIS assumed average expected water production to be 12 gpm over the estimated 12 year life of each CBM well (USDIBLM, 1999). BLM Wyodak Drainage EA assumed average water production for each CBM well to be 11.1 gpm (USDIBLM, 2000).
Fox Hills/Lance Aquifer System	Lance Formation	500-1000 (North) 1600-3000 (South)	Sandstone, fine- to medium-grained, lenticular, interbedded with sandy siltstone and claystone.	Yields up to 350 gpm but with large drawdowns and long well completion intervals. Locally flowing wells exist. Specific capacity, 0.05-2 gpm/ft; permeability, 6-35 gpd/ft ² ; transmissivity, 170-2100 gpd/ft	TDS content in waters at Foxhills/Lance System outcrops north of Niobrara County range from 600-1,500 mg/l, and in Niobrara County range from 1,000 - 3,300 mg/l. Composition mainly Sodium - Bicarbonate - Sulfate, Fluoride enrichment is characteristic of Fox Hills/Lance Formation waters. Possible high Sodium, and radionuclide content could be of concern in some areas.	Lance Formation historical source for municipal/public, domestic and stock supply. Generally yields less than 20 gpm, but yields of several hundred gallons per minute may be possible from complete section of the formation. (Hodson, Pearl and Druse, 1973)	High Fluoride content is of concern for development as source for municipal/public water systems.