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Chapter 3: County Characteristics & Risk Assessment

3 Background and Area Description

3.1 Location and Land Forms

Yellowstone County is located in south central Montana with the Yellowstone River cutting through its heartland. Elevations range from 4,700 feet above sea level south of Billings to approximately 3,000 feet in some areas in the northeastern corner of the County. Ownership is mixed between federal, tribal, state, and private owners.

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Figure 3.1. Topographic relief of Yellowstone County, Montana.

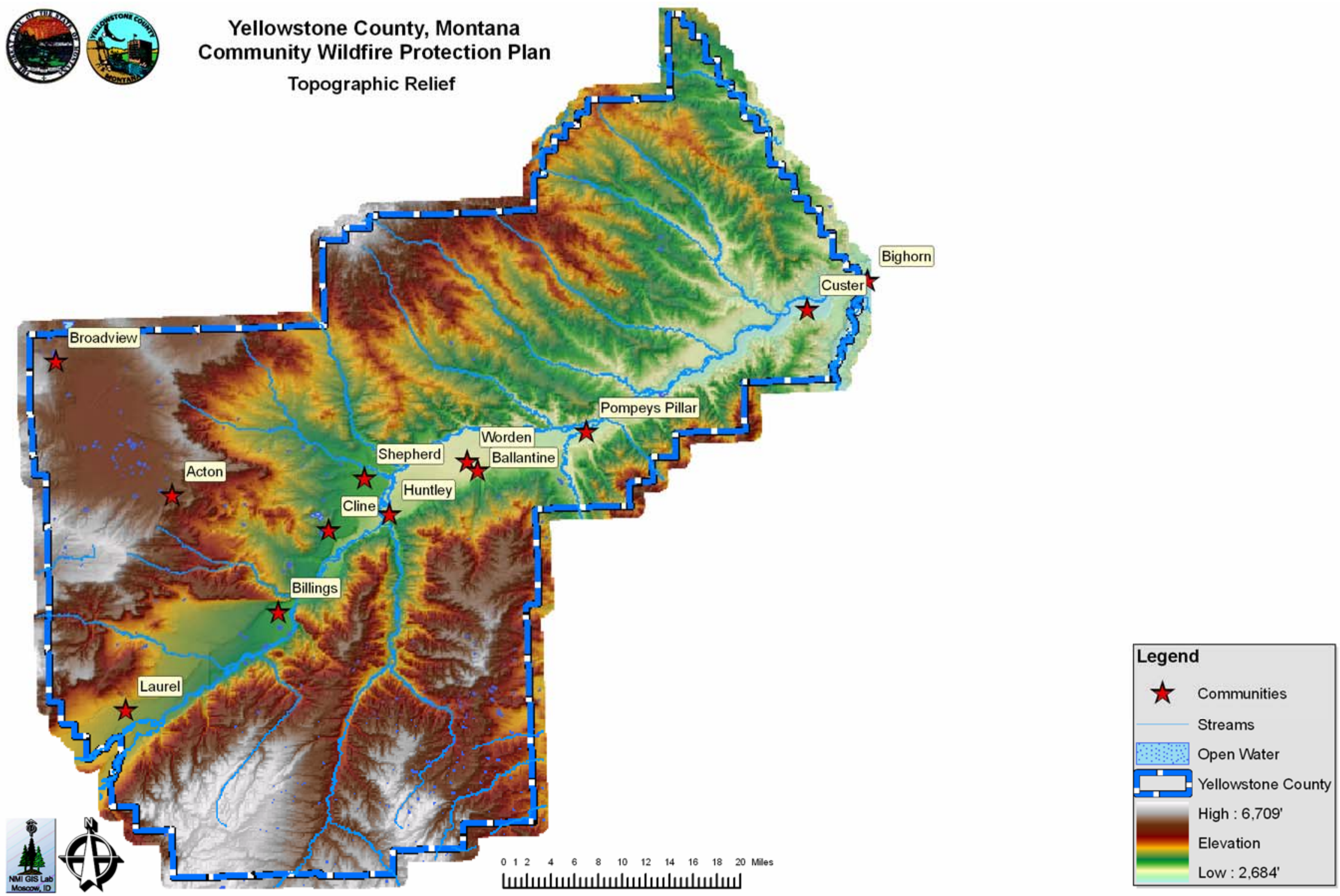

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Figure 3.2. Land Ownership in Yellowstone County.

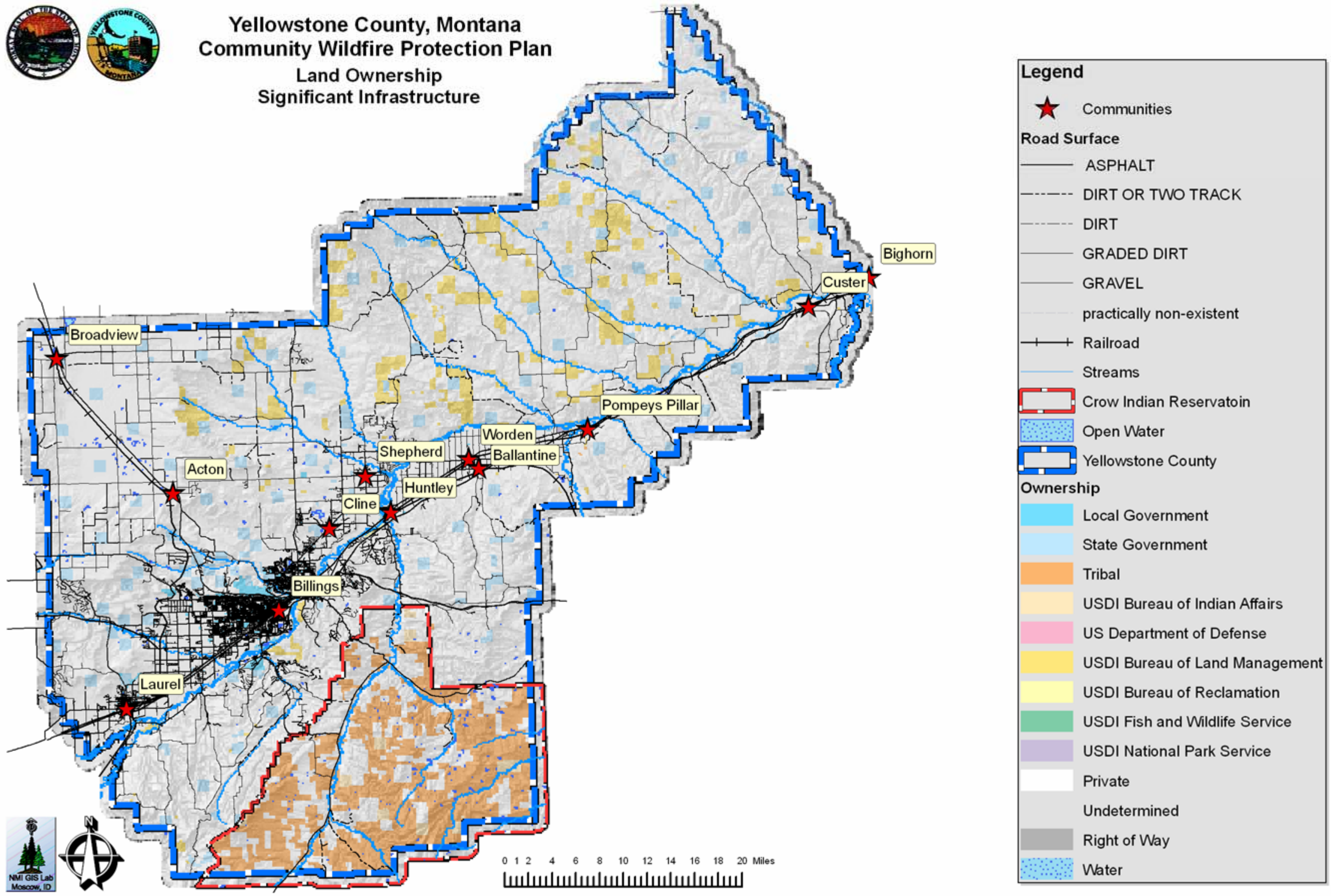

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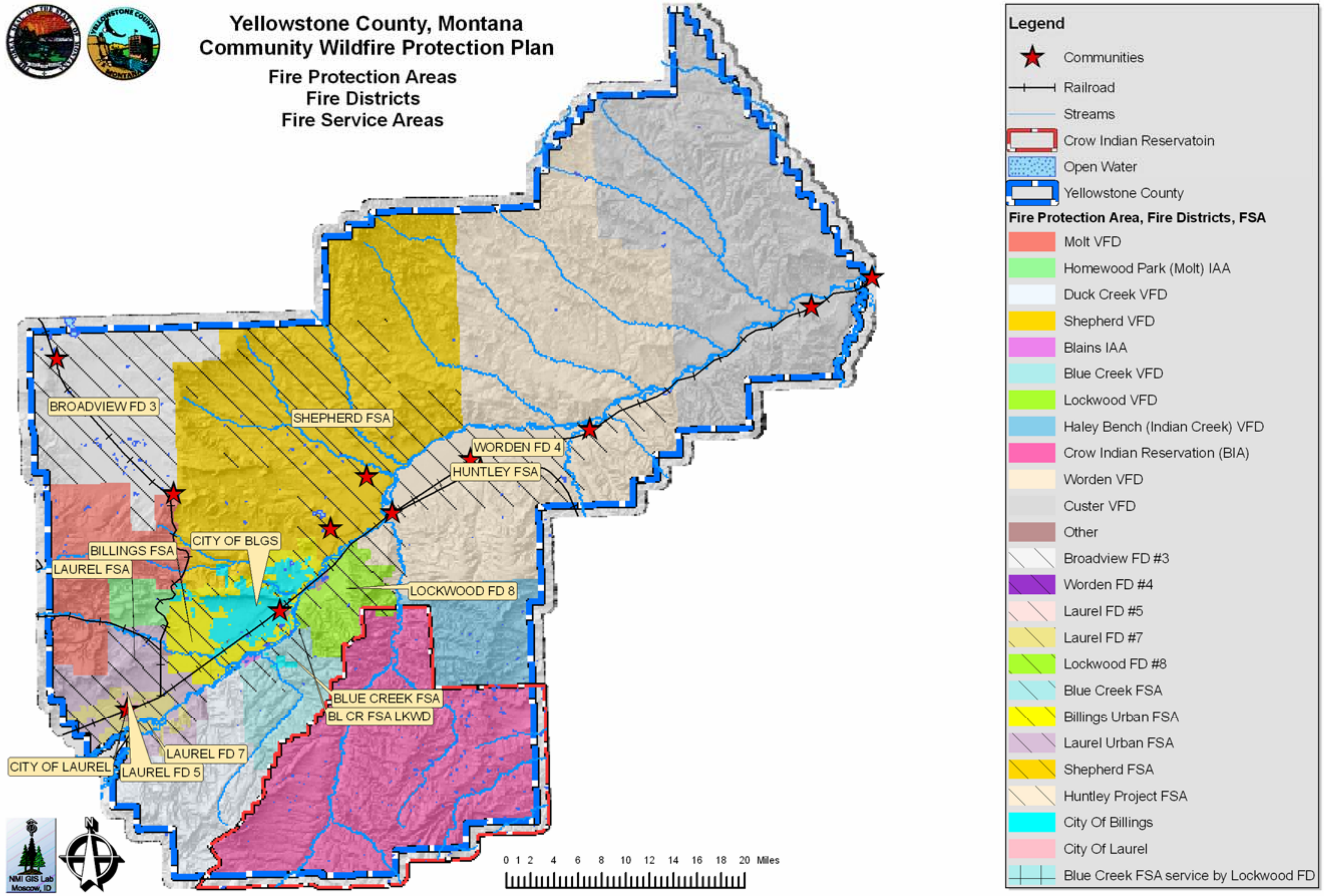
Figure 3.3. Rural and City Fire Protection in Yellowstone County.



3.2 Demographics

The number of persons residing in Yellowstone County has been growing steadily over the past few decades, rising by approximately 14 percent between 1990 and 2000. Yellowstone County remains the most populated county in Montana with a population of 129,352 in 2000. Yellowstone County has three incorporated communities, Billings (pop. 89,362), Laurel (pop. 6,142), and Broadview (pop. 184). Unincorporated communities recognized by the Census Bureau include Lockwood (pop. 4,282), Huntley (pop. 477), Worden (pop. 472), Shepherd (pop. 177), Ballantine (pop. 366), and Custer (pop. 145). The total land area of the county is roughly 2,649 square miles (1,695,392 acres).

Table 3.1 summarizes some relevant demographic statistics for Yellowstone County.

Table 3.1. Summary of selected demographic statistics for Yellowstone County, Montana (Census 2000).

Subject	Number	Percent
Total population	**129,352**	**100.0**
SEX AND AGE		
Male	63,045	48.7
Female	66,307	51.3
Under 5 years	8,440	6.5
5 to 9 years	9,463	7.3
10 to 14 years	9,517	7.4
15 to 19 years	9,180	7.1
20 to 24 years	8,519	6.6
25 to 34 years	16,087	12.4
35 to 44 years	21,172	16.4
45 to 54 years	18,426	14.2
55 to 59 years	6,249	4.8
60 to 64 years	5,076	3.9
65 to 74 years	8,636	6.7
75 to 84 years	6,475	5.0
85 years and over	2,112	1.6
Median age (years)	36.8	(X)
18 years and over	96,216	74.4
Male	45,785	35.4
Female	50,431	39.0
21 years and over	91,015	70.4
62 years and over	20,178	15.6
65 years and over	17,223	13.3
Male	7,121	5.5
Female	10,102	7.8
RELATIONSHIP		
Population	**129,352**	**100.0**
In households	126,413	97.7
Householder	52,113	40.3

Table 3.1. Summary of selected demographic statistics for Yellowstone County, Montana (Census 2000).		
Subject	**Number**	**Percent**
Spouse	27,132	21.0
Child	37,421	28.9
Own child under 18 years	30,826	23.8
Other relatives	3,548	2.7
Under 18 years	1,450	1.1
Nonrelatives	6,199	4.8
Unmarried partner	2,941	2.3
In group quarters	2,939	2.3
Institutionalized population	1,652	1.3
Noninstitutionalized population	1,287	1.0
HOUSEHOLDS BY TYPE		
Households	**52,113**	**100.0**
Family households (families)	34,488	66.2
With own children under 18 years	16,668	32.0
Married-couple family	27,362	52.5
With own children under 18 years	11,901	22.8
Female householder, no husband present	5,050	9.7
With own children under 18 years	3,454	6.6
Nonfamily households	17,625	33.8
Householder living alone	14,548	27.9
Householder 65 years and over	5,632	10.8
Households with individuals under 18 years	17,700	34.0
Households with individuals 65 years and over	16,141	31.0
Average household size	2.43	(X)
Average family size	2.97	(X)
HOUSING TENURE		
Occupied housing units	**52,084**	**100.0**
Owner-occupied housing units	36,037	69.2
Renter-occupied housing units	16,047	30.8
Average household size of owner-occupied unit	2.59	(X)
Average household size of renter-occupied unit	2.06	(X)

(Census 2000)

Figure 3.4 Yellowstone County Population Trends from 1890 – 2000.

TABLE 1: Population Of Yellowstone County And Incorporated Areas Percent Change By Decade 1890 – 2000								
Decade	Yellowstone County	Percent Change	City of Billings	Percent Change	City of Laurel	Percent Change	Town of Broadview	Percent Change
1890	2065	*****	836	*****	No Data	*****	No Data	*****
1900	6212	66.76	3221	285.29	No Data	*****	No Data	*****
1910	22,944	22.49	10,031	50.53	806	*****	No Data	*****
1920	29,600	29.01	15,100	8.48	2239	177.80	191	*****
1930	30,785	4.00	16,380	42.00	2558	14.25	260	36.13
1940	41,182	33.77	23,261	36.85	2754	7.66	140	-120.00
1950	55,875	35.68	31,834	66.02	3663	33.00	164	17.14
1960	79,016	41.41	52,851	65.12	4601	.25.60	160	-2.44
1970	87,367	10.57	61,581	16.52	4454	-3.19	123	-23.13
1980	108,035	23.65	66,798	8.47	5481	23.06	120	-2.44
1990	113,419	4.98	81,151	21.49	5686	3.74	133	10.83
2000	129,352	14.04	89,847	10.72	6255	10.00	150	12.78

Yellowstone County and City of Billings 2003 Growth Policy Plan.

3.3 Socioeconomics

Yellowstone County had a total of 52,084 occupied housing units and a population density of 2.8 persons per square mile reported in the 2000 Census (Table 3.1). Ethnicity in Yellowstone County is distributed: white 92.8%, black or African American 0.4%, American Indian or Alaskan Native 3.1 %, other race 1.3%, and Hispanic or Latino 3.7%.

Specific economic data for individual communities is collected by the US Census; in Yellowstone County this includes Billings, Laurel, and Broadview. Billings's households earn a median income of $35,147 annually, Laurel households earn $32,679, and Broadview households earn $29,500, which are both below the Yellowstone County median income during the same period ($36,727). Table 3.2 shows the dispersal of households in various income categories in both communities.

Table 3.2. Income in 1999.	Billings		Laurel		Broadview		Yellowstone County	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Less than $10,000	3686	9.8	261	10.6	5	7.1	4773	9.2
$10,000 to $14,999	3642	9.9	252	10.3	7	10	4709	9.0
$15,000 to $24,999	5823	15.5	448	18.2	16	22.9	7928	15.2
$25,000 to $34,999	5512	14.7	338	13.8	14	20	7466	14.3
$35,000 to $49,999	6677	17.8	492	20	17	24.3	9508	18.2
$50,000 to $74,999	7029	18.8	390	15.9	7	10.0	9803	18.8
$75,000 to $99,999	2641	7	206	8.4	4	5.7	4128	7.9
$100,000 to $149,999	1518	4.1	40	1.6	0	0	2375	4.6
$150,000 to $199,999	437	1.2	7	0.3	0	0	667	1.3
$200,000 or more	505	1.3	21	0.9	0	0	756	1.5
Median household income (dollars)	35,147		32,679		29,500		36,727	

(Census 2000)

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations*, directs federal agencies to identify and address any disproportionately high adverse human health or environmental effects of its projects on minority or low-income populations. In Yellowstone County, a significant number of families are at or below the poverty level. Approximately 9.2% of Yellowstone County families are below poverty level (Table 3.3).

Table 3.3. Poverty Status in 1999 (below poverty level).	Yellowstone County	
	Number	Percent
Families	2,130	(X)
Percent below poverty level	(X)	9.2
With related children under 18 years	1,806	(X)
Percent below poverty level	(X)	15.6
With related children under 5 years	990	(X)
Percent below poverty level	(X)	21.7
Families with female householder, no husband present	1,220	(X)
Percent below poverty level	(X)	31.2
With related children under 18 years	1,125	(X)
Percent below poverty level	(X)	38.5
With related children under 5 years	683	(X)
Percent below poverty level	(X)	57.4

Table 3.3. Poverty Status in 1999 (below poverty level).	Yellowstone County Number	Percent
Individuals	10,402	(X)
Percent below poverty level	(X)	12.0
18 years and over	6,851	(X)
Percent below poverty level	(X)	10.4
65 years and over	855	(X)
Percent below poverty level	(X)	7.0
Related children under 18 years	3,448	(X)
Percent below poverty level	(X)	16.5
Related children 5 to 17 years	2,168	(X)
Percent below poverty level	(X)	14.2
Unrelated individuals 15 years and over	3,860	(X)
Percent below poverty level	(X)	20.5

(Census 2000)

The unemployment rate was 2.1% in Yellowstone County in 1999, compared to 4.4% nationally during the same period. Approximately 20.6% of the Yellowstone County employed population worked in natural resources, with much of the indirect employment relying on the employment created through these natural resource occupations; Table 3.4 (Census 2000).

Table 3.4. Employment and Industry.	Yellowstone County Number	Percent
OCCUPATION		
Management, professional, and related occupations	14,505	31.8
Service occupations	7,834	17.2
Sales and office occupations	14,540	31.9
Farming, fishing, and forestry occupations	113	0.2
Construction, extraction, and maintenance occupations	3,662	8.0
Production, transportation, and material moving occupations	4,906	10.8
INDUSTRY		
Agriculture, forestry, fishing and hunting, and mining	812	1.8
Construction	2,630	5.8
Manufacturing	2,221	4.9
Wholesale trade	2,824	6.2
Retail trade	6,893	15.1
Transportation and warehousing, and utilities	2,685	5.9
Information	1,100	2.4
Finance, insurance, real estate, and rental and leasing	3,310	7.3
Professional, scientific, management, administrative, and waste management services	3,771	8.3
Educational, health and social services	9,743	21.4
Arts, entertainment, recreation, accommodation and food services	5,071	11.1
Other services (except public administration)	2,708	5.9
Public administration	1,792	3.9

Figure 3.5 Labor Force and Unemployment Rates from 1980 to 2000.

TABLE 1: YELLOWSTONE COUNTY ANNUAL AVERAGE CIVILIAN LABOR FORCE AND UNEMPLOYMENT RATES - 1980, 1990 AND 2000

	Yellowstone County Civilian Labor Force			Unemployment rate (%)		
Year	Total	Employed	Unemployed	Yellowstone County	Montana	U.S.A.
1980	55,549	52,870	2,679	4.8	6.1	7.1
1990	61,648	58,563	3,085	5.0	6.0	5.8
2000	72,921	70,158	2,763	3.8	5.2	4.2

Yellowstone County and City of Billings 2003 Growth Policy Plan

Approximately 80% of Yellowstone County's employed persons are private wage and salary workers, while around 12% are government workers (Table 3.5).

Table 3.5. Class of Worker	Yellowstone County	
	Number	Percent
Private wage and salary workers	36,439	80.0
Government workers	5,472	12.0
Self-employed workers in own not incorporated business	3,552	7.8
Unpaid family workers	97	0.2

(Census 2000)

3.4 Description of Yellowstone County

3.4.1 Recreation

This region is a favorite destination for a variety of recreational opportunities. Lake Elmo State Park is a favorite recreational opportunity for County residents offering swimming, hiking, fishing, and sail boating just outside of Billings. The Yellowstone River and the Clarks Fork of the Yellowstone River offer fishing, picnicking, and camping opportunities throughout the County as well. Pictograph Caves State Park and Pompeys Pillar draw tourists and residents alike for day use exploring, hiking, and picnicking. There are also several high-quality golf courses in the area.

Bird hunting and big game hunting for deer, elk, and antelope is especially intense every fall. During the winter, snowmobiling has become a very popular sport. Area residents can also travel to neighboring counties to take advantage of the skiing and snowshoeing opportunities.

The economic impacts of these activities to the local economy and the economy of Montana have not been enumerated. However, they are substantial given the many months of the year that activities take place and the staggering numbers of visitors that travel to this location. The large numbers of visitors to the region each year is noteworthy in light of wildfire mitigation efforts because of the combination of visitors traveling to rural and remote areas, visitors who are not necessarily familiar with rangeland and forestland fuel risk factors (e.g., campfire protocols, use of fire, etc.), and their often unfamiliarity with access routes and other factors. Because of these reasons and others, the rural areas of Yellowstone County will receive increased attention during mitigation treatments.

3.4.1.1 BLM Public Lands

There are several scattered chunks of BLM administered lands in Yellowstone County. These areas are open to the public year round. Although there are no developed sites, residents of Yellowstone County use these lands to hunt, four-wheel, mountain bike, and drive off-road vehicles among many other things.

3.4.1.2 Camping

Camping is a popular activity enjoyed by residents and visitors of Yellowstone County. In addition to the developed RV parks along the freeway routes, there are also several undeveloped campsites along the Yellowstone River, most of which are easily accessed.

3.4.1.3 Fishing and Hunting

Fishing and hunting is very important to Yellowstone County both from a recreational standpoint and as an economic resource. A wide variety of fish can be caught in Yellowstone County including: trout, catfish, crappie, perch, and bass.

For those people who prefer a gun or bow to a fly rod, Yellowstone County offers a bounty of hunting experiences. Wild birds and game, like deer, elk, black bear, antelope, pheasant, partridge, grouse, wild duck, geese, and doves are found in abundance.

3.4.2 Resource Dependency

Economic conditions can affect county population, land use, population growth (or decline), and personal income and ability of communities to fund services and infrastructure. Yellowstone County completed the Yellowstone County and City of Billings 2003 Growth Policy Plan, which outlines an economic development strategy for the future. This document also provided descriptions and data on the county economy and other factors that can affect or be affected by the economy.

Resource industries and agriculture dominate the local economy. There are three oil refineries in the county, with two of those in Billings and the third in nearby Laurel. A Western Sugar refinery is located in Billings. About 350 Montana farmers supply sugar beets to the refinery, which has a direct impact of $50 million per year on the county’s economy.

Billings is the medical and educational center for the region. The two hospitals employ over 3,200 people and have almost 600 beds. Several clinics also operate in Billings. Montana State University – Billings has 4,000 students while its College of Technology has approximately 500. Rocky Mountain College, a private, four-year university, has 800 students and is the oldest college in Montana.

The Billings and Yellowstone County economy can be summarized as follows:

- Employment grew by 1/3 between 1980 and 2000 and about 2/3 of those new workers were women.
- Employment growth in the mid to late 1990s was dominated by construction, retail sales and service jobs.

• Predicted Montana job growth through 2008 indicates that the most jobs will be produced in retail sales and services and the state growth rates for these jobs is predicted to be higher than for the U.S.

• The jobs that are predicted to grow most for the next few years have among the lowest job multipliers, thereby producing relatively low spin-off or secondary job opportunities.

• Supply of workers in Yellowstone County is predicted to equal or exceed the demand over the next several years.

• Per capita income has grown slowly over the past 30 years, but it has fallen when compared to the U.S., and has risen when compared to the state of Montana.

• When adjusted for inflation, average earnings per job have remained almost stagnant for the past 30 years and have fallen when compared to the U.S. average.

• The cost of living in Billings is slightly below the national average and is about the median among surveyed cities in Montana and the region.

• When the cost of living is compared to per capita income and earnings per job, Billings has a lower cost of living and higher income/earnings than most of the surveyed Montana cities. When compared to other surveyed cities in the region, Billings has about an equal cost of living and lower per capita income and job earnings.

• Yellowstone County and Billings aren't keeping pace with surrounding states and the nation in producing personal wealth, but appear to be doing better than the remainder of Montana.

3.4.3 Development Trends

Sixty-nine percent of the population in Yellowstone County lived in Billings in 2000. This is slightly less than the 71.5 percent of the population that lived in the City in 1990. These figures suggest a slight growth in population outside the City limits. This trend is supported by the increase in subdivision activity in the County. The growth trend has been to develop on the edges of Billings or in the County and not within the City. This trend is not because of the lack of developable parcels in the City. There are approximately 3,607 parcels classified by the Montana Department of Revenue as vacant residential land within the city limits. Of these, 3,529 parcels are two acres or less. The vacant parcels constitute 11 percent of all parcels in Billings. For the years of 2000 and 2001, there were more single family home building permits issued than there were lots created in the Billings Metro (building permit jurisdiction). There were 403 building permits issued for single family home construction in 2000, and 476 permits were issued in 2001. An estimated 298 lots were created in the Metro Area in 2000 and 312 in 2001. This trend indicates that, in addition to new construction occurring on newly created lots, lots created in previous years are being developed. Many of the older lots have remained vacant for a decade or more until being developed only recently. This is particularly true for subdivisions in the Heights, including several filings of the Lake Hills Subdivision.

According to the Billings Housing Needs Analysis, the need for low cost housing exceeds the supply. The study estimates a shortage of almost 2,200 low cost units that are affordable to households earning less than $15,000 per year. The estimates are based on the number of available units that would cost the homeowner no more than 30 percent of their income. There is also a shortage of housing for households earning more than $35,000 based on the same criteria. However, many people may choose to live in homes that are less expensive than they can afford and spend their money on other expenses.

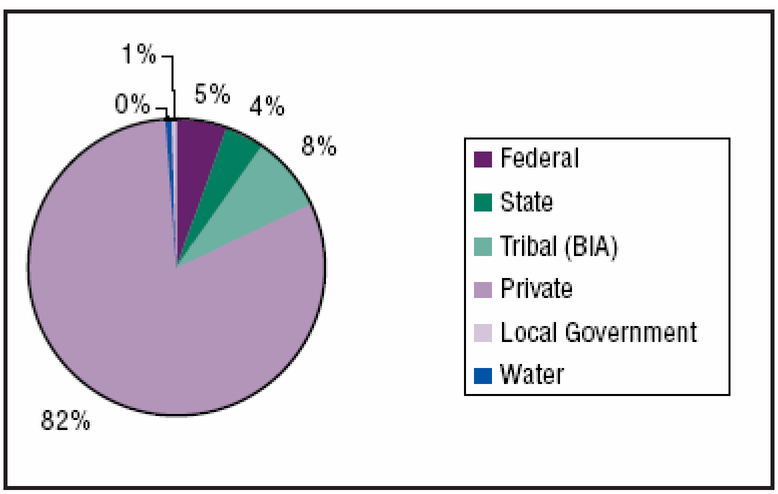
3.4.4 Land Use

Historically, Yellowstone County land use has been dominated by agriculture and related uses. Much of the early business in Billings developed to service the surrounding ranches and farms. Today, agriculture is still a dominant land use, but residential development and commercial uses have gained considerable ground.

The area of Yellowstone County is approximately 1,693,751 acres. Of the total, 1,374,730 acres, or 82 percent, is under private ownership. Tribal land administered by the U.S. Bureau of Indian Affairs comprises 139,983 acres (8 percent) and is located primarily in the southeast part of the County. Other Federal agencies, including the U.S. Bureau of Land Management, the U. S. Bureau of Reclamation, and U.S. Fish & Wildlife Service administer 88,581 acres (5 percent) and state agencies administer 73,414 acres (4 percent). State land management agencies include the Department of Natural Resources, responsible mainly for State Trust Land, and the Montana Department of Fish, Wildlife, and Parks, which oversees State Parks and fishing accesses.

Land owned by the City of Billings, City of Laurel and Yellowstone County comprise less than 1 percent of Yellowstone County. The ownership of land covered by water is also less than 1 percent where ownership is undetermined. In general terms, land use in Yellowstone County falls into five main categories: agricultural, residential, commercial, industrial and recreational. The majority of the County, over 1.3 million acres, is classified by the Montana Department of Revenue as agricultural. The primary residential and commercial centers are located in Billings, Laurel, and Lockwood and to a lesser extent, the communities of Custer, Shepherd, Huntley, Worden, Ballantine, Pompey's Pillar and Broadview. There is approximately 4,148 acres of commercially and industrially-classed property and 33,057 acres of residentially-classed property throughout the County. Industrial uses are mostly confined to Billings, Laurel and Lockwood. The remaining 350,000 acres includes land administered by the Bureau of Indian Affairs, or is not classified or is exempt.

Figure 3.6. Land ownership in Yellowstone County.



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3.4.4.1 Agricultural Land Use

The 1997 Census of Agriculture reported a 5 percent increase in the amount of land used for agricultural purposes between 1992 and 1997 in Yellowstone County. An estimated 1,526,007 acres or 90 percent of the total County land base is used for cropland and grazing. Most of the agricultural land, 1,144,617 acres, is used for livestock grazing while 381,390 acres are cultivated for crops. The amount of irrigated cropland increased from 73,261 acres in 1992 to 80,024 acres in 1997. This suggests that the loss of irrigated land to annexations and subdivisions was offset elsewhere in the County by an increase in irrigated land use. Within the County zoning jurisdiction, 69 percent or 100 square miles of land is zoned for agriculture.

Agricultural land is held in private, state and federal ownership. The Montana Department of Natural Resources manages 9,000 acres of land under agricultural production and 6,800 acres of grazing land. The Bureau of Land Management has approximately 76,900 acres allotted for grazing purposes.

3.5 Emergency Services

The City of Billings operates the 911 Dispatch Center for Yellowstone County and the City of Billings. In addition to handling law enforcement and emergency medical calls, the center also provides dispatch services to all of the fire departments in Yellowstone County except Laurel. The dispatch center, operational 24 hours a day, is located in Fire Station #1 in Billings.

With regard to wildfires, the 911 dispatch center is primarily responsible for receiving reports of fires and notifying the appropriate fire district and/or agency according to protocol sheets provided by the districts or agencies. The center will provide some support to incidents, but generally does not function as an expanded dispatch office. For large-scale incidents, the County Emergency Operations Center at Fire Station #1 is activated. The County Fire Warden will be involved in establishing and operating the EOC.

The City of Laurel also operates a 911 Dispatch Center for the City of Laurel, the Laurel Volunteer Fire Department, Laurel Police Department, and the Laurel Volunteer Ambulance. This dispatch center handles law enforcement, emergency medical calls, and dispatches fire departments with jurisdiction in the Laurel area. For large scale incidents, and EOC is set up in the Laurel Safety Complex.

3.6 Cultural Resources

The United States has a unique legal relationship with Indian tribal governments defined in history, the U.S. Constitution, treaties, statutes, Executive Orders, and court decisions. Since the formation of the union, the United States has recognized Indian tribes as domestic dependant nations under its protection. The Federal Government has enacted numerous regulations that establish and define a trust relationship with Indian tribes.

The relationship between Federal agencies and sovereign tribes is defined by several laws and regulations addressing the requirement of Federal agencies to notify or consult with Native American groups or otherwise consider their interests when planning and implementing Federal undertakings, among these are:

- **EO 13175, November 6, 2000**, Consultation and Coordination with Indian Tribal Governments.
- **Presidential Memorandum, April, 1994**. Government-Government Relations with Tribal Governments (Supplements EO 13175). Agencies must consult with federally recognized tribes in the development of Federal Policies that have tribal implications.
- **EO 13007, Sacred sites, May 24, 1996**. Requires that in managing Federal lands, agencies must accommodate access and ceremonial use of sacred sites and must avoid adversely affecting the physical integrity of these sites.

- **EO 12875, Enhancing Intergovernmental Partnerships, October 26, 1993**. Mainly concerned with unfunded mandates caused by agency regulations. Also states the intention of establishing "regular and meaningful consultation and collaboration with state, local and tribal governments on matters that significantly or uniquely affect their communities."
- **Native American Graves Protection and Repatriation Act (NAGPRA) of 1989**. Specifies that an agency must take reasonable steps to determine whether a planned activity may result in the excavation of human remains, funerary objects, sacred objects and items of cultural patrimony from Federal lands. NAGPRA also has specified requirements for notifying and consulting tribes.
- **Archaeological Resources Protection Act (ARPA), 1979**. Requires that Federal permits be obtained before cultural resource investigations begin on Federal land. It also requires that investigators consult with the appropriate Native American tribe prior to initiating archaeological studies on sites of Native American origin.
- **American Indian Religious Freedom Act (AIRFA), 1978**. Sets the policy of the US to protect and preserve for Native Americans their inherent rights of freedom to believe, express, and exercise the traditional religions of the American Indian . . . including, but not limited to access to sacred sites, use and possession of sacred objects, and the freedom to worship through ceremonies and traditional rites.
- **National Environmental Policy Act (NEPA), 1969**. Lead agency shall invite participation of affected Federal, State, and local agencies and any affected Indian Tribe(s).
- **National Historic Preservation Act (NHPA), 1966**. Requires agencies to consult with Native American tribes if a proposed Federal action may affect properties to which they attach religious and cultural significance. (Bulletin 38 of the act, identification of TCPs, this can only be done by tribes.)
- Treaties (supreme law of the land) in which tribes were reserved certain rights for hunting, fishing and gathering and other stipulations of the treaty.
- Unsettled aboriginal title to the land, un-extinguished rights of tribes.

3.6.1 Crow Indian Reservation

The Crow Reservation is in south central Montana, bordered by Wyoming to the south. The northwest boundary of the reservation is about ten miles from Billings in Yellowstone County. About 75 percent of the Crow tribe's, approximately 9,300, enrolled members live on or near the reservation. Many speak Crow as their first language.

For many years the vast coal deposits under the eastern portion of the reservation remained untapped. One mine is now in operation and is providing royalty income and employment to tribal members. The Crow use a portion of their land for irrigated and dryland farming and other portions for grazing land. They maintain a buffalo herd of 300 head. Crow Agency is home to Little Bighorn College. The college houses the Institute for MicroBusiness Development and offers degrees in eight fields.

Other points of interest on the reservation are:

- Bighorn Canyon National Recreation Area
- Little Bighorn National Monument/Reno-Benteen Battlefield
- Chief Plenty Coups State Park

- Yellowtail Dam and Reservoir

The Crow tribe call themselves "Apsaslooka", which means "children of the large-beaked bird." Other tribes called them "sharp people," meaning they were as crafty and alert as the raven. The Crow originally lived in the upper Midwest. The tribe began migrating west as early as the late 1300s. They migrated to North Dakota around 1600 and then continued their movement west. Finally, they settled along the Missouri and Yellowstone River bottoms in Montana.

Originally planters, as the Crow moved west, they came to rely on hunting, and they built a life around the buffalo. When the horse was first introduced in the 18th century, the Crow quickly became excellent horsemen and prospered.

William Clark met the Crow in 1806, and spent a month in Crow country. The expedition members, and later the fur traders, developed good relationships with the tribe. Nonetheless, the Crows, like so many other tribes, found themselves vulnerable to Euro-American diseases. Smallpox and other diseases reduced the tribe by over twenty percent.

At the same time, the buffalo were disappearing from the plains, and the tribe was forever changed. Despite their good relationship with the government, the tribe's lands dwindled and treaties were broken. Additionally, their traditional enemies, the Sioux and the Northern Cheyenne, invaded Crow land. The other tribes tried to get the Crow to work with them against the tide of white settlers, but the tribe did not have a hostile relationship with the government. George A. Custer had six Crow scouts at the Battle of The Little Bighorn. The reservation boundaries were finally fixed by 1904. The tribe has returned to an agricultural way of life, much like their ancestors 300 years before.

3.6.2 National Register of Historic Places

Section 106 of the National Historic Preservation Act requires federal agencies to consider the effects of their proposals on historic properties, and to provide state historic preservation officers, tribal historic preservation officers, and, as necessary, the Advisory Council on Historic Preservation a reasonable opportunity to review and comment on these actions.

Cultural resource impacts were qualitatively assessed through a presence/absence determination of significant cultural resources and mitigation measures to be employed during potential mitigation activities such as thinning, prescribed fire, road construction, flood abatement, and other activities.

Typical archeological sites include settlements, lithic scatters, village sites, rock art, and hunting blinds. The Crow had a network of trails throughout the area which included various trade routes, as well as gathering and hunting routes. Some of the same trails were later used by homesteaders and trappers. Traditional Cultural Properties (TCPs) are cultural resources defined as a significant place or setting, and does not necessarily have any associated material remains. For example, a TCP can be a mountain, river, or natural feature (i.e., rock formation, meadow, etc.). Some of these are present in Yellowstone County. The integrity of some cultural resources has been impacted in the past by logging activities, road building, mining, and grazing.

The National Park Service maintains the National Register of Historical Places as a repository of information on significant cultural locale. These may be buildings, roads or trails, places where historical events took place, or other noteworthy sites. The NPS has recorded sites in its database. These sites are summarized in Table 3.6.

Table 3.6. National Register of Historic Places in Payette County, Idaho.					
Item Number	**Resource Name**	**Address**	**City**	**Listed**	**Architect, Builder, or Engineer**
1	Antelope Stage Station	E of Broadview	Broadview	1983	
2	Billings Chamber of Commerce Building	303 N. 27th St.	Billings	1972	McAlister,G., Gagnon & Co.
3	Billings Historic District	Roughly bounded by N. 23rd and N. 25th Sts., 1st and Montana Aves.	Billings	1979	Crowe,J., Et al.
4	Billings West Side School	415 Broadwater Ave.	Billings	2002	Oehme, Curtis, et.al.
5	Boothill Cemetery	N of Billings	Billings	1979	
6	Electric Building	113-115 Broadway	Billings	2002	Link, John G.
7	Fire House No. 2	201 E. 30th St	Billings	1980	Ohme,Curtis E.
8	Hoskins Basin Archeological District		Billings	1974	
9	Masonic Temple	2806 Third Ave. N	Billings	1986	Link & Haire
10	Molt, Rudolph F. W., House	39 Yellowstone Ave	Billings	1987	Eames,V.W., Oehme,Curtis C.
11	Moss, Preston B., House		Billings	1982	Hardenbergh,R.J., Gagnon,E.H.
12	North, Austin, House	622 N. 29th St.	Billings	1977	Link & Haire
13	O'Donnell, I. D., House	105 Clark Ave.	Billings	1977	Eams & Sawyer, Link & Haire
14	Parmly Billings Memorial Library	2822 Montana Ave	Billings	1972	Haire,Charles S.
15	Pictograph Cave	7 mi. SE of Billings in Indian Caves Park	Billings	1966	
16	Pompey's Pillar	W of Pompey	Pompey's Pillar	1966	
17	Prescott Commons	Rimrock Rd	Billings	1982	Comstock,Wallace H.
18	US Post Office and Courthouse--Billings	2602 First Ave. N	Billings	1986	Wenderoth,Oscar, Et al
19	Yegen, Christian, House	208 S. 35th St	Billings	1979	
20	Yegen, Peter, House	209 S. 35th St	Billings	1980	Eames,Mr.

Hazard mitigation activities in and around these sites has the potential to affect historic places. In all cases, mitigation work will be intended to reduce the potential of damaging the site due to natural and man caused disasters. Areas where ground disturbance will occur will need to be inventoried depending on the location. Such actions may include, but are not be limited to, constructing firelines (handline, mechanical line, etc.), building new roads to creeks to fill water tankers, mechanical treatments, etc. Only those burn acres that may impact cultural resources that are sensitive to burning (i.e., buildings, peeled bark trees, etc.) would be examined. Burns over lithic sites are not expected to have an impact, as long as the fire is of low intensity and short duration. Some areas with heavy vegetation may need to be examined after the burn to locate and record any cultural resources although this is expected to be minimal. Traditional Cultural Properties (TCPs) may also need to be identified. Potential impact to TCPs will depend on what values make the property important and will be assessed on an individual basis.

3.7 Transportation

The transportation system hierarchy in Yellowstone County begins with the Federal Highway System, which includes Interstates 90 and 94. U.S. Routes present in the County include U.S. Highway 87, 212 and 310. Numerous State highways and secondary roads traverse the County in addition to County roads and City streets. Maintaining the condition and efficiency of all these roadways is the responsibility of the Montana Department of Transportation, the County Public Works Department and the City Public Works Department. Much of the planning for these routes is accomplished through the Billings Metropolitan Planning Organization (MPO) under the jurisdiction of the County Planning Board.

Billings Logan International Airport is a growing regional air traffic hub with a market area encompassing central and eastern Montana and northern Wyoming. The airport is served by seven passenger airlines: Northwest, Delta/Skywest, Big Sky, United/Air Wisconsin, and Horizon, with 35 scheduled flights per day. Passenger emplanements have risen from 290,000 in 1989 to 354,722 emplanements in 2001.

The Billings Urban Area relies on two major rail companies and numerous trucking firms to move freight in, out, and through the region. The geographic location and the existing infrastructure generally restrict freight movement to east-west routes. Rail lines in particular are oriented toward transcontinental east-west flows, while freeway routes provide some, though less convenient, north-south flow. The two railroad operators in Billings are Burlington Northern Sante Fe and Montana Rail Link. Both move large volumes of coal and freight through the area and serve the downtown Billings intermodal facility. A total of 53 million tons of coal and freight was moved by rail through Billings in 1996. Freight originating in the region includes coal and coal products, petroleum, farm products, lumber and wood products, and stone, clay, glass and concrete products. Ninety percent of these commodities were shipped out of state. Existing rail facilities for Montana Rail Link and Burlington Northern Sante Fe are adequate and have sufficient capacity to accommodate current and anticipated freight movement demand.

3.8 Vegetation & Climate

Vegetation in Yellowstone County is a mix of grasslands, rangelands, and forested ecosystems. An evaluation of satellite imagery of the region provides some insight to the composition of the forest vegetation of the area. The full extent of the county was evaluated for cover type as determined from Landsat 7 ETM+ imagery in tabular format, Table 3.7.

The most represented vegetated cover types are Low Cover Grasslands at 28% and Xeric Shrubs and Dryland Agriculture at approximately 13% and 12%, respectively, of the County's total area. The next most common vegetation cover type represented is Low/Moderate Cover Grasslands at 6% of the total area. Big Sage Steppe represents 5% of Yellowstone County, while Very Low Cover Grasslands cover only 4%.

Table 3.7. Cover Types in Yellowstone County.	Category	Acres	Percent of County's Total Area
Low Cover Grasslands	Upland Grasslands	478,886	28%

Table 3.7. Cover Types in Yellowstone County.	Category	Acres	Percent of County's Total Area
Xeric Shrubs	Dry Shrubland	219,041	13%
Dryland Agriculture	Agricultural	211,025	12%
Low/Moderate Cover Grasslands	Upland Grasslands	102,049	6%
Big Sage Steppe	Dry Shrubland	83,050	5%
Very Low Cover Grasslands	Upland Grasslands	75,525	4%
Wyoming Big Sage Steppe	Dry Shrubland	72,703	4%
Irrigated Agriculture	Agricultural	66,999	4%
Xeric Shrub Grass	Dry Shrub/Grassland	52,629	3%
Ponderosa Pine	Conifer Forest	50,734	3%
Greasewood	Dry Shrubland	31,163	2%
Shrub Badlands	Badlands	27,719	2%
Urban	Urban	27,180	2%
Graminoid and Forb Riparian	Mixed Riparian	26,115	2%
Mixed Mesic Shrubs	Moist Shrubland	23,120	1%
Grass Badlands	Badlands	20,375	1%
Moderate/High Cover Grasslands	Upland Grasslands	19,078	1%
Water	Water	16,600	1%
Shrub Dominated Riparian	Mixed Riparian	15,326	1%
Mixed Broadleaf Forest	Mixed Deciduous	14,921	1%
Broadleaf Dominated Riparian	Mixed Riparian	10,590	1%
Xeric Mixed Shrub	Dry Shrubland	8,392	0%
Salt Desert Shrub	Dry Shrubland	7,703	0%
Mixed Forest Non-forest Riparian	Mixed Riparian	7,367	0%
Exposed Rock	Exposed Rock	6,994	0%
Badlands	Badlands	4,801	0%
Mountain Big Sagebrush	Dry Shrubland	3,532	0%
Mixed Barren Land	Barren Land	2,629	0%
Mixed Xeric Forest	Mixed Conifer Forest	2,295	0%
Tree Grassland Associations	Tree/Grassland	1,814	0%
Douglas Fir	Conifer Forest	1,210	0%
Mixed Tree Riparian	Mixed Riparian	1,164	0%
Silver Sage	Dry Shrubland	878	0%
Limber Pine	Tree/Grassland	572	0%
Mesic Shrub Grassland	Moist Shrub/Grassland	389	0%
Mixed Shrub Herbaceous Riparian	Mixed Riparian	358	0%
Mines Quarries Gravel Pits	Mines Quarries Gravel	261	0%
Forest Savannah	Tree/Grassland	250	0%
Mixed Broadleaf Conifer Forest	Mixed Deciduous-Conif	202	0%
Cattail Marshes	Mixed Riparian	125	0%
Very Low Cover Forest	Tree/Grassland	59	0%

Table 3.7. Cover Types in Yellowstone County.	Category	Acres	Percent of County's Total Area
Juniper Sage Grass	Dry Shrubland	5	0%
Total		**1,695,828**	

Vegetative communities within the county follow the strong moisture and temperature gradient related to the major river drainages. Scarce precipitation and soil conditions result in a relatively arid environment. As moisture availability increases, so does the abundance of shrub and forest vegetation.

3.8.1 Monthly Climate Summaries in Yellowstone County

3.8.1.1 Billings

Period of Record Monthly Climate Summary

Period of Record: 7/ 1/1948 to 3/31/2005

Table 3.8. Monthly Climate Summaries for Billings, Yellowstone County, Montana.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	32.4	39.0	45.8	56.8	67.1	76.7	86.4	85.1	72.6	60.4	44.9	36.0	58.6
Average Min. Temperature (F)	13.9	19.5	24.9	33.9	43.4	51.6	58.2	56.8	46.9	37.3	25.9	18.2	35.9
Average Total Precipitation (in.)	0.76	0.62	1.03	1.76	2.26	2.12	1.10	0.86	1.26	1.11	0.71	0.65	14.25
Average Total Snowfall (in.)	10.0	7.0	9.7	8.8	1.7	0.0	0.0	0.0	1.1	3.8	6.5	8.4	57.0
Average Snow Depth (in.)	2	2	1	0	0	0	0	0	0	0	1	2	1

Percent of possible observations for period of record. Max. Temp.: 100% Min. Temp.: 100% Precipitation: 100% Snowfall: 100% Snow Depth: 100%

3.8.1.2 Laurel

Period of Record Monthly Climate Summary

Period of Record: 8/28/1951 to 2/28/1994

Table 3.9. Monthly Climate Summaries for Laurel, Yellowstone County, Montana.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)					Insuff	icient	Data						
Average Min. Temperature (F)					Insuff	icient	Data						
Average Total Precipitation (in.)	0.67	0.51	0.94	1.76	2.58	2.10	1.03	1.06	1.51	1.09	0.69	0.66	14.61
Average Total Snowfall (in.)	8.3	5.5	6.4	4.1	0.7	0.0	0.0	0.0	0.5	1.6	4.9	7.6	39.4
Average Snow Depth (in.)	3	1	0	0	0	0	0	0	0	0	1	2	1

Percent of possible observations for period of record. Max. Temp.: 0% Min. Temp.: 0% Precipitation: 92% Snowfall: 81.5% Snow Depth: 77.9%

3.8.1.3 Huntley

Period of Record Monthly Climate Summary

Period of Record: 1/ 1/1911 to 3/31/2005

Table 3.10. Monthly Climate Summaries for Huntley, Yellowstone County, Montana.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	32.8	38.5	47.0	59.8	69.4	78.0	87.4	86.0	74.0	62.3	46.4	36.4	59.8
Average Min. Temperature (F)	7.9	12.7	20.8	31.1	40.5	48.6	53.7	51.3	41.6	31.5	20.4	11.5	31.0
Average Total Precipitation (in.)	0.56	0.45	0.79	1.33	2.07	2.39	1.12	0.94	1.31	1.03	0.63	0.60	13.22
Average Total Snowfall (in.)	8.1	5.7	6.9	3.3	0.5	0.0	0.0	0.0	0.4	1.1	5.4	7.5	39.0
Average Snow Depth (in.)	4	2	1	0	0	0	0	0	0	0	1	2	1

Percent of possible observations for period of record. Max. Temp.: 97.5% Min. Temp.: 97.5% Precipitation: 97.7% Snowfall: 47.5% Snow Depth: 46.9%

3.8.1.4 Custer

Period of Record Monthly Climate Summary

Period of Record: 7/ 1/1948 to 6/30/1975

Table 3.11. Monthly Climate Summaries for Custer, Yellowstone County, Montana.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	29.1	40.2	48.4	59.7	71.4	80.0	89.3	88.9	76.2	65.1	48.9	34.7	61.0
Average Min. Temperature (F)	4.1	13.2	20.8	31.2	41.4	50.0	55.5	53.8	43.4	32.6	22.6	10.1	31.6
Average Total Precipitation (in.)	0.76	0.42	0.61	1.84	1.84	2.81	0.97	1.14	0.88	0.97	0.43	0.55	13.21
Average Total Snowfall (in.)	10.7	5.5	7.2	6.4	0.6	0.0	0.0	0.0	0.3	1.5	2.8	8.6	43.7
Average Snow Depth (in.)	4	3	1	0	0	0	0	0	0	0	0	2	1

Percent of possible observations for period of record. Max. Temp.: 53.3% Min. Temp.: 53.3% Precipitation: 54.9% Snowfall: 52.4% Snow Depth: 53.2%

3.8.1.5 Broadview, Montana

Period of Record Monthly Climate Summary

Period of Record: 9/15/1951 to 3/31/1991

Table 3.12. Monthly climate summaries for Broadview, Yellowstone County, Montana.													
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Average Max. Temperature (F)	34.0	40.2	46.9	57.0	67.2	77.0	86.0	84.5	72.2	62.1	45.5	37.5	59.2
Average Min. Temperature (F)	11.1	15.8	21.2	30.4	39.8	47.7	53.1	51.2	41.4	33.1	21.6	13.9	31.7
Average Total Precipitation (in.)	0.52	0.45	0.76	1.38	2.74	2.20	1.13	1.26	1.22	0.95	0.59	0.41	13.60
Average Total Snowfall (in.)	7.2	6.0	5.6	6.3	0.1	0.0	0.0	0.0	0.4	1.5	5.1	4.1	36.3
Average Snow Depth (in.)	2	1	1	0	0	0	0	0	0	0	1	1	1

Percent of possible observations for period of record. Max. Temp.: 88.7% Min. Temp.: 86.9% Precipitation: 97.3% Snowfall: 77.1% Snow Depth: 72.3%

3.9 Wildfire Hazard Profiles

3.9.1 Wildfire Ignition Profile

Fire was once an integral function of the majority of ecosystems in Montana. The seasonal cycling of fire across the landscape was as regular as the seasonal lightning storms plying across the canyons and mountains. Depending on the plant community composition, structural configuration, and buildup of plant biomass, fire resulted from ignitions with varying intensities and extent across the landscape. Shorter return intervals between fire events often resulted in less dramatic changes in plant composition (Johnson 1998). The fires burned from 1 to 47 years apart, with most at 5- to 20-year intervals (Barrett 1979). With infrequent return intervals, plant communities tended to burn more severely and be replaced by vegetation different in composition, structure, and age (Johnson *et al.* 1994). Native plant communities in this region developed under the influence of fire, and adaptations to fire are evident at the species, community, and ecosystem levels. Fire history data (from fire scars and charcoal deposits) suggest fire has played an important role in shaping the vegetation in the region for thousands of years (Steele *et al.* 1986, Agee 1993).

Detailed records of fire ignition and extent have been compiled by the Forest Service, Bureau of Indian Affairs, and the Bureau of Land Management. Using this data on past fire extents and fire ignition data, the occurrence of wildland fires in the region of Yellowstone County has been evaluated. Since it was a major fire that burned several hundred thousand acres, it should be noted that the Hawk Creek Fire of 1984 is not included in this dataset.

Many fires have burned in the region of Yellowstone County (Table 3.13). There were approximately 285 fire ignitions during this 25 year period, with the highest number of total ignitions peaking in 1996. Although there were fewer ignitions, more acres burned in 2000 in Yellowstone County

Table 3.13. Summary of Wildfire Ignitions and Acres Burned by Cause from 1980 – 2005.

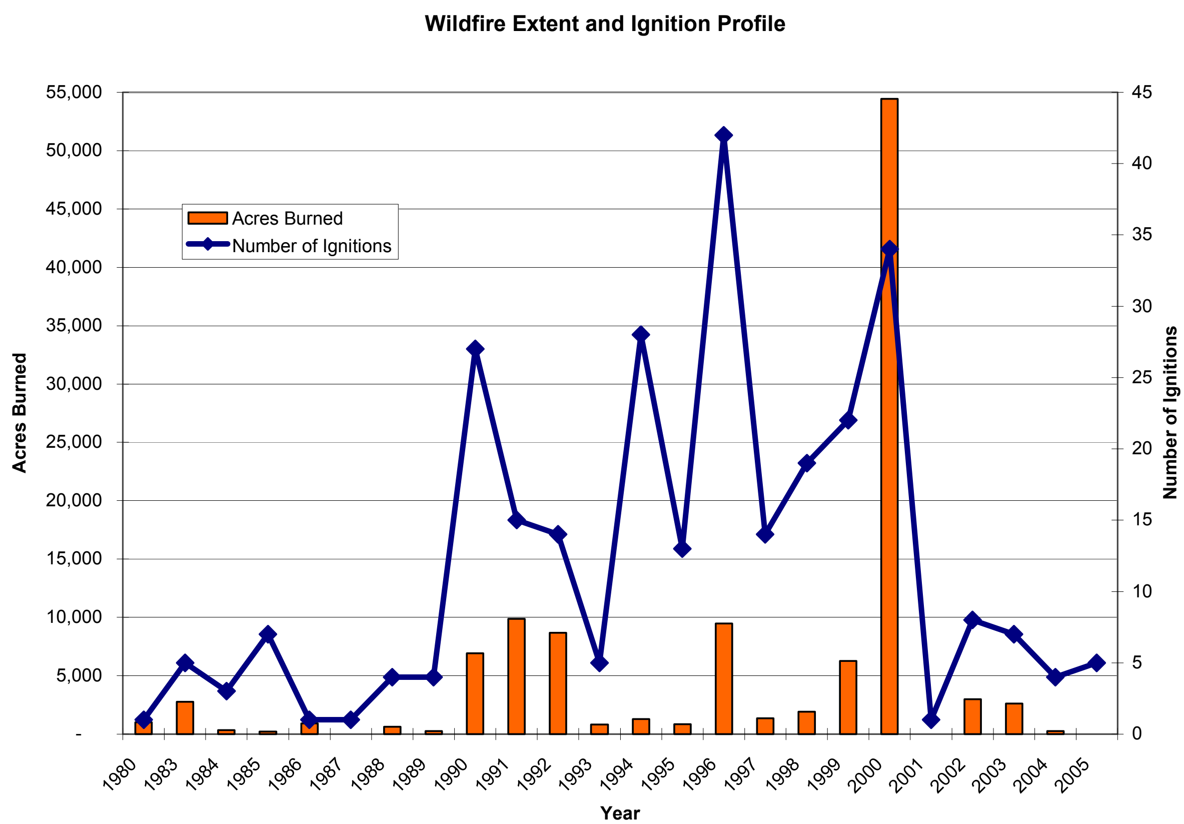
Cause	Acres Burned	Percent of Total	Number of Ignitions	Percent of Total
Campfire	1,000	1%	1	0%
Fireworks	-	0%	3	1%
Lightning	29,025	25%	81	28%
Machinery	2,000	2%	1	0%

Table 3.13. Summary of Wildfire Ignitions and Acres Burned by Cause from 1980 – 2005.

Cause	Acres Burned	Percent of Total	Number of Ignitions	Percent of Total
Mancaused	76,854	66%	120	42%
Unknown	739	1%	26	9%
Blank	6,290	5%	53	19%
Totals	**115908**		**285**	

Since 1980, it would appear that roughly 42% of all fires in Yellowstone County are human caused, while only 28% were naturally caused. There may be many factors contributing to this statistic, but the agrarian economy is likely mainly responsible. Mancaused fires have also contributed to the most acres burned throughout Yellowstone County. The large number of agriculture related wildfire ignitions has influenced this statistic greatly and it is important to note that the overwhelming majority of these fires have been contained at less than an acre.

Figure 3.7. Wildfire Extent and Ignition Profile for Yellowstone County.



During the course of the development of the Yellowstone County Community Wildfire Protection Plan all of the fire departments with jurisdiction in the County were asked to map fire ignitions by putting a dot or point on a map. This data was then merged and is summarized below in the "Past Fire Ignitions From All Departments" column of Table 3.14. In addition to the point data, the Billings Urban Fire Service Area also provided electronic data of their past fire ignitions including the cause and date of each fire. This information is summarized in Table 3.14 as well as in Section 3.9.1.2. The Shepherd Volunteer Fire Department also provided a written history of fires within their jurisdiction over the past 40 years. This information is included in the Table

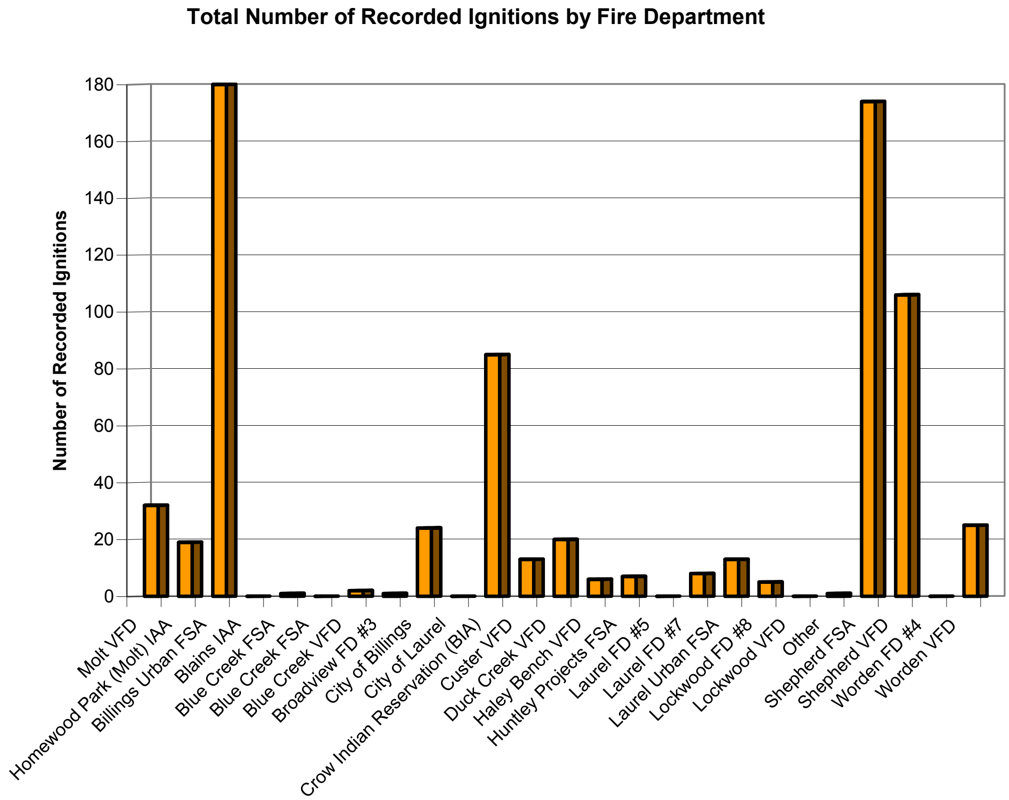
3.14 as well as in Section 3.9.1.1. This summarization allows local planners as well as fire departments to concentrate educational resources in areas with the highest frequency of recorded ignitions. This data does not; however, show dates of fires or the ultimate size of the fires. In many cases, ignitions were suppressed at less than an acre of burned area. Reference Appendix I for maps of wildfire ignition data throughout Yellowstone County.

Table 3.14. Summary of Yellowstone County Conditions by Fire Department From All Data Sources.

	Data Source			
District	**Past Fire Ignitions Data From All Departments**	**Billings Urban Fire Service Area Grass Fire Data**	**Shepherd Past Fires Data**	**Totals**
Billings Urban FSA	2	179	1	**182**
Blains IAA	0	0	0	**0**
Blue Creek FSA	0	1	0	**1**
Blue Creek FSA (provided by Lockwood FD)	0	0	0	**0**
Blue Creek VFD	2	0	0	**2**
Broadview FD #3	1	0	0	**1**
City of Billings	6	18	0	**24**
City of Laurel	0	0	0	**0**
Crow Indian Reservation	85	0	0	**85**
Custer VFD	9	0	4	**13**
Duck Creek VFD	14	0	6	**20**
Haley Bench VFD	6	0	0	**6**
Huntley Projects FSA	7	0	0	**7**
Laurel FD #5	0	0	0	**0**
Laurel FD #7	5	0	3	**8**
Laurel Urban FSA	5	2	6	**13**
Lockwood FD #8	3	2	0	**5**
Lockwood VFD	0	0	0	**0**
Other	0	1	0	**1**
Shepherd FSA	19	0	155	**174**
Shepherd VFD	14	0	92	**106**
Worden FD #4	0	0	0	**0**
Worden VFD	25	0	0	**25**
Totals	**254**	**203**	**267**	**724**

Figure 3.8 below shows the total number or recorded ignitions per fire department in Yellowstone County as summarized in Table 3.14. Some fire departments, such as the Billings Urban Fire Service Area, stand out as having a large number of ignitions. Part of the reason for this may be that they have a more complete record of ignitions or that they have been established for a longer period of time than many of the rural fire departments. It is important to remember that charting this information is a tool in order to better allocate resources to higher frequency areas; however, the data is not complete for every department and does not show the ultimate size of fires.

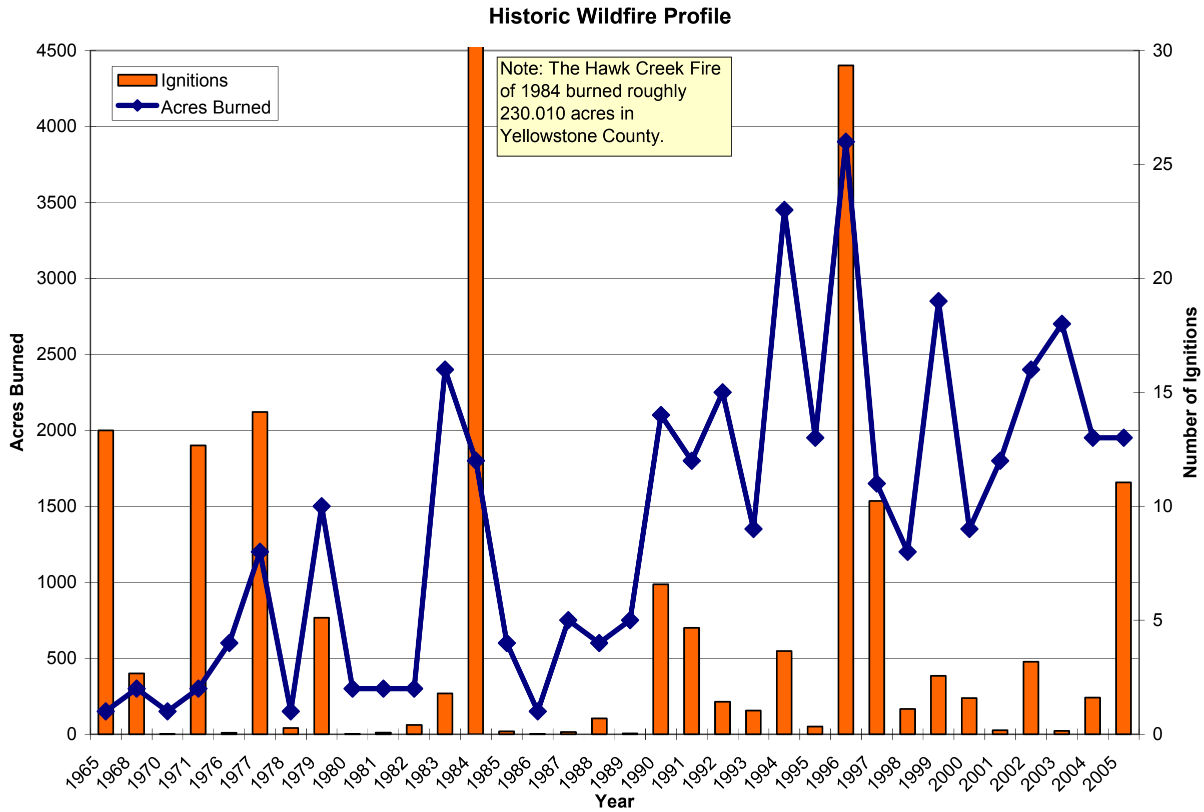
Figure 3.8. Total Number of Recorded Ignitions by Fire Department in Yellowstone County.



3.9.1.1 Shepherd Volunteer Fire Department Fire History

A long time member of the Shepherd Volunteer Fire Department has kept a personal journal of the fire history throughout the Shepherd Volunteer Fire Department's jurisdiction from 1965 through the present. While not complete, this data does provide some insight into the fire extent and frequency in the area. According to this record, there have been approximately 313 fire ignitions with 249,597 acres burned in the Shepherd area since 1965. Approximately 230,010 of those acres burned during the Hawk Creek Fire of 1984; however, the average annual acres burned is approximately 7,341. Consistent with the agency data presented in Table 3.13, the number of fire ignitions peaked in 1996 with 26 ignitions. The average annual number of fire starts in the Shepherd area is about 9.

Figure 3.9. Shepherd Volunteer Fire Department's Historic Wildfire Profile.

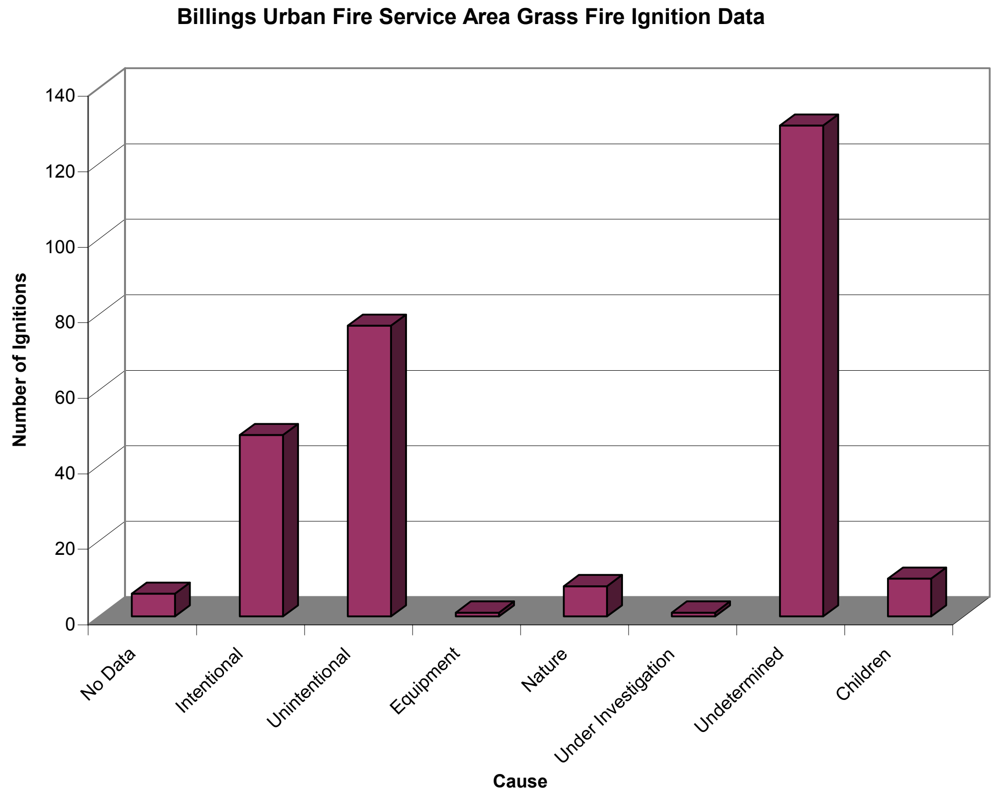


From Figure 3.8 it is clear that at least in the Shepherd area, the number of annual ignitions has been steadily increasing; however, the number of acres burned does not seem to support the same pattern.

3.9.1.2 Billings Urban Fire Service Area Statistics

The Billings Urban Fire Service Area has been recording the date and cause of grass fires within their jurisdiction since 1999. Figure 3.9 shows that only about 3% of grass fires are proven to be naturally caused.

Figure 3.10. Billings Urban Fire Service Area Grass Fire Ignition Data.



3.9.2 National Fire Statistics

Across the west, wildfires have been increasing in extent and cost of control. The National Interagency Fire Center (2005) reported over 77,500 wildfires in 2004 which burned a total of 6.7 million acres and cost $890 million in containment (Table 3.15). Data summaries for 2000 through 2004 are provided and demonstrate the variability of the frequency and extent of wildfires nationally (Table 3.15). It is important to note that the 10 year moving average number of acres burned reported each year has been increasing constantly since 2000.

Table 3.15. National Fire Season Summaries.

Statistical Highlights	2000	2001	2002	2003	2004
Number of Fires	122,827	84,079	88,458	85,943	77,534
10-year Average ending with indicated year	106,393	106,400	103,112	101,575	100,466
Acres Burned	**8,422,237**	**3,570,911**	**6,937,584**	**4,918,088**	**6,790,692**
10-year Average ending with indicated year	3,786,411	4,083,347	4,215,089	4,663,081	4,923,848
Structures Burned	861	731	2,381	5,781	1,095
Estimated Cost of Fire Suppression (Federal agencies only)	$1.3 billion	$542 million	$ 1.6 billion	$1.3 billion	$890 million

The National Interagency Fire Center, located in Boise, Idaho, maintains records of fire costs, extent, and related data for the entire nation. Tables 3.16 and 3.17 summarize some of the relevant wildland fire data for the nation, and some trends that are likely to continue into the future unless targeted fire mitigation efforts are implemented and maintained.

These statistics (Table 3.16) are based on end-of-year reports compiled by all wildland fire agencies after each fire season, and are updated by March of each year. The agencies include: Bureau of Land Management, Bureau of Indian Affairs, National Park Service, US Fish and Wildlife Service, USDA Forest Service and all State Lands.

Table 3.16. Total Fires and Acres 1960 - 2004 Nationally.

Year	Fires	Acres	Year	Fires	Acres
2004	77,534	* 6,790,692	1981	249,370	4,814,206
2003	85,943	4,918,088	1980	234,892	5,260,825
2002	88,458	6,937,584	1979	163,196	2,986,826
2001	84,079	3,555,138	1978	218,842	3,910,913
2000	122,827	8,422,237	1977	173,998	3,152,644
1999	93,702	5,661,976	1976	241,699	5,109,926
1998	81,043	2,329,709	1975	134,872	1,791,327
1997	89,517	3,672,616	1974	145,868	2,879,095
1996	115,025	6,701,390	1973	117,957	1,915,273
1995	130,019	2,315,730	1972	124,554	2,641,166
1994	114,049	4,724,014	1971	108,398	4,278,472
1993	97,031	2,310,420	1970	121,736	3,278,565
1992	103,830	2,457,665	1969	113,351	6,689,081
1991	116,953	2,237,714	1968	125,371	4,231,996
1990	122,763	5,452,874	1967	125,025	4,658,586
1989	121,714	3,261,732	1966	122,500	4,574,389
1988	154,573	7,398,889	1965	113,684	2,652,112
1987	143,877	4,152,575	1964	116,358	4,197,309
1986	139,980	3,308,133	1963	164,183	7,120,768
1985	133,840	4,434,748	1962	115,345	4,078,894
1984	118,636	2,266,134	1961	98,517	3,036,219
1983	161,649	5,080,553	1960	103,387	4,478,188
1982	174,755	2,382,036			

(National Interagency Fire Center 2004)

Table 3.17. Suppression Costs for Federal Agencies Nationally.

Year	Bureau of Land Management	Bureau of Indian Affairs	Fish and Wildlife Service	National Park Service	USDA Forest Service	Totals
2004	$ 147,165,000	$ 63,452,000	$ 7,979,000	$ 34,052,000	$ 637,585,000	**$890,233,000**
2003	$151,894,000	$ 96,633,000	$ 9,554,000	$ 44,557,000	$ 1,023,500,000	**$1,326,138,000**
2002	$ 204,666,000	$ 109,035,000	$ 15,245,000	$ 66,094,000	$ 1,266,274,000	**$1,661,314,000**
2001	$ 192,115,00	$ 63,200,000	$ 7,160,000	$ 48,092,000	$ 607,233,000	**$917,800,000**
2000	$180,567,000	$ 93,042,000	$ 9,417,000	$ 53,341,000	$ 1,026,000,000	**$1,362,367,000**
1999	$ 85,724,000	$ 42,183,000	$ 4,500,000	$ 30,061,000	$ 361,000,000	**$523,468,000**
1998	$ 63,177,000	$ 27,366,000	$ 3,800,000	$ 19,183,000	$ 215,000,000	**$328,526,000**
1997	$ 62,470,000	$ 30,916,000	$ 2,000	$ 6,844,000	$ 155,768,000	**$256,000,000**
1996	$ 96,854,000	$ 40,779,000	$ 2,600	$ 19,832,000	$ 521,700,000	**$679,167,600**
1995	$ 56,600,000	$ 36,219,000	$ 1,675,000	$ 21,256,000	$ 224,300,000	**$340,050,000**

Table 3.17. Suppression Costs for Federal Agencies Nationally.						
Year	Bureau of Land Management	Bureau of Indian Affairs	Fish and Wildlife Service	National Park Service	USDA Forest Service	Totals
1994	$ 98,417,000	$ 49,202,000	$ 3,281,000	$ 16,362,000	$ 678,000,000	**$845,262,000**

(National Interagency Fire Center 2005)

Although many very large fires, growing to over 250,000 acres have burned in Montana, actual fires have usually been controlled at much smaller extents. This is not to imply that wildfires are not a concern in this county, but to point to the aggressive and professional manner to which the wildland and rural fire districts cooperate in controlling these blazes.

3.9.2.1 Prescribed Burning of Federal Acres

Prescribed fire has been effectively used as a mitigation tool, primarily on Federal and State lands across the US, and especially in the Western US. Federal Agencies report prescribed fire usage, with summaries provided by the National Interagency Fire Center, located in Boise, Idaho. National data is provided in Tables 3.18 and 3.19.

Table 3.18. Federal Wildland Fire Agency Prescribed Fire Acres Treated

Agency	1995 Acres	1996 Acres	1997 Acres	1998 Acres	1999 Acres	2000 Acres
USDA Forest Service	570,300	617,163	1,097,658	1,489,293	1,379,960	728,237
Bureau of Indian Affairs	21,000	16,000	37,000	48,287	83,875	3,353
Bureau of Land Management	56,000	50,000	72,500	200,223	308,000	125,600
National Park Service	62,000	52,000	70,000	86,126	135,441	19,072
U.S. Fish and Wildlife Service	209,000	180,000	324,000	285,758	300,508	201,052
Total	**918,300**	**915,163**	**1,601,158**	**1,889,564**	**2,240,105**	**1,077,314**

(National Interagency Fire Center 2005)

Table 3.19. Prescribed Fire Costs, Nationally.

Year	Bureau of Land Management	Bureau of Indian Affairs	Fish and Wildlife Service	National Park Service	USDA Forest Service	Totals
1995	$ 0	$ 840,000	$ 0	$ 3,200,000	$ 16,406,000	$ 20,446,000
1996	$ 1,200,000	$ 650,000	$ 0	$ 3,200,000	$ 24,500,000	$ 29,550,000
1997	$ 1,600,000	$ 800,000	$ 0	$ 4,600,000	$ 29,146,000	$ 36,146,000
1998	$ 6,700,000	$ 2,268,000	$ 4,825,000	$ 7,000,000	$ 50,000,000	$ 70,793,000
1999	$ 10,600,000	$ 6,300,000	$ 7,404,000	$ 9,800,000	$ 65,000,000	$ 99,104,000

3.9.2.2 Firefighter Accidents

The United States currently depends on approximately 1.2 million fire fighters (municipal and wildland) to protect its citizens and property from losses caused by fire. Of these fire fighters, approximately 210,000 are career/paid and approximately 1 million are volunteers. The National Fire Protection Association (NFPA) and the U.S. Fire Administration estimate that on average, 105 fire fighters die in the line of duty each year (NIFC 2005).

Due to the growing number of homes in the wildland/urban interface, it is almost inevitable that wildland and structural firefighters will find themselves in dangerous role reversals for which they may not be adequately trained or equipped. For example, wildland fire fighters may be called on to protect threatened homes, and structural fire fighters may be called on to help battle the surrounding blazes in the wildlands.

In addition to the obvious difference of size, wildland fires and structure fires differ in that wildland fires require:

- more personnel, some of whom may have little or no fire fighting experience
- more resources spread out over a larger area.

Because of these factors, wildland fires present personal safety concerns to three areas:

- the firefighter
- the area immediately surrounding the firefighter
- the overall environment of the fire itself.

The most direct way to improve the safety of both structural and wildland fire fighters is cross-training of all fire fighters and improved equipment. While cross-training is being done in some regions throughout the country, it is still not standard practice everywhere. Until cross-training programs become universal, awareness may be the tool that saves lives.

Of the 1,046 firefighters who died while on duty from 1987 through 1996, 163 (15.6%) died while fighting wildland fires. The number of deaths was generally between 12 and 22 per year, with the exception of seven deaths in 1993 and 1996, and 33 deaths in 1994. Over the period, 23.6% of all fire ground deaths occurred at wildland fires (Firewise 2005).

This analysis includes members of municipal fire departments who responded to grass, brush and forest fires within their jurisdictions as well as career, seasonal and contract employees of state and federal wildland agencies who were involved in assigned firefighting activities at the time there were fatally injured (Firewise 2005). The federal wildland agencies include the U.S. Forest Service, the Bureau of Indian Affairs, the Bureau of Land Management, the Fish and Wildlife Service, the National Park Service and the military.

The 163 victims (1987-1996) ranged in age from 15 to 83, with a median age of 34. Fourteen of the victims were women. Approximately 70% of all wildland fire deaths (114) occurred during fire suppression activities. Another 49 deaths occurred when firefighters were responding to or returning from such fires.

3.9.2.2.1 Deaths on the Ground from Fire

The largest proportion of deaths during fire suppression activities resulted from being caught or trapped by fire progress. Twenty-five of these 38 firefighters died of smoke inhalation; the other 13 died as a result of burns. Fourteen of these 38 deaths occurred in a single incident in 1994.

Wildland fire deaths by nature of fatal injury, more commonly referred to as the medical cause of death, is important to understanding this issue. State and federal wildland officials believe that their rigorous fitness requirements lower the risk of heart attack death among firefighters under their jurisdiction. For this analysis, then, the fire ground deaths were broken down by type of department municipal (career or volunteer) or wildland agencies. A profile of the 114 fire ground victims shows that 50 were members of municipal fire departments (44 were volunteer firefighters and six were career firefighters). The other 64 firefighters were career, seasonal or contract employees of state and federal wildland agencies, or military personnel.

3.9.2.2.2 Municipal Fire Fighters

As shown in Table 3.20, heart attacks accounted for over half of the deaths of municipal firefighters during fire ground operations, while most of the deaths of state and federal employees were due to internal trauma, asphyxiation and burns.

Of the 17 municipal heart attack victims for whom medical documentation was available, nine had had prior heart attacks or bypass surgery, three had severe arteriosclerotic heart disease, three had hypertension and one was diabetic. The municipal volunteer firefighters who suffered fatal heart attacks ranged in age from 27 to 83, with a median age of 58. The one wildland agency firefighter who died of a heart attack was 38 years old and had severe arteriosclerotic heart disease.

The lower proportion of heart attacks among wildland agency firefighters may be a result of stricter fitness requirements, but it could also be a function of age. Older firefighters are more likely to suffer heart attacks and if the wildland agencies employ a significantly lower percentage of old firefighters, their experience would reflect this. Looking at all fire ground deaths, municipal vs. wildland agencies, the ages of wildland firefighters who died ranged from 18 to 64, with a median age of 32 years, while volunteer municipal firefighters ranged in age from 18 to 83, with a median age of 50. The six career municipal firefighters ranged in age from 20 to 49, with a median age of 29. Other factors besides age and fitness requirements that may impact the incidence of heart attack deaths at wildland fires include the equipment provided. In many of the incidents handled by municipal firefighters, those involved in fighting the fire did so in full protective clothing designed for structural firefighting, while wildland firefighters wear clothing, helmets and boots more appropriate to outdoor work (Firewise 2005).

Table 3.20. Wildland firefighter deaths on the fire ground by nature of Fatal Injury 1987-1996.

Fatality Cause	Federal and State Wildland Agencies	Municipal		Total
		Volunteer	Career	
Heart attack	1	27	0	28
Internal trauma	24	3	1	28
Asphyxiation	23	2	0	25
Burns	9	4	3	16
Crushing	4	4	0	8
Electric shock	1	2	0	3
Heat stroke	0	1	2	3
Stroke	2	0	0	2
Bleeding	0	1	0	1
Total	64	44	6	114

As far as the other types of injuries suffered on the fire ground are concerned, increased use of fire shelters could result in a reduction in fatal burns and smoke inhalation deaths and safer handling of aircraft could reduce the number of deaths due to aircraft crashes during suppression activities.

3.9.2.2.3 Deaths While Responding to or Return from Alarms

Of the 163 wildland-related deaths that occurred between 1987 and 1996, 49 occurred when firefighters were responding to or returning from such fires. Thirty four of the 49 deaths were the result of vehicle crashes, 12 were heart attacks, one firefighter was crushed when a tree fell on the crew area of a moving truck, one firefighter was crushed between two pieces of apparatus while he attempted to start the rear-mounted pump in preparation for response to an incident and one firefighter drowned at a base camp after returning from the fire line.

The 34 deaths in crashes occurred in 25 separate incidents. Ten contractors and four federal employees were killed in six aircraft crashes. Eleven firefighters were killed in 10 crashes involving tankers, and five firefighters were killed when their personal vehicles crashed. The remaining four deaths resulted from crashes involving an engine, a brush unit, a supply vehicle and a military vehicle.

The 12 heart attack victims included eight municipal firefighters, three forestry employees and one contractor. Five of the 12 firefighters had had prior heart attacks or bypass surgery, one had severe arteriosclerotic heart disease and one was diabetic. No medical information was available for the other five heart attack victims.

3.9.2.2.4 Montana State Fatalities

Within Montana State, wildland fire injuries have been documented by the National Interagency Fire Center (2005) and are summarized in Table 3.21. From 1932-2003, there have been 38 fatalities during 16 incidents involving significant injuries. Burn over and entrapments are common themes in the listed fatalities. In order to reduce the risks to firefighters responding to wildland fire events, these issues must be addressed and eliminated.

Table 3.21. Wildfire accidents reported in Montana, 1910-2003.

Year	Place	Type of Accident	Organization	Fatalities
1933	Basin	Hypothermia	Federal	1
1934	Glacier NP	Snag	Federal	1
1934	Lincoln NF	Snag	Federal	1
1937	Missoula	Burnover	Federal	1
1949	Helena NF	Burnover	Federal	13
1967	Kootenai NF	Burnover	Federal	2
1984	Humansville	Burnover	Unknown	2
1988	Flathead NF	Snag	Federal	1
1988	Not Reported	Engine Rollover	Federal	1
1988	Not Reported	Snag	Other	1
1988	Not Reported	Vehicle	Federal	1
1991	Missoula	Fire Training	Federal	1
1991	Not Reported	Aircraft	Federal	2
1994	Missoula	Air tanker	Contractor/Federal	2
1996	Colstrip	Burnover	Private	2
1999	Pompeys Pillar	Dozer Burnover	Contractor	0
2001	Livingston	Helicopter	Contractor	3
2001	Not Reported	Snag	Federal	1
2002	Dillon	Work Capacity Test	State	1
2003	Missoula	Heart Attack	State	1

(National Interagency Fire Center 2005)

3.10 Analysis Tools and Techniques to Assess Fire Risk

Yellowstone County and the adjacent counties of Golden Valley, Musselshell, Rosebud, Treasure, Big Horn, Carbon, and Stillwater were analyzed using a variety of techniques, managed on a GIS system (ArcGIS 9). Physical features of the region were represented by data layers including roads, streams, soils, elevation, and remotely sensed images from the Landsat 7 ETM+ satellite. Field visits were conducted by specialists from Northwest Management, Inc., and others. Discussions with area residents and fire control specialists augmented field visits and provided insights to forest health issues and treatment options. This information was analyzed and combined to develop an assessment of wildfire risk in the region.

3.10.1 Fire Prone Landscapes

Schlosser *et al.* 2002, developed a methodology to assess the location of fire prone landscapes on forested and non-forested ecosystems in the western US. This analysis procedure has been completed on approximately 45 million acres across Montana, Wyoming, Idaho, Washington, and Nevada since 2002.

The goal of developing the Fire Prone Landscapes analysis is to make inferences about the relative risk factors across large geographical regions (multiple counties) for wildfire spread. This analysis uses the extent and occurrence of past fires as an indicator of characteristics for a specific area and their propensity to burn in the future. Concisely, if a certain combination of vegetation cover type, canopy closure, aspect, slope, stream and road density have burned with a high occurrence and frequency in the past, then it is reasonable to extrapolate that they will have the same tendency in the future, unless mitigation activities are conducted to reduce this potential.

The analysis for determining those landscapes prone to wildfire utilized a variety of sources.

Digital Elevation: Digital elevation models (DEM) for the project used USGS 30 meter DEM data provided at quarter-quadrangle extents. These were merged together to create a continuous elevation model of the analysis area.

The merged DEM file was used to create two derivative data layers: aspect and slope. Both were created using the spatial analyst extension in ArcGIS 9. Aspect data values retained one decimal point accuracy representing the cardinal direction of direct solar radiation, represented in degrees. Slope was recorded in percent and also retained one decimal point accuracy.

Remotely Sensed Images: Landsat 7 Enhanced Thematic Mapper (ETM+) images were used to assess plant cover information and percent of canopy cover. The Landsat ETM+ instrument is an eight-band multi-spectral scanning radiometer capable of providing high-resolution image information of the Earth's surface. It detects spectrally-filtered radiation at visible, near-infrared, short-wave, and thermal infrared frequency bands from the sun-lit Earth. Nominal ground sample distances or "pixel" sizes are 15 meters in the panchromatic band; 30 meters in the 6 visible, near and short-wave infrared bands; and 60 meters in the thermal infrared band.

The satellite orbits the Earth at an altitude of approximately 705 kilometers with a sun-synchronous 98-degree inclination and a descending equatorial crossing time of 10 a.m. daily.

Image spectrometry has great application for monitoring vegetation and biophysical characteristics. Vegetation reflectance often contains information on the vegetation chlorophyll absorption bands in the visible region and the near infrared region. Plant water absorption is easily identified in the middle infrared bands. In addition, exposed soil, rock, and non-vegetative surfaces are easily separated from vegetation through standard hyper-spectral analysis procedures.

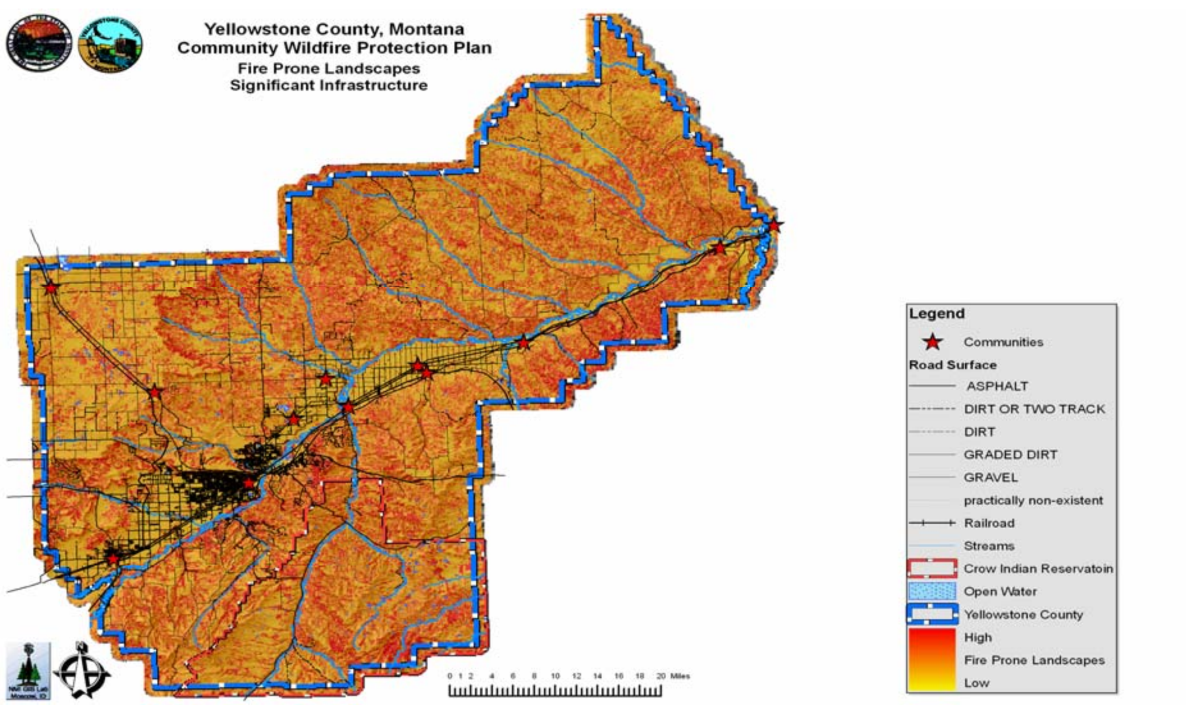
Landsat 7 ETM images were obtained to conduct hyper-spectral analysis for this project. The image was obtained in 1998. Hyper-spectral analysis procedures followed the conventions used by the Montana Vegetation and Land Cover Classification System, modified from Redmond (1997) and Homer (1998).

Riparian Zones: Riparian zones were derived from stream layers.

Past Fires: Past fire extents represent those locations on the landscape that have previously burned during a wildfire. Past fire extent maps were obtained from a variety of sources for the central Montana area including the U.S. Forest Service and the Montana Department of Natural Resources and Conservation. The Yellowstone County Fire Warden digitized fires reported by the Rural Fire Departments of Yellowstone County into a GIS system so that a full wildfire database was available to characterize wildfire occurrence in Yellowstone County. This data was used in the formation of the Fire Prone landscapes assessment.

Fire Prone Landscapes: Using the methodology developed by Schlosser *et al.* (2002), and refined for this project, the factors detailed above were used to assess the potential for the landscape to burn during the fire season in the case of fire ignition. Specifically, the entire region was evaluated at a resolution of 30 meters (meaning each pixel on the screen represented a 30 meter square on the ground) to determine the propensity for a particular area (pixel) to burn in the case of a wildfire. The analysis involved creating a linear regression analysis within the GIS program structure to assign a value to each significant variable, pixel-by-pixel. The analysis ranked factors from 0 (little to no risk) to 100 (extremely high risk) based on past fire occurrence.

Figure 3.11. Fire Prone Landscapes in Yellowstone County.



This map is presented for reference in this section of the plan. This map and additional maps are detailed in Appendix I.

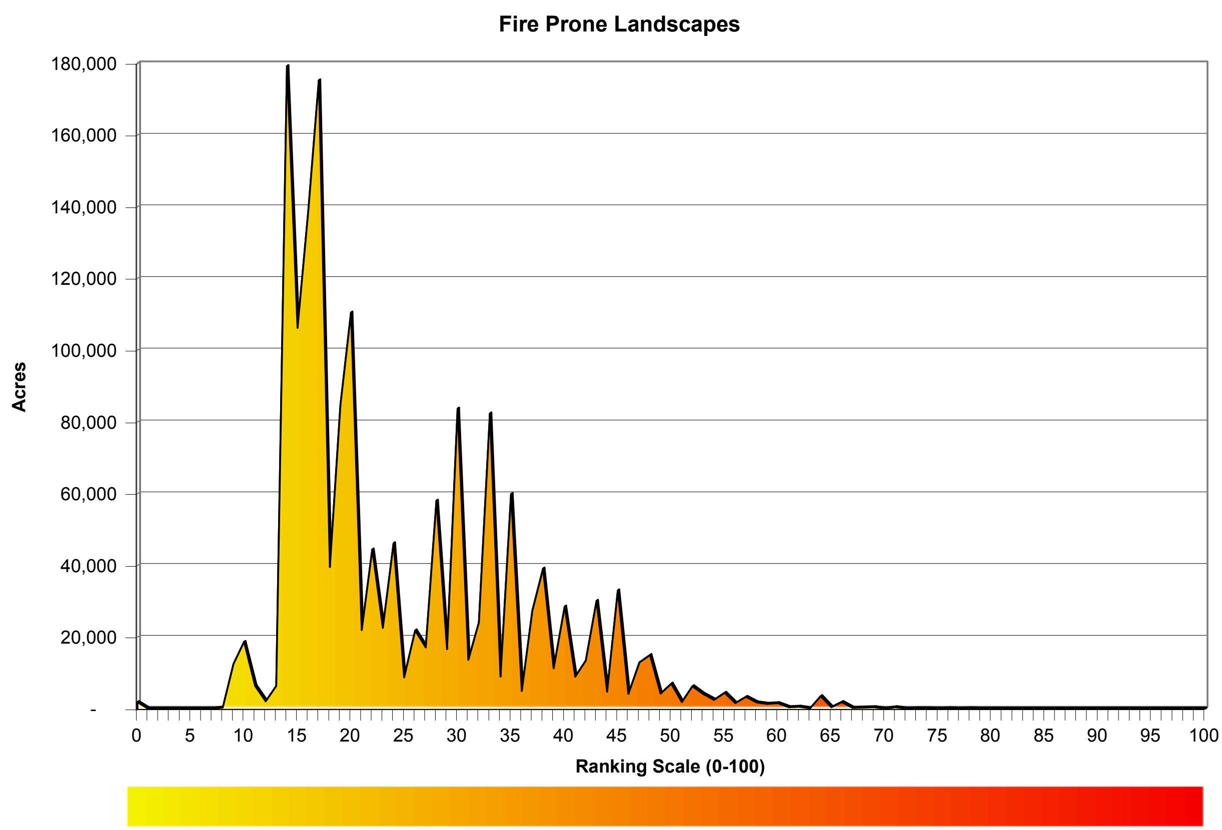
The maps depicting these risk categories display yellow as the lowest risk and red as the highest with values between a constant- gradient from yellow to orange to red (Table 3.22).

While large maps (16 square feet) have been provided as part of this analysis, smaller size maps are presented in the Appendices.

Table 3.22. Fire Prone Landscape rankings and associated acres in each category for Yellowstone County.

Color Code	Value	Total Acres	Percent of Total Area
	0	1,913	0%
	10	31,471	2%
	20	849,101	50%
	30	341,170	20%
	40	300,135	18%
	50	133,476	8%
	60	28,860	2%
	70	8,281	0%
	80	1,187	0%
	90	61	0%
	100	3	0%

Figure 3.12: Distribution of area by Fire Prone Landscape Class.



The risk category values developed in this analysis should be considered **ordinal data**, that is, while the values presented have a meaningful ranking, they neither have a true zero point nor scale between numbers. Rating in the “40” range is not necessarily twice as “risky” as rating in the “20” range. These category values also do not correspond to a rate of fire spread, a fuel loading indicator, or measurable potential fire intensity. Each of those scales is greatly influenced by weather, seasonal and daily variations in moisture (relative humidity), solar radiation, and other factors. The risk rating presented here serves to identify where certain constant variables are present, aiding in identifying where fires typically spread into the largest fires across the landscape.

3.10.2 Historic Fire Regime

The US Forest Service has provided their assessment of Historic Fire Regimes for western Montana. These measures of forest conditions are the standard method of analysis for the USDA Forest Service. The Historic Fire Regime map is presented in Appendix I.

In the fire-adapted ecosystems of Montana, fire is undoubtedly the dominant process in terrestrial systems that constrain vegetation patterns, habitats, and ultimately, species composition. Land managers need to understand historical fire regimes (that is, fire frequency and fire severity prior to settlement by Euro-Americans) to be able to define ecologically appropriate goals and objectives for an area. Moreover, managers need spatially explicit knowledge of how historical fire regimes vary across the landscape.

Many ecological assessments are enhanced by the characterization of the historical range of variability which helps managers understand: (1) how the driving ecosystem processes vary from site to site; (2) how these processes affected ecosystems in the past; and (3) how these processes might affect the ecosystems of today and the future. Obviously, historical fire regimes are a critical component for characterizing the historical range of variability in the fire adapted ecosystems of Montana. Furthermore, understanding ecosystem departures provides the necessary context for managing sustainable ecosystems. Land managers need to understand how ecosystem processes and functions have changed prior to developing strategies to maintain or restore sustainable systems. In addition, the concept of departure is a key factor for assessing risks to ecosystem components. For example, the departure from historical fire regimes may serve as a useful proxy for the potential of severe fire effects from an ecological perspective.

We used a database of fire history studies in the region to develop modeling rules for predicting historical fire regimes (HFRs). Tabular fire-history data was stratified into spatial data ecoregions, potential natural vegetation types (PNVs), slope classes, and aspect classes to derive rule sets which were then modeled spatially. Expert opinion was substituted for a stratum when empirical data was not available.

Fire is the dominant disturbance process that manipulates vegetation patterns in Montana. The HFR data were prepared to supplement other data necessary to assess integrated risks and opportunities at regional and subregional scales.

3.10.2.1 General Limitations

These data were derived using fire history data from a variety of different sources. These data were designed to characterize broad scale patterns of historical fire regimes for use in regional and subregional assessments. Any decisions based on these data should be supported with field verification, especially at scales finer than 1:50,000. Although the resolution of the HFR theme is 30 meter cell size, the expected accuracy does not warrant their use for analyses of areas smaller than about 10,000 acres (for example, assessments that typically require 1:24,000 data).

Table 3.23. Historic Fire Regime by area in Yellowstone County.

Historic Fire Regime Description	Regime	Acres	Percent
Non-lethal Fires	I	46,259	3%
Mixed severity, short return interval	I	166	0%
Mixed severity, long return interval	III	43,783	3%
Mixed severity, high elevation	II	803,108	47%
Stand replacement, short return interval	III	26,854	2%
Stand replacement, long return interval	IV	329,623	19%
Stand replacement; grass/shrub type	V	109,676	6%
Agriculture	Agriculture	283,641	17%
Rock / barren	Urban	27,163	2%
Urban	Sparce Vegetation	9,543	1%
Water	Water	16,012	1%

3.10.3 Fire Regime Condition Class

The US Forest Service has provided their assessment of Fire Regime Condition Class for Yellowstone County to this Community Wildfire Protection Plan analysis. These measures of forest conditions are the standard method of analysis for the USDA Forest Service.

A natural fire regime is a general classification of the role fire would play across a landscape in the absence of modern human mechanical intervention, but including the influence of aboriginal burning (Agee 1993, Brown 1995). Coarse scale definitions for natural (historical) fire regimes have been developed by Hardy *et al.* (2001) and Schmidt *et al.* (2002) and interpreted for fire and fuels management by Hann and Bunnell (2001). The five natural (historical) fire regimes are classified based on average number of years between fires (fire frequency) combined with the severity (amount of replacement) of the fire on the dominant overstory vegetation. These five regimes include:

I – 0-35 year frequency and low (surface fires most common) to mixed severity (less than 75% of the dominant overstory vegetation replaced);

II – 0-35 year frequency and high (stand replacement) severity (greater than 75% of the dominant overstory vegetation replaced);

III – 35-100+ year frequency and mixed severity (less than 75% of the dominant overstory vegetation replaced);

IV – 35-100+ year frequency and high (stand replacement) severity (greater than 75% of the dominant overstory vegetation replaced);

V – 200+ year frequency and high (stand replacement) severity.

As scale of application becomes finer these five classes may be defined with more detail, or any one class may be split into finer classes, but the hierarchy to the coarse scale definitions should be retained.

A fire regime condition class (FRCC) is a classification of the amount of departure from the natural regime (Hann and Bunnell 2001). Coarse-scale FRCC classes have been defined and mapped by Hardy *et al.* (2001) and Schmidt *et al.* (2001) (FRCC). They include three condition classes for each fire regime. The classification is based on a relative measure describing the degree of departure from the historical natural fire regime. This departure results in changes to one (or more) of the following ecological components: vegetation characteristics (species composition, structural stages, stand age, canopy closure, and mosaic pattern); fuel composition; fire frequency, severity, and pattern; and other associated disturbances (e.g. insect and diseased mortality, grazing, and drought). There are no wildland vegetation and fuel conditions or wildland fire situations that do not fit within one of the three classes.

The three classes are based on low (FRCC 1), moderate (FRCC 2), and high (FRCC 3) departure from the central tendency of the natural (historical) regime (Hann and Bunnell 2001, Hardy *et al.* 2001, Schmidt *et al.* 2002). The central tendency is a composite estimate of vegetation characteristics (species composition, structural stages, stand age, canopy closure, and mosaic pattern); fuel composition; fire frequency, severity, and pattern; and other associated natural disturbances. Low departure is considered to be within the natural (historical) range of variability, while moderate and high departures are outside.

Characteristic vegetation and fuel conditions are considered to be those that occurred within the natural (historical) fire regime. Uncharacteristic conditions are considered to be those that did not occur within the natural (historical) fire regime, such as invasive species (e.g. weeds, insects, and diseases), "high graded" forest composition and structure (e.g. large trees removed in a frequent surface fire regime), or repeated annual grazing that maintains grassy fuels across relatively large areas at levels that will not carry a surface fire. Determination of the amount of departure is based on comparison of a composite measure of fire regime attributes (vegetation characteristics; fuel composition; fire frequency, severity and pattern) to the central tendency of the natural (historical) fire regime. The amount of departure is then classified to determine the fire regime condition class. A simplified description of the fire regime condition classes and associated potential risks are presented in Table 3.24. Maps depicting Fire Regime and Condition Class are presented in Appendix I.

Table 3.24. Fire Regime Condition Class Definitions.

Condition Class	Description	Potential Risks
Condition Class 1	Within the natural (historical) range of variability of vegetation characteristics; fuel composition; fire frequency, severity and pattern; and other associated disturbances.	Fire behavior, effects, and other associated disturbances are similar to those that occurred prior to fire exclusion (suppression) and other types of management that do not mimic the natural fire regime and associated vegetation and fuel characteristics. Composition and structure of vegetation and fuels are similar to the natural (historical) regime. Risk of loss of key ecosystem components (e.g. native species, large trees, and soil) is low.
Condition Class 2	Moderate departure from the natural (historical) regime of vegetation characteristics; fuel composition; fire frequency, severity and pattern; and other associated disturbances.	Fire behavior, effects, and other associated disturbances are moderately departed (more or less severe). Composition and structure of vegetation and fuel are moderately altered. Uncharacteristic conditions range from low to moderate. Risk of loss of key ecosystem components is moderate.
Condition Class 3	High departure from the natural (historical) regime of vegetation characteristics; fuel composition; fire frequency, severity and pattern; and other associated disturbances.	Fire behavior, effects, and other associated disturbances are highly departed (more or less severe). Composition and structure of vegetation and fuel are highly altered. Uncharacteristic conditions range from moderate to high. Risk of loss of key ecosystem components is high.

The analyses of Fire Regime Condition Class in Yellowstone County shows that approximately 10% of the County is in Condition Class 1 (low departure), just about 1% is in Condition Class 2 (moderate departure), with the remaining 2% of the area is in Condition Class 3 (Table 3.25).

Table 3.25. Fire Regime Condition Class by Area in Yellowstone County.		
Condition Class	**Acres**	**Percent**
Low	86,568	5%
Moderate	1,268,666	75%
High	701	0%
Agriculture	286,136	17%
Sparse Vegetation	9,773	1%
Urban	27,259	2%
Water	16,012	1%
Burned Areas	713	0%

See the Appendix I for map of Fire Regime Condition Class.

3.10.4 Predicted Fire Severity

Current fire severity (CFS) is an estimate of the relative fire severity if a fire were to burn a site under its current state of vegetation. In other words, how much of the overstory would be removed if a fire were to burn today. The US Forest Service (Flathead National Forest) did not attempt to model absolute values of fire severity, as there are too many variables that influence fire effects at any given time (for example, temperature, humidity, fuel moisture, slope, wind speed, wind direction). Current Fire Severity maps are depicted in Appendix I.

The characterization of likely fire severity was based upon historic fire regimes, potential natural vegetation, cover type, size class, and canopy cover with respect to slope and aspect. Each cover type was assigned a qualitative rating of fire tolerance based upon likely species composition and the relative resistance of each species to fire. The US Forest Service researchers defined 3 broad classes of fire tolerance: high tolerance (<20 percent post-fire mortality); moderate tolerance (20 to 80 percent mortality); and low tolerance (>80 percent mortality). We would expect that fires would be less severe within cover types comprised by species that have a high tolerance to fire (for example, western larch and ponderosa pine). Conversely, fires would likely burn more severely within cover types comprised by species having a low tolerance to fire (for example grand fir, subalpine fir). Data assignments were based upon our collective experience in the field, as well as stand structure characteristics reported in the fire-history literature. For example, if they estimated that a fire would remove less than 20 percent of the overstory, the current fire severity would be assigned to the non-lethal class (that is, NL). However, if they expected fire to remove more than 80 percent of the overstory, the current fire severity was assigned to a stand replacement class (that is, SR or SR3).

3.10.4.1 Purpose

Fire is a dominant disturbance process in Montana. The likely effect of fire upon vegetation (i.e., current fire severity) is critical information for understanding the subsequent fire effects upon wildlife habitats, water quality, and the timing of runoff. There have been many reports of how fire suppression and timber harvest has affected vegetation patterns, fuels, and fire behavior. The US Forest Service researchers from the Flathead National Forest, derived the current fire severity theme explicitly to compare with the historical fire regime theme to evaluate how fire severity has changed since Euro-American settlement (that is, to derive fire-regime condition class).

3.10.4.2 General Limitations

These data were designed to characterize broad scale patterns of estimated fire severity for use in regional and subregional assessments. Any decisions based on these data should be supported with field verification, especially at scales finer than 1:100,000. Although the resolution of the CFS theme is 90 meter cell size, the expected accuracy does not warrant their use for analyses of areas smaller than about 10,000 acres (for example, assessments that typically require 1:24,000 data).

Current fire severity rule-set was developed for an "average burn day" for the specific vegetation types in our area. Any user of these data should familiarize themselves with the rule sets to better understand our estimate of current fire severity.

Table 3.26. Predicted Fire Severity by area in Yellowstone County.

Predicted Fire Severity	Regime	Acres	Percent of Area
Mixed Severity-Short Interval	I	1,947	0%
Mixed Severity-Long Interval	III	43,645	3%
Non-Lethal Fires	I	43,521	3%
Non-forest-Mixed Severity-Moderate Interval	III	26,592	2%
Non-forest-Stand Replacement-Short Interval	II	799,375	47%
Agriculture	Agriculture	283,641	17%
Urban	Urban	27,163	2%
Sparse Vegetation	Sparce Vegetation	9,925	1%
Water	Water	16,012	1%
Recently Burned Area	Recently Burned Area	6,887	0%
Non-forest-Stand Replacement-Moderate Interval	IV	328,105	19%
Non-forest-Stand Replacement-Long Interval	V	109,013	6%

3.10.5 On-Site Evaluations

Fire control and evaluation specialists as well as hazard mitigation consultants evaluated the communities of Yellowstone County to determine, first-hand, the extent of risk and characteristics of hazardous fuels in the Wildland-Urban Interface. The on-site evaluations have been summarized in written narratives and are accompanied by photographs taken during the site visits. These evaluations included the estimation of fuel models as established by Anderson (1982). These fuel models are described in the following section of this document.

3.10.6 Fuel Model Descriptions

Anderson (1982) developed a categorical guide for determining fuel models to facilitate the linkage between fuels and fire behavior. These 13 fuel models, grouped into 4 basic groups: grass, chaparral and shrub, timber, and slash, provide the basis for communicating fuel conditions and evaluating fire risk. There are a number of ways to estimate fuel models in forest and rangeland conditions. The field personnel from Northwest Management, Inc., that evaluated communities and other areas of Yellowstone County have all been intricately involved in wildland fire fighting and the incident command system. They made ocular estimates of fuel models they observed. In an intense evaluation, actual sampling would have been employed to determine fuel models and fuel loading. The estimations presented in this document (Chapter 3) are estimates based on observations to better understand the conditions observed.

Fuel Model 0- This type consists of non-flammable sites, such as exposed mineral soil and rock outcrops. Other lands are also identified in this type.

3.10.6.1 Grass Group

3.10.6.1.1 Fire Behavior Fuel Model 1

Fire spread is governed by the fine, very porous, and continuous herbaceous fuels that have cured or are nearly cured. Fires are surface fires that move rapidly through the cured grass and associated material. Very little shrub or timber is present, generally less than one-third of the area.

Grasslands and savanna are represented along with stubble, grass-tundra, and grass-shrub combinations that met the above area constraint. Annual and perennial grasses are included in this fuel model.

This fuel model correlates to 1978 NFDRS fuel models A, L, and S.

Fuel model values for estimating fire behavior

Total fuel load, < 3-inch dead and alive, tons/acre 0.74
Dead fuel load, ¼-inch, tons/acre 0.74
Live fuel load, foliage, tons/acre 0
Fuel bed depth, feet 1.0

3.10.6.1.2 Fire Behavior Fuel Model 2

Fire is spread primarily through the fine herbaceous fuels, either curing or dead. These are surface fires where the herbaceous material, in addition to litter and dead-down stemwood from the open shrub or timber overstory, contribute to the fire intensity. Open shrub lands and pine stands or scrub oak stands that cover one-third to two-thirds of the area may generally fit this model; such stands may include clumps of fuels that generate higher intensities and that may produce firebrands. Some pinyon-juniper may be in this model.

This fuel model correlates to 1978 NFDRS fuel models C and T.

Fuel model values for estimating fire behavior

Total fuel load, < 3-inch dead and alive, tons/acre 4.0
Dead fuel load, ¼-inch, tons/acre 2.0
Live fuel load, foliage, tons/acre 0.5
Fuel bed depth, feet 1.0

3.10.6.1.3 Fire Behavior Fuel Model 3

Fires in this fuel are the most intense of the grass group and display high rates of spread under the influence of wind. Wind may drive fire into the upper heights of the grass and across standing water. Stands are tall, averaging about 3 feet (1 m), but considerable variation may occur. Approximately one-third or more of the stand is considered dead or cured and maintains the fire. Wild or cultivated grains that have not been harvested can be considered similar to tall prairie and marshland grasses.

This fuel correlates to 1978 NFDRS fuel model N.

Fuel model values for estimating fire behavior

Total fuel load, < 3-inch dead and live, tons/acre 3.0
Dead fuel load, ¼-inch, tons/acre 3.0
Live fuel load, foliage tons/acre 0
Fuel bed depth, feet 2.5

3.10.6.2 Shrub Group

3.10.6.2.1 Fire Behavior Fuel Model 4

Fire intensity and fast-spreading fires involve the foliage and live and dead fine woody material in the crowns of a nearly continuous secondary overstory. Stands of mature shrubs, 6 or more feet tall, such as California mixed chaparral, the high pocosin along the east coast, the pinebarrens of New Jersey, or the closed jack pine stands of the north-central States are typical candidates. Besides flammable foliage, dead woody material in the stands significantly contributes to the fire intensity. Height of stand qualifying for this model depends on local conditions. A deep litter layer may also hamper suppression efforts.

This fuel model represents 1978 NFDRS fuel models B and O; fire behavior estimates are more severe than obtained by Models B or O.

Fuel model values for estimating fire behavior

Total fuel load, <3-inch dead and live, tons/acre 13.0
Dead fuel load, ¼-inch, tons/acre 5.0
Live fuel load, foliage, tons/acre 5.0
Fuel bed depth, feet 6.0

3.10.6.2.2 Fire Behavior Fuel Model 5

Fire is generally carried in the surface fuels that are made up of litter cast by the shrubs and the grasses or forbs in the understory. The fires are generally not very intense because surface fuel loads are light, the shrubs are young with little dead material, and the foliage contains little volatile material. Usually shrubs are short and almost totally cover the area. Young, green stands with no dead wood would qualify: laurel, vine maple, alder, or even chaparral, manzanita, or chamise.

No 1978 NFDRS fuel model is represented, but model 5 can be considered as second choice for NFDRS model D or as third choice for NFDRS model T. Young green stands may be up to 6 feet (2m) high but have poor burning properties because of live vegetation.

Fuel model values for estimating fire behavior

Total fuel load, <3-inch dead and live, tons/acre 3.5
Dead fuel load, ¼-inch, tons/acre 1.0
Live fuel load, foliage, tons/acre 2.0
Fuel bed depth, feet 2.0

3.10.6.2.3 Fire Behavior Fuel Model 6

Fires carry through the shrub layer where the foliage is more flammable than fuel model 5, but this requires moderate winds, greater than 8 mi/h (13 km/h) at mid-flame height. Fire will drop to the ground at low wind speeds or at openings in the stand. The shrubs are older, but not as tall as shrub types of model 4, nor do they contain as much fuel as model 4. A broad range of shrub conditions is covered by this model. Fuel situations to be considered include intermediate stands of chamise, chaparral, oak brush, low pocosin, Alaskan spruce taiga, and shrub tundra. Even hardwood slash that has cured can be considered. Pinyon-juniper shrublands may be represented but may over-predict rate of spread except at high winds, like 20 mi/h (32 km/h) at the 20-foot level.

The 1978 NFDRS fuel models F and Q are represented by this fuel model. It can be considered a second choice for models T and D and a third choice for model S.

Fuel model values for estimating fire behavior

Total fuel load, <3-inch dead and live, tons/acres............. 6.0
Dead fuel load, 1/4 –inch, tons/acre 1.5
Live fuel load, foliage, tons/acre 0
Fuel bed depth, feet.. 2.5

3.10.6.2.4 Fire Behavior Fuel Model 7

Fires burn through the surface and shrub strata with equal ease and can occur at higher dead fuel moisture contents because of the flammability of live foliage and other live material. Stands of shrubs are generally between 2 and 6 feet (0.6 and 1.8 m high). Palmetto-gallberry understory-pine overstory sites are typical and low pocosins may be represented. Black spruce-shrub combinations in Alaska may also be represented.

This fuel model correlates with 1978 NFDRS model D and can be a second choice for model Q.

Fuel model values for estimating fire behavior

Total fuel load, <3-inch dead and live, tons/acre 4.9
Dead fuel load, ¼-inch, tons/acre 1.1
Live fuel load, foliage, tons/acre 0.4
Fuel bed depth, feet.. 2.5

3.10.6.3 Timber Group

3.10.6.3.1 Fire Behavior Fuel Model 8

Slow-burning ground fires with low flame lengths are generally the case, although the fire may encounter an occasional "jackpot" or heavy fuel concentration that can flare up. Only under severe weather conditions involving high temperatures, low humilities, and high winds do the fuels pose fire hazards. Closed canopy stands of short-needle conifers or hardwoods that have leafed out support fire in the compact litter layer. This layer is mainly needles, leaves, and occasionally twigs because little undergrowth is present in the stand. Representative conifer types are white pine, and lodgepole pine, spruce, fire and larch

This model can be used for 1978 NFDRS fuel models H and R.

Fuel model values for estimating fire behavior

Total fuel load, <3-inch, dead and live, tons/acre 5.0
Dead fuel load, ¼-inch, tons/acre 1.5
Live fuel load, foliage, tons/acre 0
Fuel bed depth, feet... 0.2

3.10.6.3.2 Fire Behavior Fuel Model 9

Fires run through the surface litter faster than model 8 and have longer flame height. Both long-needle conifer stands and hardwood stands, especially the oak-hickory types, are typical. Fall fires in hardwoods are predictable, but high winds will actually cause higher rates of spread than predicted because of spotting caused by rolling and blowing leaves. Closed stands of long-needled pine like ponderosa, Jeffrey, and red pines, or southern pine plantations are grouped in this model. Concentrations of dead-down woody material will contribute to possible torching out of trees, spotting, and crowning.

NFDRS fuel models E, P, and U are represented by this model. It is also a second choice for models C and S.

Fuel model values for estimating fire behavior

Total fuel load, <3-inch dead and live, tons/acre 3.5
Dead fuel load, ¼-inch, tons/acre 2.9
Live fuel load, foliage, tons/acre 0
Fuel bed depth, feet 0.2

3.10.6.3.3 Fire Behavior Fuel Model 10

The fires burn in the surface and ground fuels with greater fire intensity than the other timber models. Dead-down fuels include greater quantities of 3-inch (7.6 cm) or larger limbwood, resulting from overmaturity or natural events that create a large load of dead material on the forest floor. Crowning out, spotting, and torching of individual trees are more frequent in this fuel situation, leading to potential fire control difficulties. Any forest type may be considered if heavy down material is present; examples are insect- or disease-ridden stands, wind-thrown stands, overmature situations with dead fall, and aged light thinning or partial-cut slash.

The 1978 NFDRS fuel model G is represented.

Fuel model values for estimating fire behavior

Total fuel load, < 3-inch dead and live, tons/acre 12.0
Dead fuel load, ¼-inch, tons/acre 3.0
Live fuel load, foliage, tons/acre 2.0
Fuel bed depth, feet 1.0

The fire intensities and spread rates of these timber litter fuel models are indicated by the following values when the dead fuel moisture content is 8 percent, live fuel moisture is 100 percent, and the effective wind speed at mid-flame height is 5 mi/h (8 km/h):

Table 3.27. Comparative Fire Intensities and Rates of Spread in Timber Fuel Models.

Fuel Model	Rate of Spread (Chains/hour)	Flame length (Feet)
8	1.6	1.0
9	7.5	2.6
10	7.9	4.8

Fires such as above in model 10 are at the upper limit of control by direct attack. More wind or drier conditions could lead to an escaped fire.

3.10.6.4 Logging Slash Group

3.10.6.4.1 Fire Behavior Fuel Model 11

Fires are fairly active in the slash and herbaceous material intermixed with the slash. The spacing of the rather light fuel load, shading from overstory, or the aging of the fine fuels can contribute to limiting the fire potential. Light partial cuts or thinning operations in mixed conifer stands, hardwood stands, and southern pine harvests are considered. Clearcut operations generally produce more slash than represented here. The less-than-3-inch (7.6-cm) material load is less than 12 tons per acre (5.4 t/ha). The greater-than-3-inch (7.6-cm) is represented by not more than 10 pieces, 4 inches (10.2 cm) in diameter, along a 50-foot (15 m) transect.

The 1978 NFDRS fuel model K is represented by this model.

Fuel model values for estimating fire behavior

Total fuel load, < 3-inch, dead and live, tons/acre 11.5
Dead fuel load, ¼-inch, tons/acre 1.5
Live fuel load, foliage, tons/acre 0
Fuel bed depth, feet 1.0

3.10.6.4.2 Fire Behavior Fuel Model 12

Rapidly spreading fires with high intensities capable of generating firebrands can occur. When fire starts, it is generally sustained until a fuel break or change in fuels is encountered. The visual impression is dominated by slash and much of it is less than 3 inches (7.6 cm) in diameter. The fuels total less than 35 tons per acres (15.6 t/ha) and seem well distributed. Heavily thinned conifer stands, clearcuts, and medium or heavy partial cuts are represented. The material larger than 3 inches (7.6 cm) is represented by encountering 11 pieces, 6 inches (15.3 cm) in diameter, along a 50-foot (15-m) transect.

This model depicts 1978 NFDRS model J and may overrate slash areas when the needles have dropped and the limbwood has settled. However, in areas where limbwood breakup and general weathering have started, the fire potential can increase.

Fuel model values fore estimating fire behavior

Total fuel load, < 3-inch, dead and live, tons/acre 34.6
Dead fuel load, ¼-inch, tons/acre 4.0
Live fuel load, foliage, tons/acre 0
Fuel bed depth, feet 2.3

3.10.6.4.3 Fire Behavior Fuel Model 13

Fire is generally carried across the area by a continuous layer of slash. Large quantities of material larger than 3 inches (7.6 cm) are present. Fires spread quickly through the fine fuels and intensity builds up more slowly as the large fuels start burning. Active flaming is sustained for long periods and a wide variety of firebrands can be generated. These contribute to spotting problems as the weather conditions become more severe. Clearcuts and heavy partial-cuts in mature and overmature stands are depicted where the slash load is dominated by the greater-tayhn-3-inch (7.6-cm) diameter material. The total load may exceed 200 tons per acre (89.2 t/ha) but fuel less than 3 inches (7.6 cm_ is generally only 10 percent of the total load. Situations where the slash still has “red’ needles attached but the total load is lighter, more like model 12, can be represented because of the earlier high intensity and quicker area involvement.

The 1978 NFDRS fuel model I is represented. Areas most commonly fitting his model are old-growth stands west of the Cascade and Sierra Nevada Mountains. More efficient utilization standards are decreasing the amount of large material left in the field.

Fuel model values for estimating fire behavior

Total fuel load, < 3-inch dead and live, tons/acre 58.1
Dead fuel load, ¼-inch, tons/acre 7.0
Live fuel load, foliage, tons/acre 0
Fuel bed depth, feet 3.0

For other slash situations:

Hardwood slash ....Model 6
Heavy “red” slash...Model 4
Overgrown slash ....Model 10
Southern pine clearcut slash.........................Model 12

The comparative rates of spread and flame lengths for the slash models at 8 percent dead fuel moisture content and a 5 mi/h (8 km/h) mid-flame wind are presented in Table 3.28.

Table 3.28. Comparative Fire Intensities and Rates of Spread in Slash Fuel Models.

Fuel Model	Rate of Spread (Chains/hour)	Flame length (Feet)
11	6.0	3.5
12	13.0	8.0
13	13.5	10.5

3.11 Wildland-Urban Interface

3.11.1 People and Structures

A key component in meeting the underlying need is the protection and treatment of fire hazard in the wildland-urban interface. The wildland-urban interface refers to areas where wildland vegetation meets urban developments, or where forest fuels meet urban fuels (such as houses). These areas encompass not only the interface (areas immediately adjacent to urban development), but also the continuous slopes and fuels that lead directly to a risk to urban developments. Reducing the fire hazard in the wildland urban interface requires the efforts of federal, state, local agencies, and private individuals (Norton 2002). “The role of [most] federal agencies in the wildland urban interface includes wildland fire fighting, hazard fuels reduction, cooperative prevention and education and technical experience. Structural fire protection [during a wildfire] in the wildland urban interface is [largely] the responsibility of Tribal, state, and local governments” (USFS 2001). Property owners share a responsibility to protect their residences and businesses and minimize fire danger by creating defensible areas around them and taking other measures to minimize the fire risks to their structures (USFS 2001). With treatment, a wildland-urban interface can provide firefighters a defensible area from which to suppress wildland fires or defend communities. In addition, a wildland urban interface that is properly thinned will be less likely to sustain a crown fire that enters or originates within it (Norton 2002).

By reducing hazardous fuel loads, ladder fuels, and tree densities, and creating new and reinforcing defensible space, landowners would protect the wildland-urban interface, the biological resources of the management area, and adjacent property owners by:

- minimizing the potential of high-severity ground or crown fires entering or leaving the area;

- reducing the potential for firebrands (embers carried by the wind in front of the wildfire) impacting the WUI. Research indicates that flying sparks and embers (firebrands) from a crown fire can ignite additional wildfires as far as 1¼ miles away during periods of extreme fire weather and fire behavior (McCoy *et al.* 2001 as cited in Norton 2002);
- improving defensible space in the immediate areas for suppression efforts in the event of wildland fire.

Four wildland/urban conditions have been identified for use in the wildland urban interface (Norton 2002). These include the Interface Condition, Intermix Condition, Occluded Condition, and Rural Condition. Descriptions of each are as follows:

- **Interface Condition** – a situation where structures abut wildland fuels. There is a clear line of demarcation between the structures and the wildland fuels along roads or back fences. The development density for an interface condition is usually 3+ structures per acre;
- **Intermix Condition** – a situation where structures are scattered throughout a wildland area. There is no clear line of demarcation, the wildland fuels are continuous outside of and within the developed area. The development density in the intermix ranges from structures very close together to one structure per 40 acres;
- **Occluded Condition** – a situation, normally within a city, where structures abut an island of wildland fuels (park or open space). There is a clear line of demarcation between the structures and the wildland fuels along roads and fences. The development density for an occluded condition is usually similar to that found in the interface condition and the occluded area is usually less than 1,000 acres in size; and
- **Rural Condition** – a situation where the scattered small clusters of structures (ranches, farms, resorts, or summer cabins) are exposed to wildland fuels. There may be miles between these clusters.

Structure locations in Yellowstone County were first mapped by the Yellowstone County GIS Department for use in the 911 database. However, this dataset was missing a number of structures in the city of Billings, as well as in the rural regions of the county. To determine the location of these structures, aerial photography from 1998 and 2004 was used to manually locate missing structures and add them to the dataset. The result was a GIS data layer including most, if not all, of the structures in Yellowstone County.

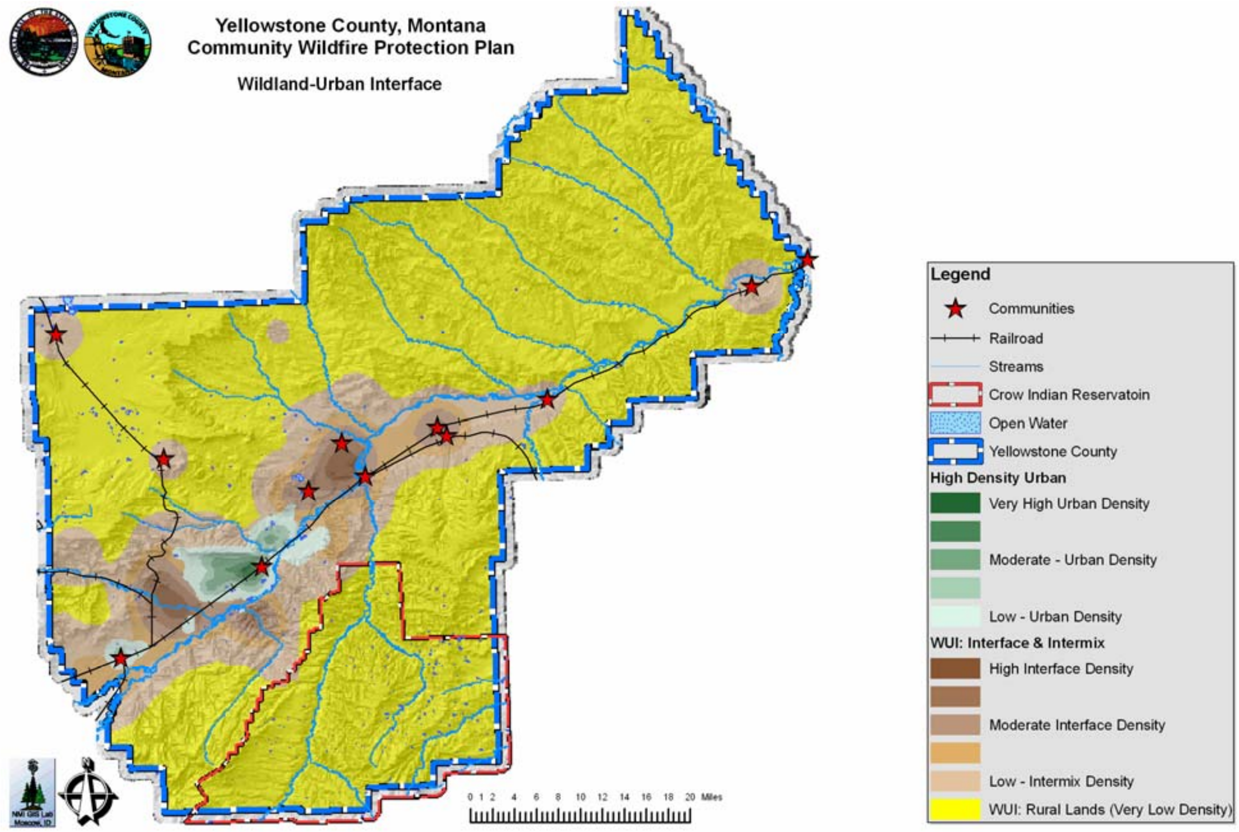
All structures are represented by a “dot” on the map. No differentiation is made between a garage and a home, or a business and a storage building. The density of structures and their specific locations in this management area are critical in defining where the potential exists for casualty loss in the event of a wildfire in the region.

By evaluating this structure density, we can define WUI areas on maps by using mathematical formulae and population density indexes to define the WUI based on where structures are located. The resulting population density indexes create concentric circles showing high density areas of Interface and Intermix WUI, as well as Rural WUI (as defined by Secretary Norton of the Department of Interior). This portion of the analysis allows us to “see” where the highest concentrations of structures are located in reference to high risk landscapes, limiting infrastructure, and other points of concern.

It is critical to understand that in the protection of people, structures, infrastructure, and unique ecosystems, this portion of the analysis only serves to identify structures and by some extension the people that inhabit them. It does not define the location of infrastructure and unique ecosystems. Other analysis tools will be used for those items.

The WUI interface areas as defined here are presented in map form in the Appendices.

Figure 3.13. Wildland-Urban Interface of Yellowstone County.



This map is presented for reference in this section of the plan. This map and additional maps are detailed in Appendix I.

3.11.2 Infrastructure

Yellowstone County has both significant infrastructure and unique ecosystems within its boundaries. Of note for this Wildfire Protection Plan is the existence of highway routes (e.g., Interstates 90 and 94 and U.S. Routes 87, 212, and 312 and State Route 3), oil fields and refineries, and the presence of power lines supplying surrounding counties. These resources will be considered in the protection of infrastructural resources for Yellowstone County and to the larger extent of this region, and the rest of Montana.

High Tension Power Lines have been mapped and are presented in the Appendices. Protection of these lines from loss during a wildfire is paramount in as much as the electrical power they provide serves not only the communities of Yellowstone County but of surrounding counties. The protection of these lines allows for community sustainability, support of the economic viability of Yellowstone County, and the protection of people who rely on that power. Fuels mitigation under power lines has received considerable attention in forested ecosystems as timber is thinned and heavy accumulations of brush are managed. This practice should be mandated into the future. However, the importance of management of rangeland ecosystems under high tension power lines should not be overlooked. Brush intermixed with grasses and other species, during extreme fire weather events, coupled with steep slopes can produce considerable heat and particulate matter. When this occurs under power lines, the result can be arcing between lines and even failure of the electrical media itself. Fuel mitigation treatments in high risk areas, especially where multiple lines are co-located, will be recommended for treatments.

3.11.3 Ecosystems

Yellowstone County is a diverse ecosystem with a complex array of vegetation, wildlife, and fisheries that have developed with, and adapted to fire as a natural disturbance process. A century of wildland fire suppression coupled with past land-use practices (primarily livestock grazing and farming) has altered plant community succession and has resulted in dramatic shifts in the fire regimes and species composition. As a result, woodlands and rangelands in Yellowstone County have become more susceptible to large-scale, high intensity fires posing a threat to life, property, and natural resources including wildlife and special status plant populations and habitats. High-intensity, stand-replacing fires have the potential to seriously damage soils and native vegetation. In addition, an increase in the number of large high intensity fires throughout the nation's forest and rangelands, has resulted in significant safety risks to firefighters and higher costs for fire suppression (House of Representatives, Committee on Agriculture, Washington, DC, 1997).

3.12 Soils

Our soil resource is an extremely important component for maintaining a healthy ecosystem and economy. Fire can play an intricate role in this process, if it occurs under normal conditions of light fuels associated with low intensity underburns. However, the buildup of fuels and consequent high severity fires can cause soils to become water repellent (hydrophobic), and thus greatly increases the potential for overland flow during intense rains. Soil in degraded conditions does not function normally, and will not be able to sustain water quality, water yield, or plant communities that have normal structure, composition, and function. Fire is also strongly correlated with the carbon-nutrient cycles and the hydrologic cycle. Fire frequency, extent, and severity are controlled to a large degree by the availability of carbon, as well as the moisture regime (Quigley & Arbelbide 1997).

Soils were evaluated for their propensity to become hydrophobic during and after a fire as evidenced by the presence of clay and clay derivatives (e.g., clay loam, cobbly clay) in the upper soil layers. In addition, their permeability and tendency to allow runoff to infiltrate the soil was evaluated. Soils formed in place tend to contain high amounts of clay, silt and sand and low amounts of organic material in the surface horizons. These soils are located on the higher terraces and hills north and south of the Yellowstone River valley. The transported soils found in the Yellowstone River valley are more loam rich. On average, soils in Yellowstone County are well drained with moderate permeability.

Low to moderate intensity fires would be not be expected to damage soil characteristics in the region, especially if the hotter fires in this range were limited to small extents associated with jackpots of cured fuels. Hot fires providing intense heat to the C horizon substrate depth have the potential to create hydrophobic characteristics in that layer. This can result in increased overland flow during heavy rains, following wildfire events, potentially leading to mass wasting. Rocky and gravelly characteristics in the A horizon layer would be expected to be displaced, while the silty and loamy fines in these soils may experience an erosion and displacement potential. These soils will experience the greatest potential impacts resulting from hot fires that burn for prolonged periods (especially on steep slopes).

3.12.1 Fire Mitigation Practices to Maintain Soil Processes

Firelines constructed by hand or with the use of machinery will have varying impacts, depending upon construction techniques. If only the surface litter is removed in the fireline construction, minor increases to soil erosion may occur. If trenches are dug which channelize runoff down steep slopes, heavy rilling or gullying could occur depending upon rock content of surface layers exposed. Jackpot burning and, to a greater extent, large scale pile burning would result in greater soil heating, but with localized impacts. Loss of soil carbon, nitrogen, sulphur, phosphorus, potassium, and soil organisms would be high in the soil surface layer. Soil physical structure could be altered thereby creating hydrophobic soils, especially where clay content is moderate or high. Loosely stacked hand piles resulting from typical defensible space projects in Yellowstone County would not be expected to have lasting affects on soil properties.

Indirect effects of prescribed burning to slope stability are highly variable in the soil types found in Yellowstone County. Vegetation structure, including root strength after over-burning, is maintained from three to fifteen years following low to moderate intensity burns and therefore soil saturation potential is not greatly altered. Re-vegetation of burned areas within this time frame will be a critical component to maintaining soil resources and pre-empting noxious weeds and invasive species from occupying the site. Locale experiencing high intensity burns will need to be evaluated immediately for mechanical erosion control followed by re-vegetation efforts. Holding soils in place will be a difficult challenge in many locations, especially on moderate to steep slopes.

Where heavy grazing has occurred in the past, there is also a possibility that soil productivity has been reduced. This is especially true in riparian areas where animal concentrations have historically been the greatest. These areas generally have easily compacted soils, and are where cattle tend to linger if not managed well. Mining also has significant effects on soil quality through soil compaction and mass displacement. Grazing across Yellowstone County was observed to be maintained in a sustainable manner without the overgrazing found in other areas of the region.

Severe fires in the past have consumed surface organics and volatilized nitrogen into the air. On some sites, however, these severe burns are a natural process, and therefore the inherent soil productivity may not be reduced. On other sites, however, where low intensity underburns typically occurred, high intensity wildland fires have consumed amounts of soil organics in excess of the historic patterns. Furthermore, excessive soil heating in these intense fires likely resulted in creation of water repellent soils, and therefore increased overland flow and soil erosion. In these cases, it can be assumed that wildland fires have reduced long-term soil productivity. Soil compaction damage typically is persistent in the area; several decades of rest from further compactive forces are needed until adequate soil recovery occurs. Loss of organics due to displacement and severe fire also requires decades to recuperate. This slow recovery from soil damage makes cumulative effects to soil productivity and soil hydrologic function a major concern.

To avoid potential impacts, wherever possible, firelines should be located outside of highly erosive areas, steep slopes, intermittent streams, and riparian and other sensitive areas. Following prescribed fire or fire suppression activities, firelines should be rehabilitated.

3.13 Hydrology

The Montana Department of Natural Resources and Conservation Water Resources Division is charged with the development of the Montana State Ground Water Plan. Included in the Plan is the statewide water policy plan along with detailed subsections regarding the protection, education, and remediation of Montana's ground water resources. The Montana DNRC Water Resources Division has prepared Surface Water Supply Index Maps for all of the surface water systems in Montana. This agency also addresses statewide floodplain management, streamflow conditions, and dams and canals, and water rights issues.

The geology and soils of this region lead to slow to moderate moisture infiltration. Soils that have a clay pan or clay layer near the surface inhibit downward water transmission; thus, have a high potential for overland flow. Clayey soils also have a high shrink swell potential. Disrupted vegetation patterns from logging or agriculture (soil compaction) and wildland fire (especially hot fires that increase soil hydrophobic characteristics), can lead to increased surface runoff and debris flow to stream channels.

A correlation to mass wasting due to the removal of vegetation caused by high intensity wildland fire has been documented for the central Montana region. Burned vegetation can result in changes in soil moisture and loss of rooting strength that can result in slope instability, especially on slopes greater than 30%. The greatest watershed impacts from increased sediment will be in the lower gradient, depositional stream reaches.

3.13.1 Fire Mitigation Practices to Maintain Hydrologic Processes

The effects of wildland fire and prescribed burning on water quality are variable. The removal of the vegetative canopy will tend to reduce transpiration and increase water yield, especially during the growing season and immediately afterwards (MacDonald *et al.* 1991). Prescribed burning is used to maintain a healthy, dynamic ecosystem while meeting land management objectives. Prescribed burning objectives include reduction of natural fuels, assuring current and future habitat conditions for native plants and animals, improvement of forest health, and enhancement, protection, and maintenance of old growth and riparian areas. The majority of the burned areas are expected to receive low intensity ground fires with some areas of moderate intensity. This may include occasional torching of single trees or larger clumps of trees and consumption of some patches of regeneration. Impacts to soil and large woody debris are expected to be minimal, given project targets. In rangeland ecosystems, prescribed fire will have variable impacts dependant on burn intensity and proximity to streams. Stream buffering (low intensity to no burn around streams) has been shown to preserve most if not all normal sediment filtering functions.

A large, stand-replacing fire could have negative effects on watershed conditions, thus affecting both fish and habitat in streams. Treatment with low to moderate intensity fire would result in a mosaic pattern of burned and unburned areas of ground level vegetation species and ground level natural fuels. Some patches of shade-tolerant, fire intolerant species may also be consumed. Prescribed burning is not designed to consume all vegetation within project areas. Each treatment will leave a mosaic of burned and unburned areas. Once the target fuels and the risk of fire carrying from one tributary to another have been reduced, hand ignition may be considered on a site-specific basis.

The effects on sediment yield vary according to the intensity of fire; degree of soil disturbance; steepness of the slope and drainage network; the size of the area burned; and the extent to which the vegetation controls the movement and storage of sediment. Fire also increases surface erosion and sediment delivery rates by removing the litter layer and organic debris that traps sediment both on slopes and in the stream channel (MacDonald *et al.* 1991). The magnitude of these effects will depend on the geomorphic sensitivity of the landscape, which is largely a function of slope steepness and parent material (Swanson 1978).

Fire can greatly increase surface erosion by temporarily creating a hydrophobic soil layer. Soils within the project area are generally at moderate risk for hydrophobic conditions due to their fine-grained textures and clay content. In addition, the relatively low burn intensity of the prescribed fires will also help prevent the formation of hydrophobic soils.

The effects of wildland fire or prescribed fire are generally considered in terms of potential short-term, negative effects and long-term benefits of fuels reduction, which will result in a decreased risk of high intensity, stand-replacing fire. Potential short-term effects to streams and fish include increased risk of landslides, mass movement and debris torrents, increases in surface sediment erosion, possible reduction in streamside vegetation resulting in changes within management areas, and possible increases in water yield depending on the amount and severity of the vegetation burned. Long-term effects include increases in nutrient delivery, possible increases in woody debris in streams, and possible increases in stream temperature if shading is significantly reduced. The design criteria described above minimizes the risk that landslides, mass movement, significant increases in surface sediment yield, and significant changes in water yield will occur.

Reduction of vegetation will mostly be limited to creeping ground fires, which will reduce understory vegetation, but will not affect mature trees or result in significant mortality to the overstory. Spring burning often results in minimal riparian vegetation burned because streamside areas have higher humidity and live plant moisture. Fall burning will more likely result in understory vegetation removal, with a possibility of some tree and large shrub mortality, especially outside of riparian zones where live plant moisture is less.

Riparian buffer strips will be maintained, thereby preserving canopy cover for shading, sediment filtering, and streambank and floodplain stability (PACFISH guidelines). Areas not burned will provide significant protection from adverse water quality impacts associated with wildland fire and prescribed burning. Therefore, effects to fish and habitat in these streams from increased water yield are unlikely. The area has been roaded from past management activities. Therefore, increased road densities from road construction are not expected to be of a magnitude to increase sedimentation to affected drainages provided adequate planning for new road construction is implemented. Forest practices in the area will be conducted to meet the standards of the Montana Streamside Management Law. These rules are designed to use best management practices that are adapted to and take account of the specific factors influencing water quality, water quality objectives, on-site conditions, and other factors applicable to the site where a forest practice occurs.

3.14 Air Quality

The primary means by which the protection and enhancement of air quality is accomplished is through implementation of National Ambient Air Quality Standards (NAAQS). These standards address six pollutants known to harm human health including ozone, carbon monoxide, particulate matter, sulfur dioxide, lead, and nitrogen oxides (USDA Forest Service 2000). There are nine monitoring stations in Yellowstone County that are monitored for EPA emission standards. All locations are in compliance and well below allowable emission thresholds. These stations are positioned at Billings Logan International Airport, Pine Hills, Beartooth, Brickyard Lane, St. Lukes, Coburn Road, Lockwood Park, Johnson Lane, and Bernhardt Road in Laurel (Yellowstone City-County Health Department 2005).

Smoke emissions from fires potentially affect an area and the airsheds that surround it. Climatic conditions affecting air quality in central Montana are governed by a combination of factors. Large-scale influences include latitude, altitude, prevailing hemispheric wind patterns, and mountain barriers. At a smaller scale, topography and vegetation cover also affect air movement patterns. Air quality in the area and surrounding airshed is generally good to excellent. However, locally adverse conditions can result from occasional wildland fires in the summer and fall, and prescribed fire and agricultural burning in the spring and fall. All major river drainages are subject to temperature inversions which trap smoke and affect dispersion, causing local air quality problems. Air quality is also affected by winter inversions trapping emissions form internal combustion engines and wood burning stoves.

Yellowstone County is in the Montana Airshed Unit 10: Idaho/Montana Airshed Group Operating Guide (Levinson 2002). An airshed is a geographical area which is characterized by similar topography and weather patterns (or in which atmospheric characteristics are similar, e.g., mixing height and transport winds). The USDA Forest Service, Bureau of Land Management, and the Montana Department of Natural Resources and Conservation are all members of the Idaho/Montana State Airshed Group, which is responsible for coordinating burning activities to minimize or prevent impacts from smoke emissions. Prescribed burning must be coordinated through the Missoula Monitoring Unit, which coordinates burn information, provides smoke forecasting, and establishes air quality restrictions for the Idaho/Montana Airshed Group. The Monitoring Unit issues daily decisions which may restrict burning when atmospheric conditions are not conducive to good smoke dispersion. Burning restrictions are issued for airsheds, impact zones, and specific projects. The monitoring unit is active March through November. Each Airshed Group member is also responsible for smoke management all year.

The Clean Air Act, passed in 1963 and amended in 1977, is the primary legal authority governing air resource management. The act established a process for designation of Class I and Class II areas for air quality management. Class I areas receive the highest level of protection and numerical thresholds for pollutants are most restrictive for this Class. The Gates of the Mountains Wilderness and the Anaconda-Pintler Wilderness Class 1 areas lie distantly to the northwest and west, respectively, of Yellowstone County.

All of the communities within Yellowstone County could be affected by smoke or regional haze from burning activities in the region. Montana Department of Environmental Quality maintains Air Pollution Monitoring Sites throughout Montana. The Air Pollution Monitoring program monitors all of the six criteria pollutants. Measurements are taken to assess areas where there may be a problem, and to monitor areas that already have problems. The goal of this program is to control areas where problems exist and to try to keep other areas from becoming problem air pollution areas (Louks 2001).

The Clean Air Act provides the principal framework for national, state, and local efforts to protect air quality. Under the Clean Air Act, OAQPS (Organization for Air Quality Protection Standards) is responsible for setting standards, also known as national ambient air quality standards (NAAQS), for pollutants which are considered harmful to people and the environment. OAQPS is also responsible for ensuring these air quality standards are met, or attained (in cooperation with state, Tribal, and local governments) through national standards and strategies to control pollutant emissions from automobiles, factories, and other sources (Louks 2001).

3.14.1 Fire Mitigation Practices to Maintain Air Quality

Smoke consists of dispersed airborne solids and liquid particles, called particulates, which can remain suspended in the atmosphere for a few days to several months. Particulates can reduce visibility and contribute to respiratory problems. Very small particulates can travel great distances and add to regional haze problems. Regional haze can sometimes result from multiple burn days and/or multiple owners burning within an airshed over too short a period of time to allow for dispersion.

For prescribed fires, there are three principle strategies to manage smoke and reduce air quality effects. They include:

1. **Avoidance -** This strategy relies on monitoring meteorological conditions when scheduling prescribed fires to prevent smoke from drifting into sensitive receptors, or suspending burning until favorable weather (wind) conditions exist. Sensitive receptors can be human-related (e.g. campgrounds, schools, churches, and retirement homes) or wildlife-related (threatened and endangered species and their critical habitats);
2. **Dilution –** This strategy ensures proper smoke dispersion in smoke sensitive areas by controlling the rate of smoke emissions or scheduling prescribed fires when weather systems are unstable, not under conditions when a stable high-pressure area is forming with an associated subsidence inversion. An inversion would trap smoke near the ground; and
3. **Emission Reduction –** This strategy utilizes techniques to minimize the smoke output per unit area treated. Smoke emission is affected by the number of acres burned at one time, pre-burn fuel loadings, fuel consumption, and the emission factor. Reducing the number of acres burned at one time would reduce the amount of emissions generated by that burn. Reducing the fuel beforehand reduces the amount of fuel available. Prescribed burning when fuel moistures are high can reduce fuel consumption. Emission factors can be reduced by pile burning or by using certain firing techniques such as mass ignition.

If weather conditions changed unexpectedly during a prescribed burn, and there was a potential for violating air quality standards or for adverse smoke impacts on sensitive receptors (schools, churches, hospitals, retirement homes, campgrounds, wilderness areas, and species of threatened or endangered wildlife), the management organization may implement a contingency plan, including the option for immediate suppression. Considering 1) the proposed action would result in prescribed fire on a relatively small number of acres, 2) burning as part of this mitigation plan's implementation in the County will most likely occur over a 5-year or 10-year period at a minimum, and 3) the County will adhere to Montana/Idaho Airshed Group advisories and management strategies to minimize smoke emissions, prescribed fire activities would not violate national or state emission standards and would cause very minor and temporary air quality impacts. The greatest threat to air quality would be smoke impacts on sensitive receptors; however, the relative scarcity of sensitive receptors within the County minimizes this potential air quality impact.

In studies conducted through the Interior Columbia Basin Management Project, smoke emissions were simulated across the Basin to assess relative differences among historical, current, and future management scenarios. In assessing the whole Upper Columbia Basin, there was a 43 percent reduction in smoke emissions between the historical and current periods (Quigley and Arbelbide 1997). The projected smoke emissions varied substantially with the vastly different management scenarios. The consumptive demand and passive management scenarios were projected to substantially increase smoke emissions above current levels. The active management scenarios were projected to result in a decrease of current levels.

Although prescribed fire smoke would occur more frequently than wildland fire smoke, since prescribed fires are scheduled during the year, the effects of wildland fire smoke on visibility are more acute. Prescribed fires produce less smoke than wildland fires for comparatively shorter periods, because they are conducted under weather conditions that provide for better smoke dispersion. In a study conducted by Holsapple and Snell (1996), wildland fire and prescribed fire scenarios for the Columbia Basin were modeled. In conclusion, the prescribed fire scenarios did not exceed the EPA particulate matter (PM 10) standard in a 24-hour period. Similar projections were observed for a PM 2.5 threshold. Conversely, all wildland fire scenarios exceeded air quality standards. Similar responses were reported by Huff *et al.* (1995) and Ottmar *et al.* (1996)

when they compared the effects of wildland fire to prescribed fire on air quality. The impacts of wildland fire and management ignited prescribed fire on air quality vary because of the differences in distribution of acres burned, the amount of fuel consumed per acre (due to fuel moisture differences), and the weather conditions in which typical spring and fall prescribed burns occur. This analysis reveals wildland fire impacts on air quality may be significantly greater in magnitude than emissions from prescribed burns. This may be attributable, in part, to the fact that several states within the project area have smoke management plans requiring favorable weather conditions for smoke dispersion prior to igniting wildland fires (Quigley and Arbelbide 1997).