CHAPTER 4
WATERSHED AND FLOODPLAIN CHARACTERISTICS

GEOGRAPHIC SETTING

The Ahtanum and Wide Hollow watersheds are within Yakima County, which lies east of the Cascade Range, between Mount Adams, Mt. Rainier and the Columbia River, in the south-central region of Washington State (see Figure 1-1). The watersheds stretch east from headwaters in the Cascade Mountains downstream through the cities of Yakima and Union Gap to the confluence with the Yakima River. The Ahtanum basin does not extend quite fully west to the Cascade divide. The Wide Hollow basin lies to the north and adjacent to the Ahtanum basin and its headwaters do not extend as far west into the Cascade Mountain range. The northern boundary of the basins is formed by Cowiche Mountain, and the southern boundary by Ahtanum Ridge.

Elevations range from over 6,500 feet in the mountainous portion of the watershed area to 1,000 feet in Union Gap. There are three general types of topography represented in the Ahtanum and Wide Hollow basins - mountains in the west, foothills and a dissected plateau with hollows (small valleys formed by geologic folding) in the middle sections of the watersheds, and a broad, flat expanse of floodplain /and Missoula Flood Deposits in, and adjacent to, the urban areas and the Yakima River.

The headwaters of Ahtanum Creek are high in the Cascade Mountains, and are significantly affected by the rain shadow effect of the Cascade Divide Crest, which lies 10 miles further west than the headwaters. The North Fork and South Fork of Ahtanum originate in the Cascades and meet downstream from the settlement of Tampico, to form Ahtanum Creek. Ahtanum Creek and its two distributaries - Bachelor and Hatton Creeks - flow through the middle portions the Ahtanum Valley and rejoin the creek upstream of the City of Union Gap. Ahtanum Creek enters the Yakima River just near Union Gap, upstream of the Wapato Dam. Drainage area of the watershed is approximately 173 square miles.

Wide Hollow Creek begins in the hills west of Yakima, and flows through the southwestern portion of the City of Yakima. Two tributaries, Cottonwood Creek to the south and Shaw Creek to the north, flow into Wide Hollow Creek. Wide Hollow Creek enters the Yakima River in the City of Union Gap. Drainage area of Wide Hollow Creek is approximately 78 square miles.

Spring (Chambers) Creek East is a tributary to Wide Hollow near its confluence with the Yakima River and flows through the eastern edge of the City of Union Gap. Originally a side offshoot channel of the Yakima River, Spring (Chambers) Creek East has been cut off from the Yakima by a closed floodgate under Interstate 82. Currently, Spring (Chambers) Creek East flows are derived from springs and from stormwater drainage.

Irrigation diversions and channel relocations to assist farming practices have had a significant effect on the channel forms and hydrology of Ahtanum and Wide Hollow Creeks since the latter part of the nineteenth century.

The watersheds are subject to frequent flooding due a combination of hydrology, alterations to hydrology through diversions, some from and to other watersheds, topography, man-made land form and channel alterations, and naturally occurring floodplain characteristics. Both creeks flow into the Yakima River in Union Gap.

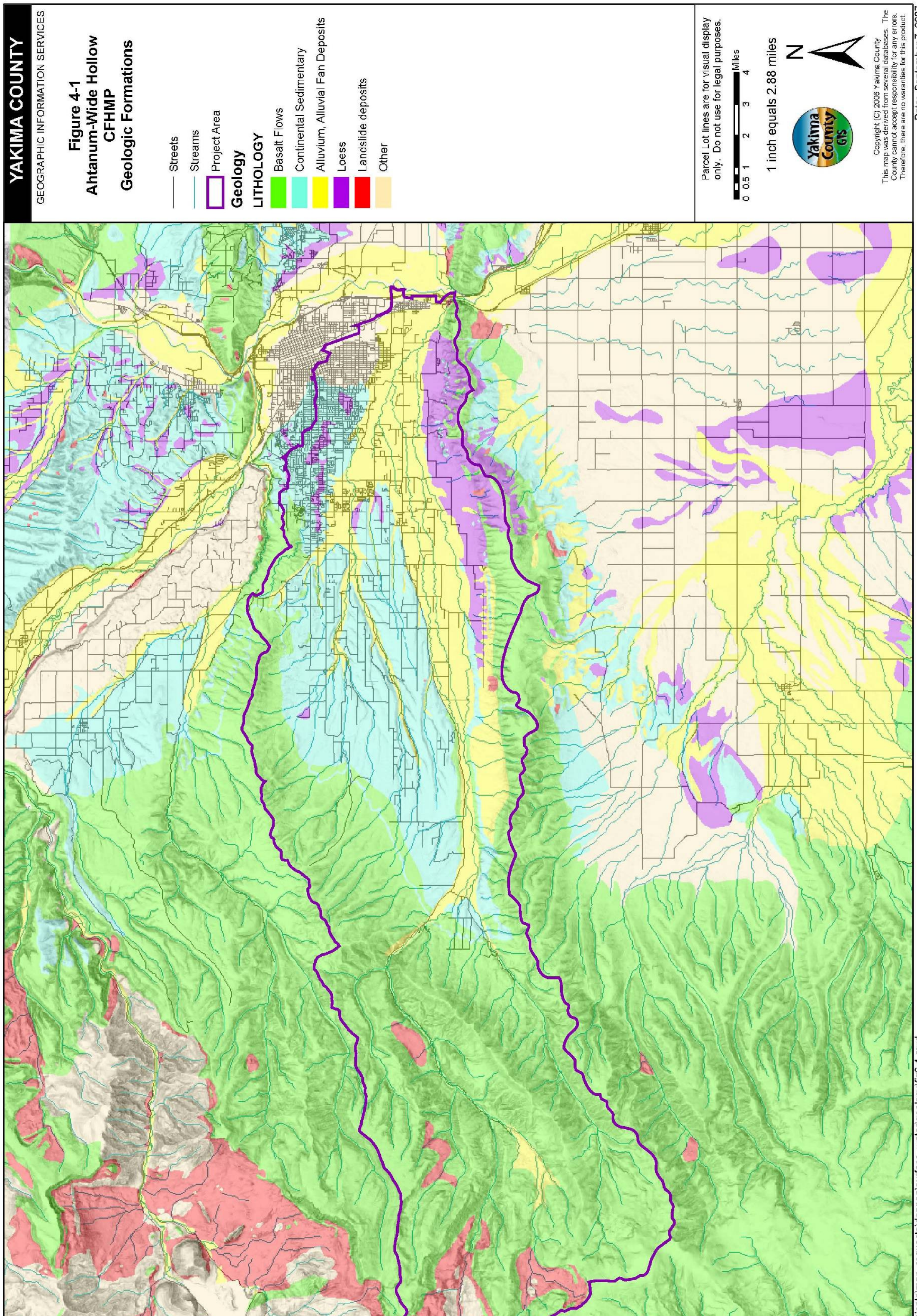
GEOLOGY

Structural Geologic Units

The Ahtanum-Wide Hollow watershed area lies within the Columbia Basin physiogeographic province, and is adjacent to the Cascades province. Two geologic formations dominate the topography in the watershed area: the Columbia River Basalt Group, and Consolidated and Unconsolidated Non-Marine Sedimentary Rocks (Figure 4-1). The Columbia River Basalt Group is a cumulative series of layers that covers 63,208 square miles in the states of Washington, Oregon, and Idaho (WA Department of Natural Resources, 2005). These basalt flows originated in a series of events from fissures in southeast Washington beginning about 15 million years ago (WA Department of Natural Resources, 2005). Geologic and volcanic activity associated with the rise of the Cascade Range resulted in large amounts of sands and gravels being deposited on top of these layers and eventual cementing of the gravel layers due to pressure and dissolved minerals, primarily caliche, to form the Ellensburg formation.

Additionally, the Columbia River Basalt group has been squeezed in a north-south direction, folding the Columbia River Basalts and the Ellensburg formation (weakly consolidated gravels) that overlies them into a series of ridges and valleys that extend along the entire Cascade Range from the Fraser River in Canada to the Columbia River. In the project area, the valley created by these dual processes of uplift and folding is called the Moxee Valley, which is drained by Ahtanum and Wide Hollow Creeks on its western extent, and also contains the Yakima River, and Moxee Creek or drain in its western extent. Ahtanum Creek has downcut through these consolidated and unconsolidated layers to form the Ahtanum Valley, which is bounded on the north by a large plateau of this Ellensburg formation, and on the south by a much less extensive area of this formation that overlays exposed basalts.

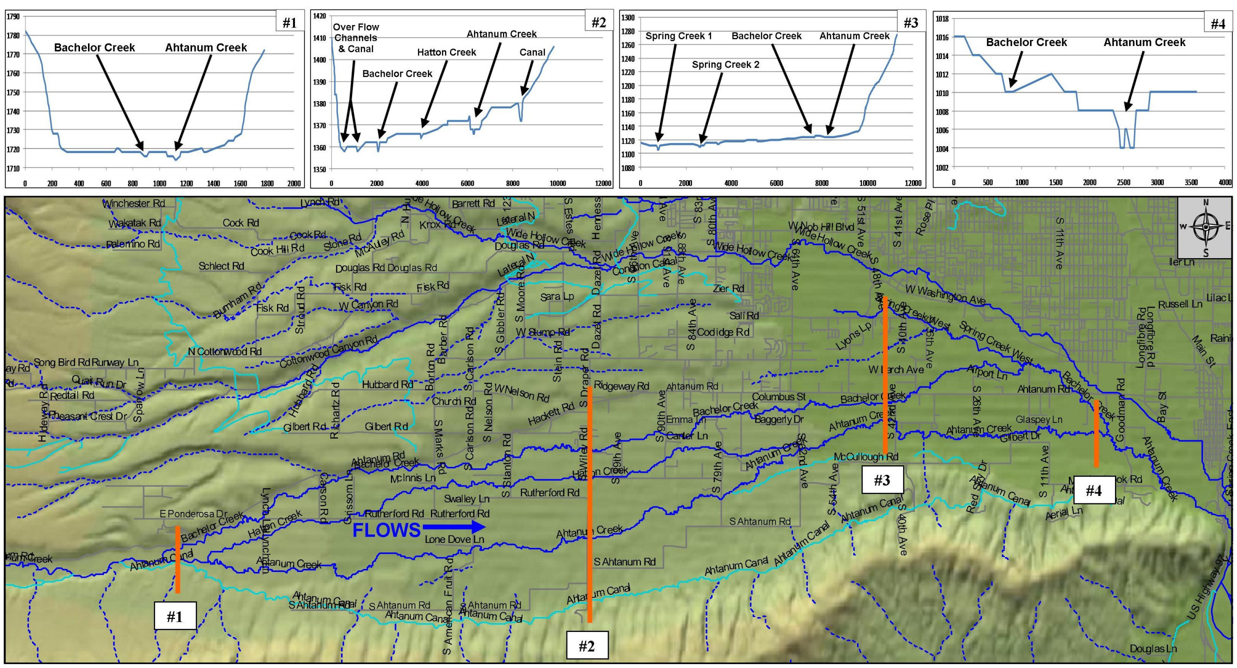
Wide Hollow Creek and its tributaries drain the foothills of the Cascade Range and flow across the Ellensburg formation plateau which lies north of Ahtanum Creek. The streams have cut wide valleys through these formations, with the Ellensburg formation forming the valley walls. These are the characteristic "Hollows" from which Wide Hollow Creek gets its name. Several of these "Hollows" also drain toward Ahtanum Creek, or its tributary, Bachelor Creek.


YAKIMA COUNTY
GEOGRAPHIC INFORMATION SERVICES
Figure 4-1
Ahtanum-Wide Hollow
CFHMP
Geologic Formations
Streets
Streams
Project Area
Geology
LITHOLOGY
Basalt Flows
Continental Sedimentary
Alluvium, Alluvial Fan Deposits
Loess
Landslide deposits
Other
Parcel Lot lines are for visual display only. Do not use for legal purposes.
0 0.5 1 2 3 4 Miles
1 inch equals 2.88 miles
N
Yakima County GIS
Copyright (C) 2006 Yakima County. This map was derived from several databases. The County cannot accept responsibility for any errors. Therefore, there are no warranties for this product.
Date: September 7, 2007
File: \\Gis-bluedog\gis_data\disk_5\projects\map_requests\donnaa\surface_water\geology\fig3-1.mxd

These processes of folding and uplift are continuing to the present day, with the northern faces of fold ridges rising faster than the southern faces, and tilting of the valley bottom between. This fold uplift also tends to warp the valley floors, contributing to the complexity of flood plains and flooding patterns.

At the Narrows on Ahtanum Creek, (shown as cross-section 1 on Figure 4-2) , soils information indicates that periodic movement of the northern and southern folds has resulted in repeated formation of a lake upstream of the Narrows through which Ahtanum Creek has repeatedly downcut (Kinneson and Sceva, 1964), even in relatively modern times. Cross sections of the entire Ahtanum Valley, based on LiDAR Flights, reveal the ongoing warping of the valley floor. Upstream of the Narrows, the floodplain is tilted toward the South. The floodplain is level at the Narrows (x-section #1), tilts downward toward the north below the Narrows (x-section #1) until the vicinity of Emma Lane, (x-section #3) where it begins to tilt back toward the south, then levels out, and then is tilted to the south again as it approaches the Yakima River (x-section #4). These changes in valley side-slope have a dominating influence on flow paths in the valley. Ahtanum Creek is not in the low point in the floodplain, overbank flows can travel long distances, and in some cases never return to Ahtanum Creek. (Figure 4-2)

Figure 4-2



SURFICIAL GEOLOGY

Most of the watershed is overlain by thin to relatively thick layers of material that have been transported by wind or water.

Beginning approximately 13,500 years ago, a series of catastrophic floods – the Missoula or Bretz Floods – repeatedly deposited sediments in the lower elevations of the Moxee Valley, generally below 1200 feet in elevation. These sediments are fine-grained silts and sands that were eroded from the "channeled scablands" (Bretz, 1923) of eastern Washington, as water from glacial Lake Missoula was released by collapse of the glacial ice dams that formed the lake. Wallula Gap, near the confluence of the Walla Walla River and the Columbia River, acted as a constriction on the large volume of water released by the flood, and formed a temporary lake – Lake Lewis – which extended across much of what is now central Washington and parts of Oregon. These events effected the current valley in two ways: 1) leaving large areas of undulating sediment deposits that effect the routing of floodwaters across the valley floors, and 2) providing a source of silt that was transported by wind to adjacent slopes (Ritzville series), some of which in turn was carried into stream channels and deposited on the floodplain as the Logy or Track soil series.

The soil series that are related to Missoula Flood Deposits are generally alkaline to highly alkaline soils, with a well developed, cemented caliche (generally a white layer composed of calcium carbonate salts) layer. This alkalinity limits the productivity of these soils for orchard crops. In many locations in the lower watershed, water tables are near the surface, which has lead to the development of wetland soils (increased amounts of organic matter and weathered clays) the intermixture of low areas and slightly higher "ridge" has resulted in large areas of mosaics of wetland and non-wetland soils in the lower Wide Hollow and Ahtanum watersheds (Figures 4-3 & 4-4).

Wind–deposited loess covers much of the watershed. This loess was deposited during glacial periods and also after the Missoula floods noted above. Deep deposits of loess and soils derived from transported loess are found on the foothills and the plateau drained by Wide Hollow Creek. Especially deep and productive soils are found in the "hollows" in this area, as well as a large silt fan that Wide Hollow Creek has formed downstream from the plateau, and in adjacent areas of the Ahtanum Valley. These relatively deep silt soils have a large water storage capacity, and can absorb large amounts (up to 7 inches) of precipitation in the upper soil layers. When these types of soils are wetted and then frozen however, they become relatively impervious to rainfall and snowmelt. Due to the soils in the lower watershed, major flood events follow a similar weather pattern – rain or snow, followed by sub freezing (usually sub-zero) temperatures, followed by snow, and turn followed by a rapid snowmelt event at all elevations in the watershed. In the upper watersheds, the layers of loess are thin or absent, and most soils there are the result of weathering in place of the native basalts, and in forested areas, volcanic ash from repeated eruptions of Cascade volcanoes, of which Mount St. Helens in 1980 is the most recent.

Figure 4-3

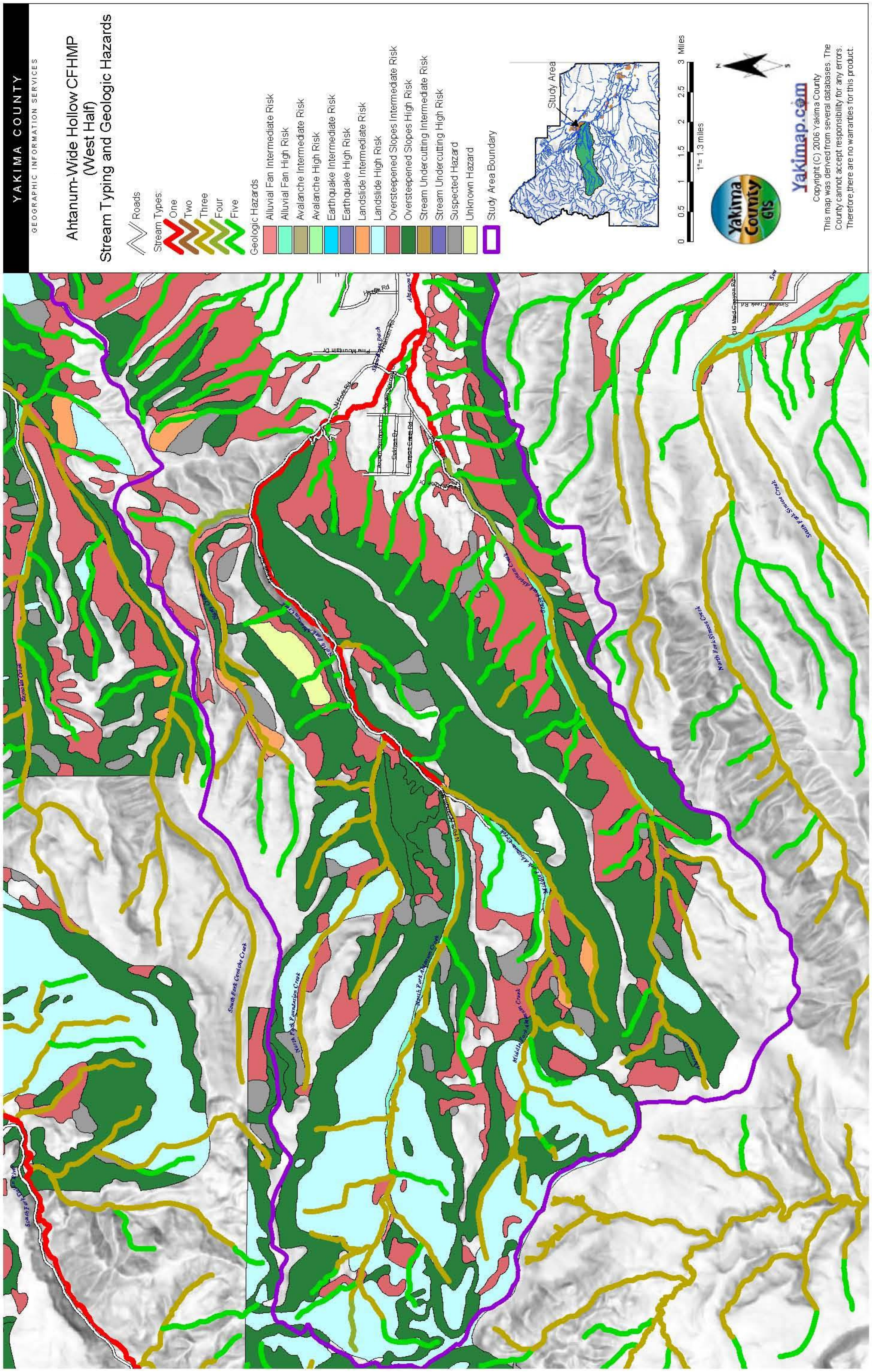
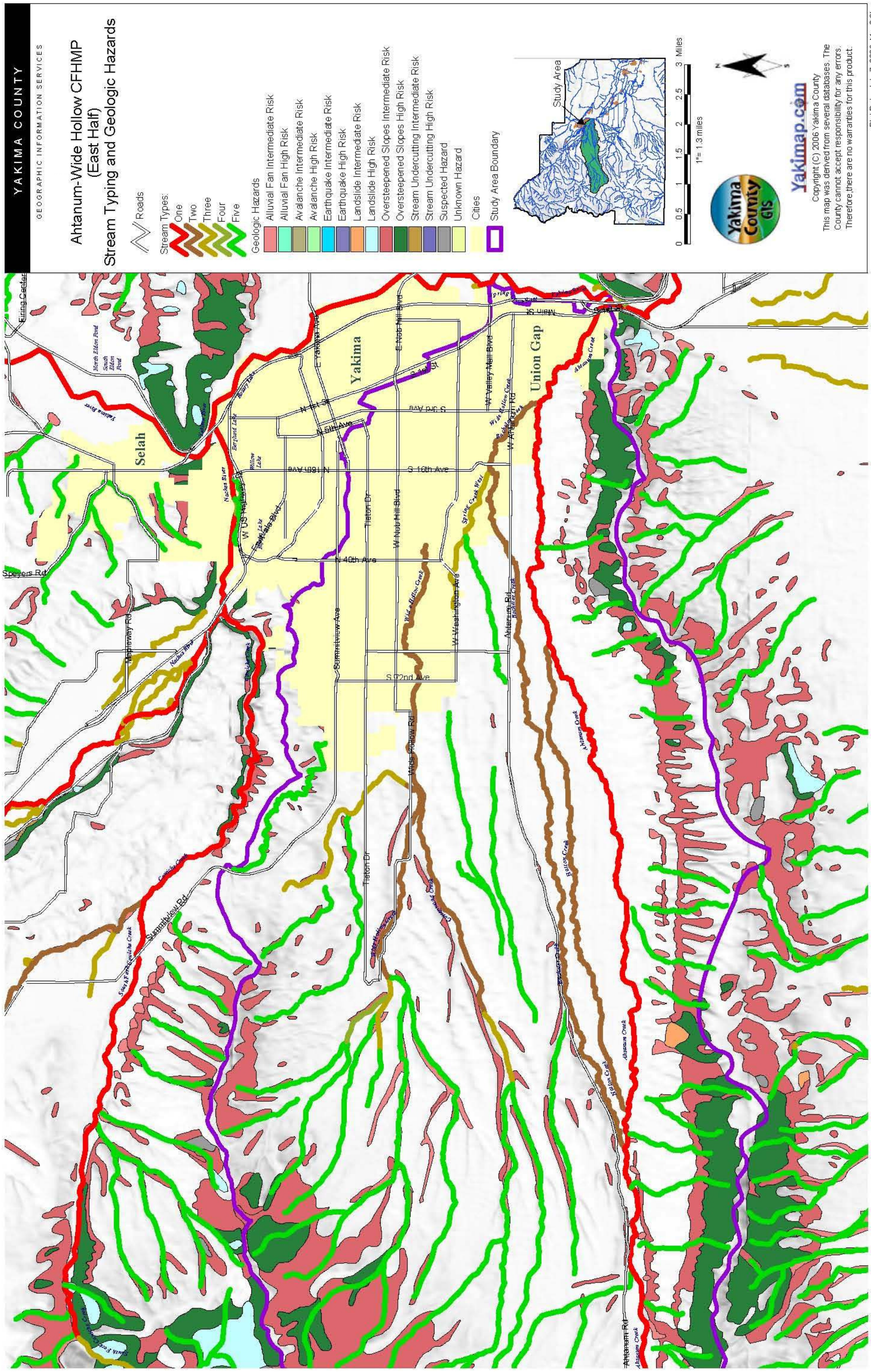

YAKIMA COUNTY
GEOGRAPHIC INFORMATION SERVICES
Ahtanum-Wide Hollow CFHMP
(West Half)
Stream Typing and Geologic Hazards
Roads
Stream Types:
One
Two
Three
Four
Five
Geologic Hazards
Alluvial Fan Intermediate Risk
Alluvial Fan High Risk
Avalanche Intermediate Risk
Avalanche High Risk
Earthquake Intermediate Risk
Earthquake High Risk
Landslide Intermediate Risk
Landslide High Risk
Oversteepened Slopes Intermediate Risk
Oversteepened Slopes High Risk
Stream Undercutting Intermediate Risk
Stream Undercutting High Risk
Suspected Hazard
Unknown Hazard
Study Area Boundary
Study Area
0 0.5 1 1.5 2 2.5 3 Miles
1"= 1.3 miles
Yakima County GIS
Yakimap.com
Copyright (C) 2006 Yakima County
This map was derived from several databases. The County cannot accept responsibility for any errors. Therefore, there are no warranties for this product.

Figure 4-4


YAKIMA COUNTY
GEOGRAPHIC INFORMATION SERVICES
Ahtanum-Wide Hollow CFHMP
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Stream Typing and Geologic Hazards
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Stream Types:
One
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Avalanche High Risk
Earthquake Intermediate Risk
Earthquake High Risk
Landslide Intermediate Risk
Landslide High Risk
Oversteepened Slopes Intermediate Risk
Oversteepened Slopes High Risk
Stream Undercutting Intermediate Risk
Stream Undercutting High Risk
Suspected Hazard
Unknown Hazard
Cities
Study Area Boundary
Study Area
0 0.5 1 1.5 2 2.5 3 Miles
1" = 1.3 miles
Yakima County GIS
Yakimap.com
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Plot Date: July 7, 2006; Map3 3b
Selah
Yakima
Union Gap
Speyers Rd
Summitview Ave
Tieton Dr
Wide Hollow Rd
W Nob Hill Blvd
W Washington Ave
Ahtanum Rd
S 72nd Ave
N 40th Ave
N 16th Ave
S 16th Ave
N 5th Ave
S 3rd Ave
N 1st St
E Nob Hill Blvd
W Valley Mall Blvd
Main St
Summitview Rd
Ahtanum Creek
Wide Hollow Creek
Cowiche Creek
Naches River
Yakima River

DRAINAGE IMPROVEMENT DISTRICTS

The high water table and the presence of caliche layers in all of these soils led to the construction of numerous artificial drainage networks leading to creeks to lower the water table, increase agricultural productivity, and allow high rates of application of irrigation water to "flush" alkalinity out of the soil profile. These systems were for the most part were constructed in the first half of the 20th century, when this area was dominated by agricultural land uses. With the expansion of the urban areas, many of these systems, especially those supported by taxing districts and known as Drainage Improvement Districts (DIDs), are now located in the cities and serve dual purpose of lowering groundwater tables and providing urban stormwater conveyance to the creeks. This has been accomplished by direct connection of storm water discharge to the DIDs. Recent investigations show that ninety-five percent of the connections are from storm water and the function is one of storm water, as farmland irrigation has effectively ceased with urban expansion. Currently there are six DIDs within the basin that discharge into Ahtanum and Wide Hollow Creeks. See Figure 4-5.

In addition, installation of buried infrastructure in these areas – such as water, sewer, or power lines - often requires the installation of permanent or temporary drainage systems, or results in the disruption or destruction of existing drainage systems.

CLIMATE

The climate in the Ahtanum area varies from desert conditions in the southern lowlands with average rainfalls of 6 inches to moist alpine conditions in the mountain headwater region. This area, like the surrounding Yakima Valley region, is shielded from winter cold-air masses moving southward from Canada by the Rocky Mountains to the east and north, and shielded from moist Pacific Ocean marine air moving eastward by the Cascade Mountain barrier to the east. This produces relatively mild winters, and warm and dry summers. Average temperatures and mean monthly precipitation is shown in Table 4-1, Figure 4-6 and Figure 4-7.

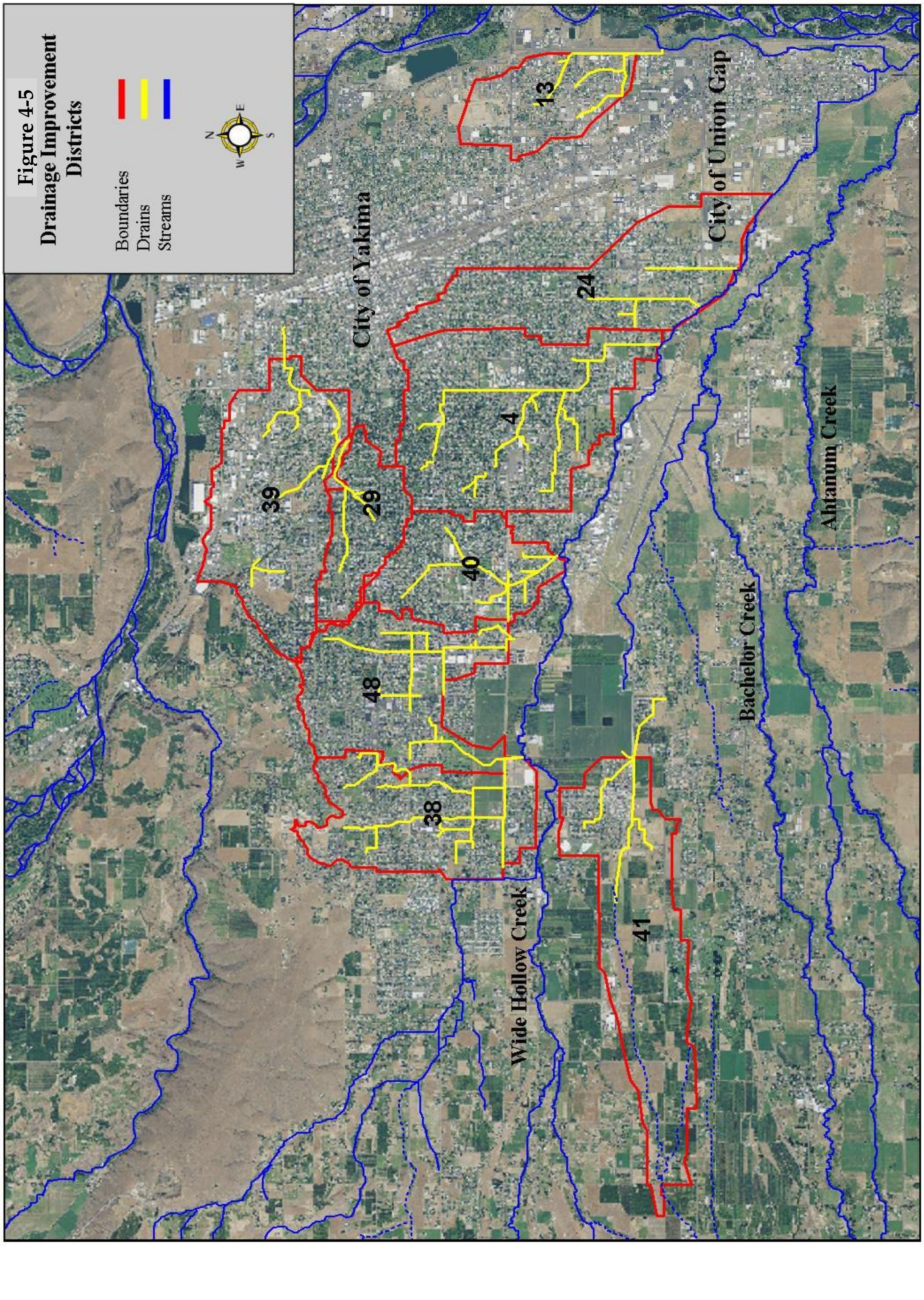


Figure 4-5
Drainage Improvement
Districts
Boundaries
Drains
Streams
N
E
S
W
City of Yakima
City of Union Gap
13
24
4
39
29
40
48
38
41
Wide Hollow Creek
Bachelor Creek
Ahtanum Creek

While winters are generally mild, in most winters several weeks to months of temperature inversions occur. These inversions keep colder, dry, dense air in the lower elevations of the watershed below approximately 3,000 feet. These conditions can effect flooding in a in the watershed in two ways. Prolonged cold temperatures generate anchor ice formation, especially in the steeper canyons which do not receive direct sunlight in the winter. In severe episodes, the entire channel may freeze, routing water flowing water onto the floodplain. If weather conditions change rapidly, breakup of this anchor ice may occur, ice jams can them form on infrastructure or natural debris. Inversions can also cause freezing of the soil profile to a considerable depth, making lower elevation soils impermeable to snowmelt or runoff. If a weather change is accompanied by snowmelt, localized severe flooding can result in specific areas of the watershed; if the change in weather is accompanied by rain-on-snow or rapid snowmelt at higher elevations, generalized flooding can be expected throughout the watershed, as was the case in the 1974 flood, which is the flood of record for this basin.

The dominant climatological factor is that both watersheds lie in the rainshadow of the Cascade Mountains. Storm systems generally move west to east across the watershed, the Cascade Crest forces these storms to rise as they come over the mountains, causing increased precipitation on the western slopes. This increased precipitation is continued for a distance of 8-10 miles on the east side of the crest as storms are still rising and losing water after the crest. Past this high precipitation band, snow and rainfall decrease rapidly. The Ahtanum and Wide Hollow watersheds are bounded on the south, west and north by another series of mountain ranges, and lie in the rain shadow of those mountains as well. The upper Ahtanum Creek watershed, which is several miles closer to the Cascade crest, can accumulate significant snowfall on the broad the ridge crests that surround the valley, particularly to the west, while Wide Hollow Creek's watershed has only limited areas that can accumulate snowfall due to the very small area in the watershed that lies at high elevation, and its relative distance further east of the Cascade crest. See Figure 4-6.

Figure 4-6

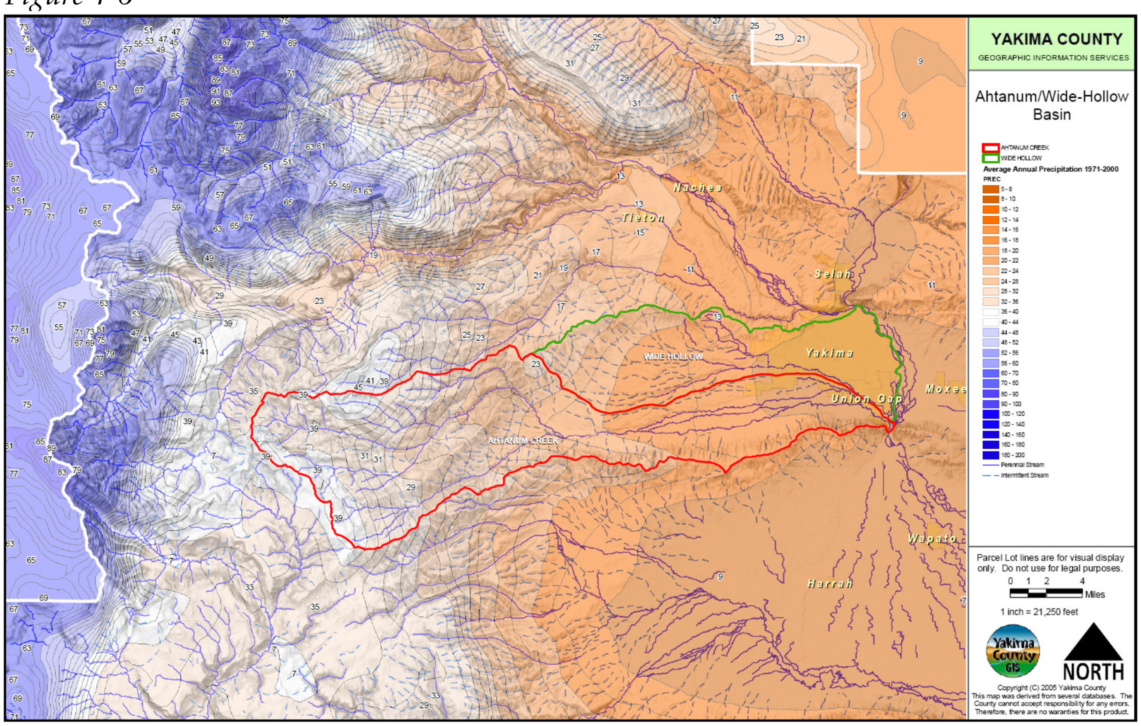


TABLE 4-1
CLIMATE DATA FOR THE YAKIMA AREA

	Temperature		Precipitation			Snowfall		
Month	Avg Daily Max (°F)	Avg Daily Min (°F)	Monthly Avg (in)	Max on Record (in)	Min on Record (in)	Monthly Avg (in)	Max on Record (in)	Min on Record (in)
January	37	20	1.23	3.66	0.09	8.21	24.20	0.20
February	46	26	0.75	2.46	0.00	3.34	16.50	0.00
March	55	30	0.69	2.63	0.01	1.56	11.50	0.00
April	64	35	0.49	1.62	0.00	0.00	0.20	0.00
May	73	42	0.50	2.76	0.03	0.00	0.00	0.00
June	80	49	0.73	2.53	0.01	0.00	0.00	0.00
July	87	53	0.16	0.71	0.00	0.00	0.00	0.00
August	86	52	0.34	2.10	0.00	0.00	0.00	0.00
September	78	44	0.38	2.07	0.00	0.00	0.00	0.00
October	64	35	0.55	2.22	0.00	0.16	2.90	0.00
November	48	28	1.04	2.83	0.00	2.46	21.20	0.00
December	38	22	1.24	4.19	0.07	8.76	50.00	0.00
Annual	63	36	8.07	13.22	4.18	23.59	56.10	1.50

SOURCE: EarthInfo 1994 (National Weather Station 9465 for period 1946-1993).

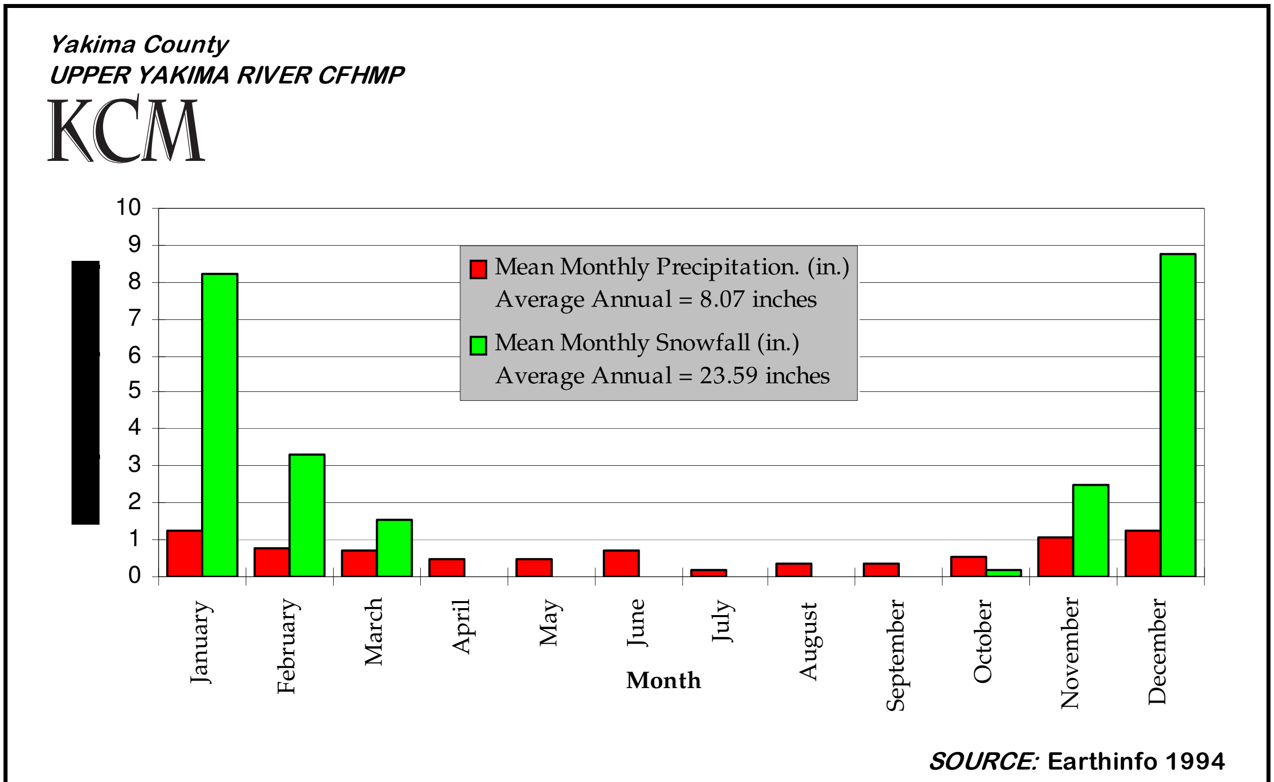


FIGURE 4-7

MEAN MONTHLY PRECIPITATION IN YAKIMA

Figure 4-7. Mean Monthly Precipitation in Yakima (Source: Naches CFHMP)

Annual Flow Patterns in the Ahtanum and Wide Hollow Watershed

Ahtanum Basin

Streamflows in the upper watershed respond typically to variations in snowpack and rainfall (see Figure 4-7). Long-term and seasonal hydrograph responses from the upper watershed do not suggest that significant hydrologic changes have occurred since streamflow data became available in 1913. Flows from the upper watershed in the range of 350 to 400 cfs (see figure 4-8) have been identified as "channel forming" (i.e. a 2 year flow). Natural low flows typically range from 20 to 25 cfs, but are further reduced by irrigation diversion.

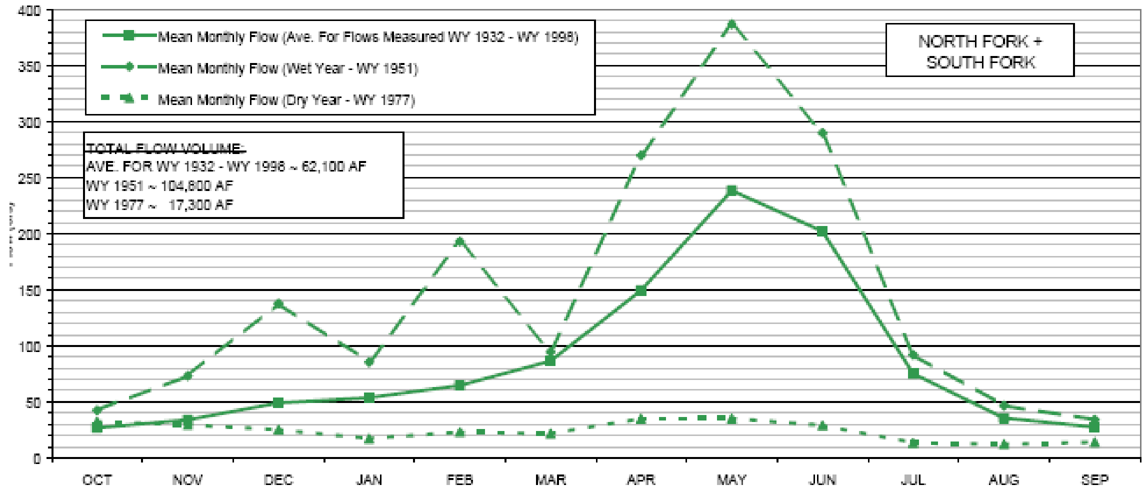


Figure 4-8 – Combined Wet, Average and Dry Year Streamflows for Ahtanum Creek North and South Forks (without irrigation diversion). Source: Ahtanum Creek Watershed Restoration Program EIS, Ecology, 2005

Streamflow data in the middle portion of the watershed is very limited. There has never been a continuous record of streamflows over a full hydrologic year in this portion of the watershed. With the exception of intermittent spot measurements, historical flow conditions are largely unknown. Routine streamflow measurements have been initiated at various gage sites monitored by the Yakama Nation since 2001. The most complete record is at Carson Road and at American Fruit Road, below both the Ahtanum Irrigation District and upper WIP diversions. The effect of diversions from the AID and WIP canals is clearly shown in the hydrograph at Carson Road.

In the lower watershed, this pattern of lower summer flows in continued, but is somewhat modified by the regional water table of the Moxee Valley. From its confluence with the Yakima River to a point approximately five miles upstream (between 42nd and 62nd Avenues) the river and water table are affected by the flow patterns of the Yakima River. The flow patterns of the Yakima River have been modified by the irrigation storage dams, and flows remain high throughout the summer. As Ahtanum Creek approaches the Yakima River, summer flows in the Ahtanum (and Bachelor) generally increase, due to influence from the water table of the Yakima River and also tributary inputs from Spring and Bachelor Creeks, both of which are also fed by the local water table.

Irrigation influences on the hydrology of Ahtanum Creek.
The first stream diversion for irrigation in the Yakima Valley was constructed by Yakama Chief Kamiakin in the mid-1800s, near what is now Slavin Road, upstream of the St. Joseph's Mission. After the establishment of the Mission in 1852, the Catholic priests also constructed an irrigation system for their garden ("Saint Joseph's Mission at Ahtanum Creek is founded in the Yakima Valley on April 3, 1852." historylink.org).

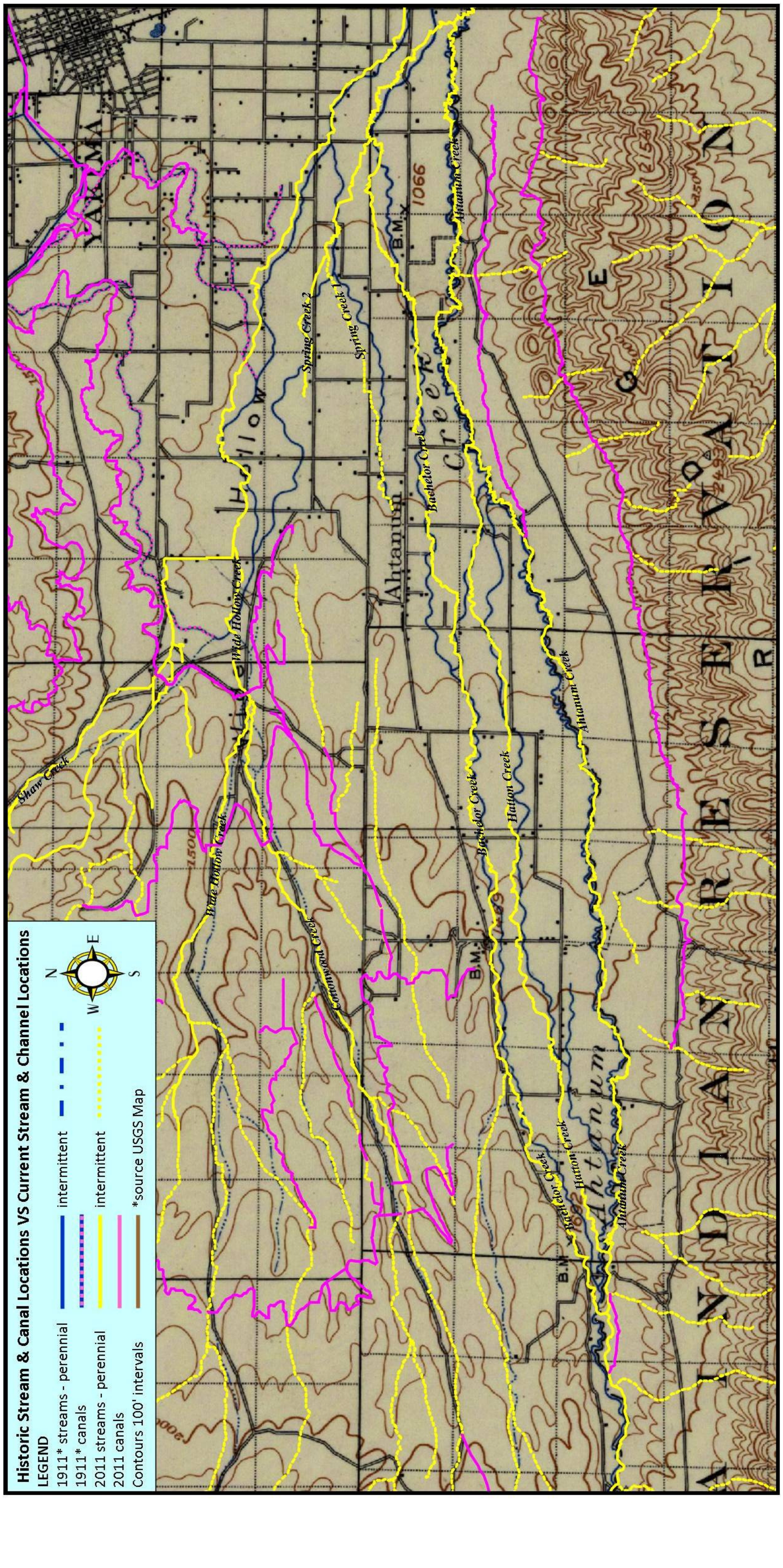
Currently, there are two diversions near the Ahtanum Mission property. The Upper Wapato Irrigation Project (WIP) diversion diverts water into the WIP canal, which is managed by the

Yakama Nation/Bureau of Indian Affairs. The WIP canal follows the contours of Ahtanum ridge, and supplies water to farms on the south side of Ahtanum Creek on the Yakama Reservation. The Bachelor Creek diversion, managed by the Ahtanum Irrigation District (AID), diverts water into Bachelor Creek which supplies water to farms north of Ahtanum Creek. Just downstream from the Bachelor diversion, Hatton Creek separates from the mainstem of Ahtanum Creek. Thus, Ahtanum, Bachelor, and Hatton continue downstream in three branches. During flood events, these creeks become active flood channels of Ahtanum Creek. Hatton Creek rejoins Ahtanum Creek at 62nd Avenue eight miles downstream from the Mission. Bachelor Creek returns near Goodman Road, fourteen miles downstream and only 2 miles from the Yakima River. Bachelor Creek also has a considerable watershed of its own which on the North Side of the Ahtanum Valley and a portion of the foothills. The stream changes in location since 1911 can be seen on Figure 4-9.

Prior to the 1960s the AID diverted water year-round, for irrigation during the spring, summer and fall, and stockwater in the winter. Anecdotal evidence indicates that Ahtanum Creek routinely was dry below the diversions during the summer. After 1964, pursuant to a lawsuit filed by the United States on behalf of the Yakama Indian Nation, and referred to as the Pope decree, AID was required to cease diversion after July 10 in any given year, and resumes diversion in late October. All irrigation diversions after July 10 are reserved for the Wapato Irrigation Project for use on the Reservation; prior to July 10th 25% of the available flow is reserved for use by the WIP. Low flows are still prevalent in the early summer, but recent changes in diversion amounts by the WIP have improved summer streamflow after July 10. Since 2001, a continuous flowing reach has been established below the diversions after July 10, with flows on the order of 8 to 10 cfs (Ahtanum Assessment Executive Summary, 2004).

Bachelor and Hatton Creeks are used as irrigation conveyance by the AID and other water users. Flow in these creeks is reduced or eliminated after July 10 as described above. Beginning in October in most years, irrigation delivery resumes in these systems, and continues throughout the winter. This lowers the flows in Ahtanum Creek for much of the year, and also results in "charging" of the surficial aquifer in the Ahtanum Valley via leakage from these conveyances. Flooding patterns are likely altered by this practice since in most years very little available water storage capacity is available in the soil profile of the lower valley, and during inversions, the lower valley soil profile can freeze to a significant depth, increasing runoff generated by rain or rain-on-snow events. Spring Creek West, near the Yakima Airport, is a stream fed by natural spring water, and poses a flood risk to areas around the Yakima Air Terminal. The 1911 USGS mapping shows that the headwaters of Spring Creek West previously contained an intermittent channel, which has been removed through farming practices.

Figure 4-9


Historic Stream & Canal Locations VS Current Stream & Channel Locations
LEGEND
1911* streams - perennial
intermittent
1911* canals
2011 streams - perennial
intermittent
2011 canals
Contours 100' intervals
*source USGS Map
N
E
S
W
Shaw Creek
Wide Hollow Creek
Spring Creek 2
Spring Creek 1
Bachelor Creek
Hatton Creek
Ahtanum Creek
Cottonwood Creek
Ahtanum
YAKIMA

Irrigation influences on the hydrology of Wide Hollow Basin

The natural hydrograph of Wide Hollow Creek was likely very flashy above 48th Avenue (almost the midpoint of the watershed) and stable below that point to its confluence with the Yakima. The upper watershed hydrology is driven by snowmelt runoff, and usually a peak runoff occurs in early May most years, lasting a week or less. Natural flow continues in the upper watershed until June or early July in most years, and discontinues after that. In the lower watershed, a series of natural springs and high water tables drain cool clear water to the creek, exhibiting very little variation in flow (approximately 7 cfs) through the winter, based on limited flow sampling by Yakima County Surface Water Division.

Except for the headwaters of the creek that drain the foothills, the natural hydrograph has been dramatically altered. Wide Hollow Creek is used as a conveyance for irrigation water and receives a relatively large amount of irrigation "spill" during the irrigation season. This additional flow results in an "inverted" hydrologic cycle. This means that during times of year when the flow would naturally be low, such as in the summer, it is actually high. This is most severe below the Congdon Ditch input, which is currently located upstream of 96th Avenue, but most of the tributary streams to Wide Hollow also exhibit inverted hydrographs.

The introduction of the Congdon Ditch in 1906 was a dramatic alteration to the basin drainage in that it brought Naches River flows to the upper watershed and preceded major channel realignments within the basin. This ditch was reworked several times between then and 1918. The 1911 USGS map of the basin shown in Figure 4-10, shows the initial alignment that tailed out into the Shaw Creek and Wide Hollow Creek confluence located approximately mid-way between the future alignments of Wide Hollow and Tieton Roads. The map also shows the current stream locations and the significant realignments of the Wide Hollow and Shaw Creek channels made to enhance agricultural benefits. Figure 4-11 shows the irrigation ditches in place in 1947 after Shaw Creek and Wide Hollow creeks had been moved. The early map shows many cases where channels have disappeared or been moved to valley walls, such as Shaw Creek at the former confluence with Wide Hollow and Wide Hollow Creek just upstream of the airport. Spring Creek upstream of the Airport has been filled in and presumably replaced by field tiles. Although this facilitates flood irrigation it creates significant flood hazard for existing and future urbanization.

The Yakima-Tieton Irrigation District, the Yakima Valley Canal Company (Congdon Ditch) and various other small districts supply irrigation water to residents in the Wide Hollow Watershed. The Yakima-Tieton serves the upper portions of the watershed. Prior to the 1980's, all of the upper tributary streams in the Wide Hollow drainage were used as irrigation conveyance by the Yakima-Tieton, now they only carry relatively small volumes of stock water to specific parcels. With the almost total conversion of the Naches-Tieton to a piped delivery system in the early 1980s, these tributaries are no longer major components of the irrigation delivery system. However, these streams were altered when they were integral to irrigation delivery,

Figure 4-10

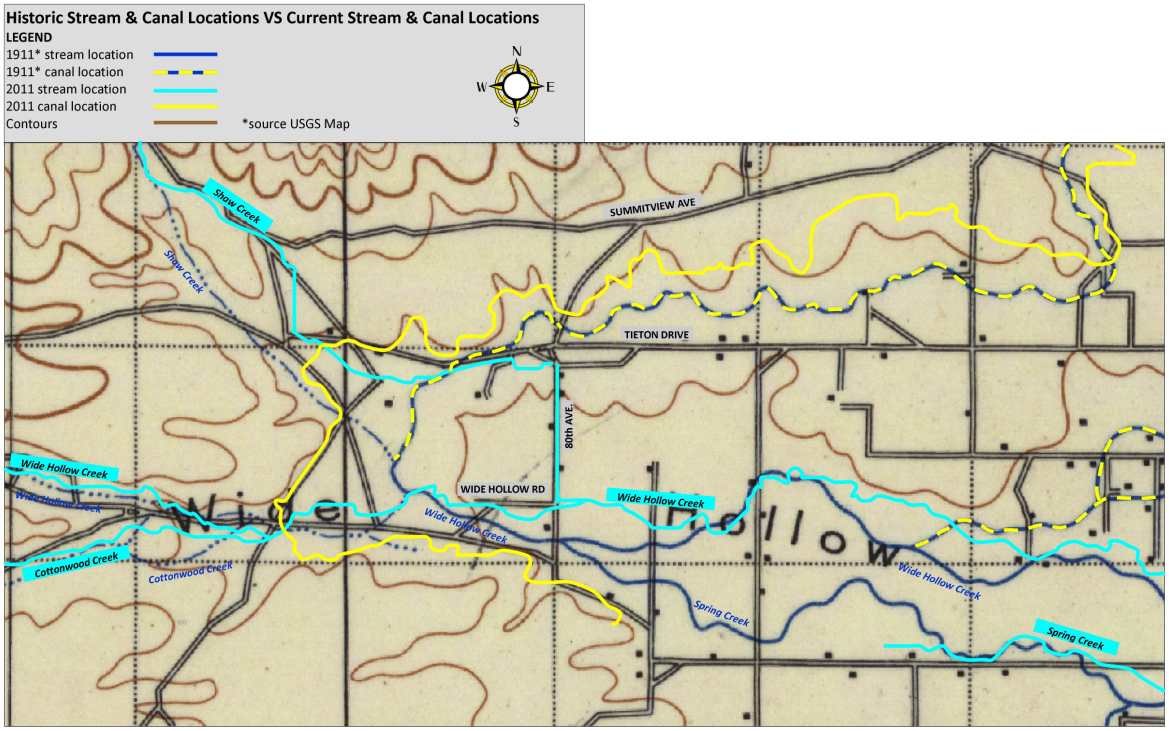
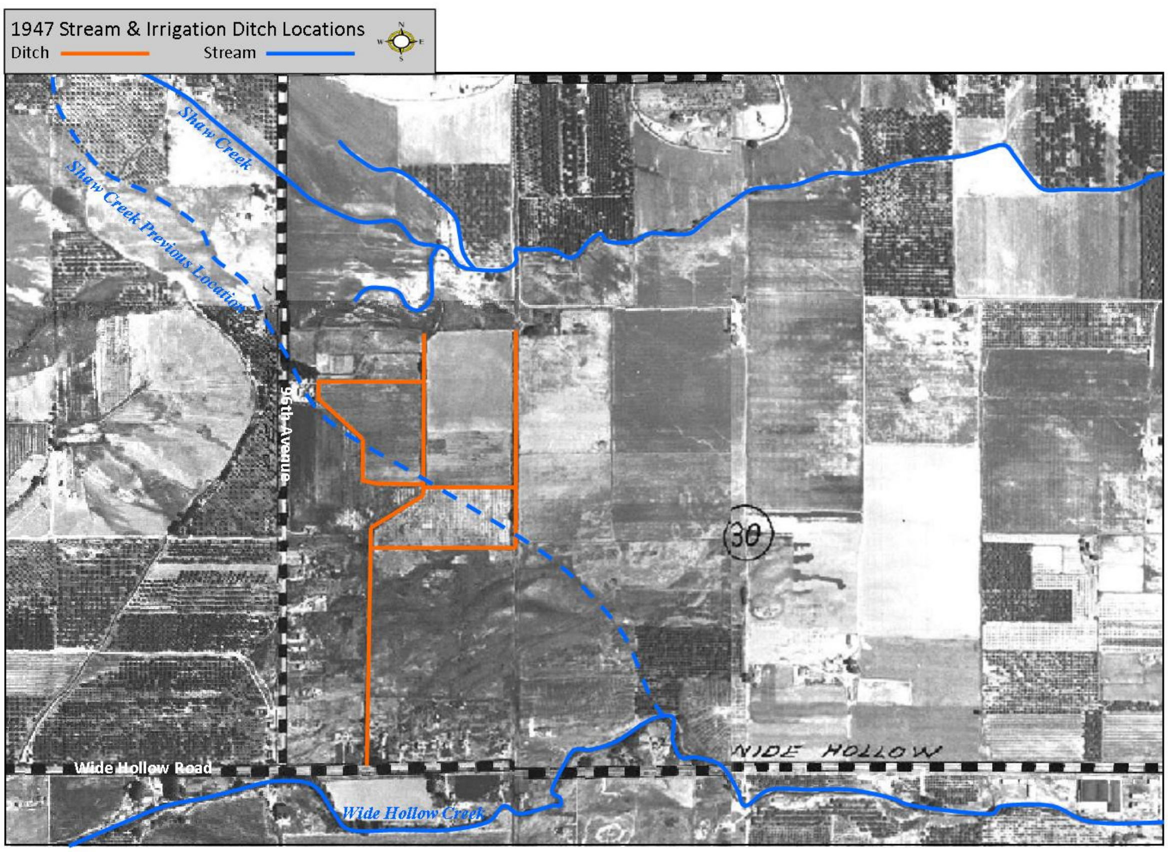


Figure 4-11



and they have not been restored to their former channel shape, location or function. Currently many of these streams are "perched" in their floodplains (i.e. on the highest spot in the valley floor) to allow more efficient delivery of irrigation water, even though these channels are no longer used for irrigation delivery. These perched channels can pose significant flood hazard during flood events due to their position on the floodplain and the loss of natural channel form and processes combined with cessation of channel maintenance for irrigation conveyance.

An example of these altered tributary systems is Cottonwood Creek, a tributary to Wide Hollow Creek, which follows a canyon to its confluence with Wide Hollow Creek. Much of Cottonwood Creek is aligned along the south side of the valley and slightly perched to allow farming and delivery of irrigation water to the canyon floodplain. Also Shaw Creek is a small stream, which has been altered into a roadside ditch as it approaches Wide Hollow Creek, near West Valley Park. Shaw creek is prone to sheet flooding from snow melt events. Sheet flooding also occurs in upper Wide Hollow Creek itself, above its confluence with Cottonwood Canyon Creek.

Spring (Chambers) Creek East, in Union Gap, is a side channel of the Yakima River, which has been cut off from the Yakima River by I-82. Water from Spring (Chambers) Creek is used for irrigation. Water still enters the creek through springs, drainage systems and stormwater runoff. It is also prone to backwater flooding effects from the Yakima River. The current configuration is fed by groundwater drains and has extremely stable flow pattern throughout the year.

STREAM CHANNEL AND FLOODPLAIN MORPHOLOGY

The interaction of hydrology and climate over time with geologic processes and surficial geology determines the dynamic riverine topographic features in an ongoing process referred to as fluvial geomorphology. This interaction, along with agricultural interventions, defines the present- day features and flow tendencies during floods in the Ahtanum and Wide Hollow basins. These geomorphic processes can be locally altered by human actions, which may change flooding patterns. The natural and human-caused stream and floodplain geomorphic processes drive flood conditions (depth, velocity, duration) of floods.

Ahtanum Creek

North and South Fork Ahtanum Creek – These stream channels are generally in narrow canyons which follow geologic fault lines in the Columbia Basin Basalts. Stream gradients are fairly steep, most in excess of 2.5% gradient. The majority of the streams are very confined in their channels, but small areas of forested floodplain do exist, and are increasingly being subdivided and used for vacation or retirement homes. The combination of steep gradients, confined valleys, and naturally high rates of sediment supply result in stream channels that have high availability of coarse and fine sediments, and high levels of energy to transport sediments, woody debris, and erode banks. The channels themselves generally maintain a single thread with limited side channel development. Channel pattern is generally sinuous, migration of the channel does occur in the forested floodplains, but rapid channel migration is relatively rare.

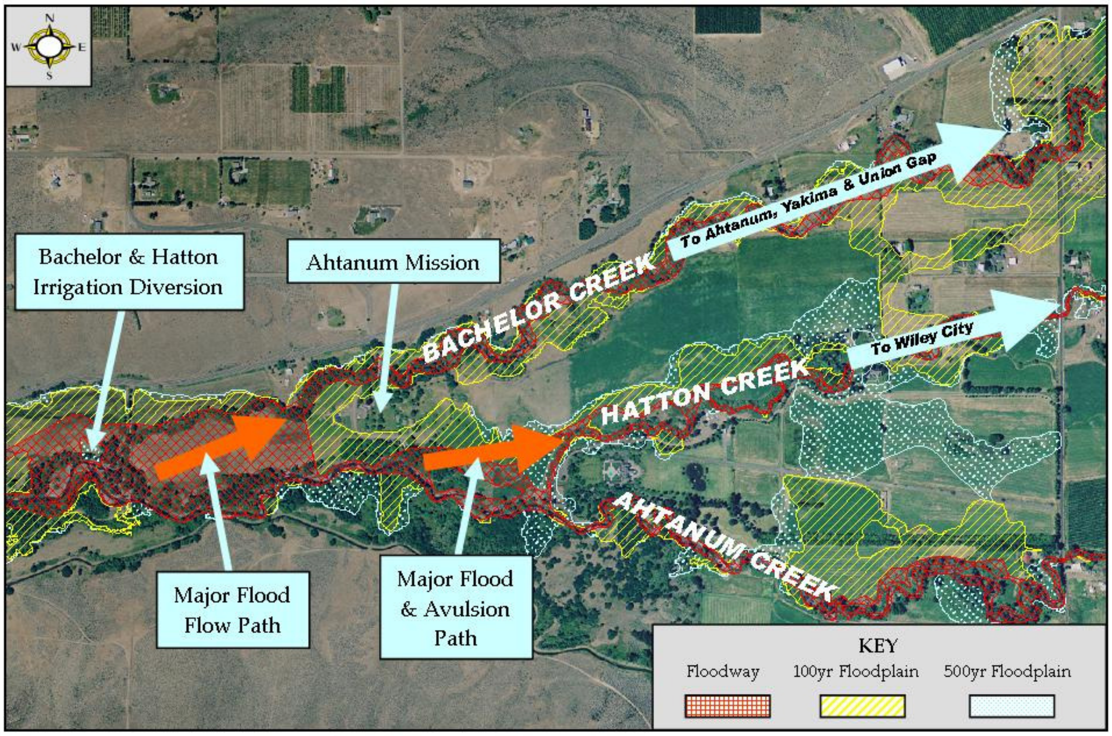
Alluvial Fans and Ahtanum above the Narrows – Where both the North Fork and South Fork Ahtanum leave the confined mountain valleys and enter the larger Moxee Valley, they have created large alluvial fans. Both streams are naturally unstable in the upper portions of these areas due to the large amounts of coarse sediments that are deposited in this location. Farther along the fans, there are several old relict channels which have been occupied by these streams in relatively recent times. Downstream of the fans, Ahtanum Creek lies on a broad floodplain with a gradient of approximately 1.8%. The channels, floodplain, and the fans above them are mostly composed of boulders and gravels. The channels on the floodplain and on the fans are subject to periodic episodes of rapid channel migration.

The Narrows on Ahtanum Creek – The Narrows is formed by the close proximity of two "folds" of Columbia Basalts that lie exposed at the surface, which form a geologic "nick point" between the upper Ahtanum Valley and the remainder of the Valley. Typical of these nick points, the stream on the upper end has developed side channels and a water table near the surface. In the narrowest portion of the valley, channel and floodplain gradients are steep, and the stream has high energy for erosion, but a relatively low coarse sediment load, channel migration can be expected to be rapid under these conditions.

The Ahtanum Mission – Below the Narrows, the floodplain broadens, and this area is a major depositional zone for finer silts transported from the upper watershed. The channel is generally sinuous and single thread, and somewhat incised in the floodplain. The two distributaries of Ahtanum Creek exit from the channel in this location. Bachelor Creek is currently used as an irrigation conveyance, and is fed by the Ahtanum Irrigation District diversion located just upstream from the Mission. Bachelor Creek flows along the northern valley wall, Ahtanum Creek the southern wall. Based on the types of soils and the stream landforms in the area, and reports of the early settlement of the mission, Bachelor Creek was probably a natural side channel of Ahtanum Creek. See Figure 4-12

Hatton Creek, which formerly was fed by a diversion directly from Ahtanum Creek, was probably also a natural side channel and its "natural" exit from Ahtanum lies in the low point of the floodplain between Bachelor and Ahtanum Creeks. Given the generally level topography in the floodplain, the potential for avulsion or other rapid channel movement at this location is high. Records do not indicate that such avulsions have occurred since establishment of the Mission in 1853, and for much of that time irrigation diversions and control structures have been in place. The man made works and their maintenance at this location have likely effected the likelihood of avulsion, although recent avulsion threats have increased and required intervention.

Figure 4-12 The Ahtanum Mission Flow Diversion



Ahtanum from the Mission to the confluence with Yakima River – Below the Mission the creek flows through stream deposited sediments for several miles, then through Missoula flood deposits. The channel itself is similar in both areas – slightly incised, sinuous and fairly stable, with the exception of the Emma Lane / 42nd Avenue area, where the channel is perched to the north within its floodplain. The upper portion, above Wiley Road typically has a wider floodplain and numerous relict channels are present. In the Missoula flood deposits, the floodplain is much narrower and the channel even more stable, probably as a result of the strong caliche layer which makes these sediment deposits somewhat resistant to lateral erosion. Near the confluence with the Yakima River, upstream to the vicinity of Fulbright Park, the geomorphic floodplain of Ahtanum Creek meets the geomorphic floodplain of the Yakima River, and widens dramatically. With the construction of Interstate 82 in the early 1970s the mouth of Ahtanum Creek altered, and now enters the Yakima River approximately ½ mile downstream of its "natural" confluence.

Wide Hollow Creek

The upper reaches of Wide Hollow Creek occur on the slopes of Pine and Cowiche Mountains. There is very little forest cover on the upper watershed, but there are large areas of medium elevation that can be prone to rain on snow events. In most years, there is some snowpack in the watershed that usually drains off in less than a week during early to mid-May.

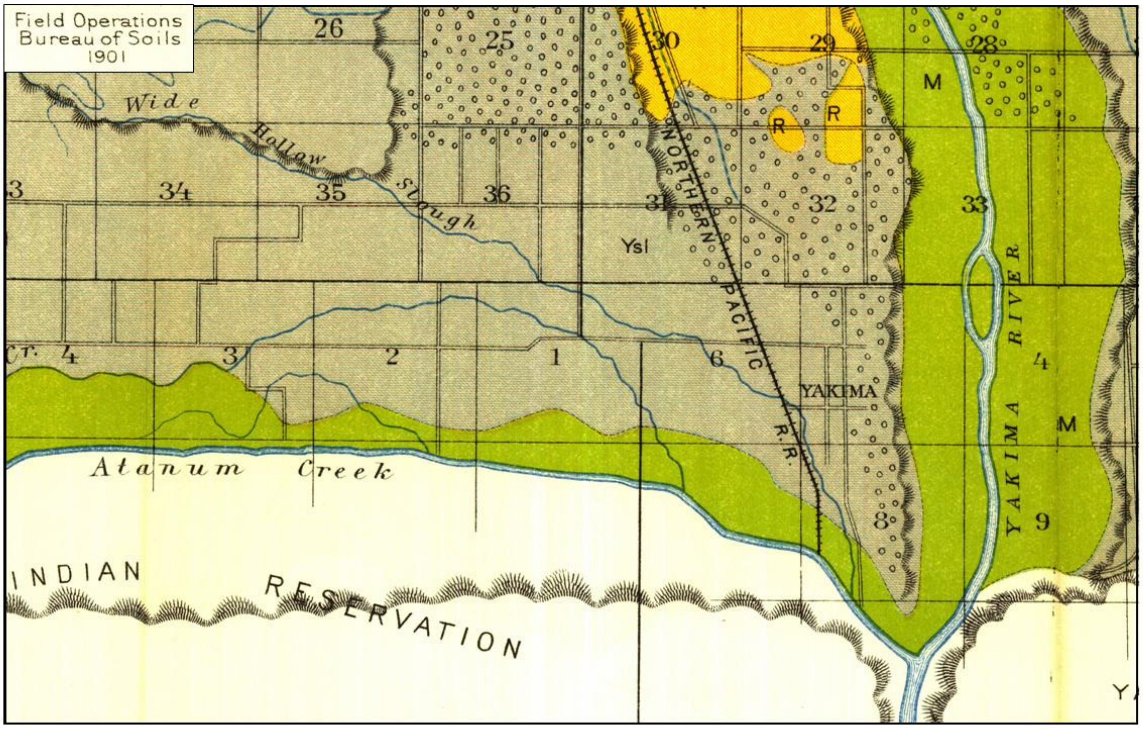
Below the foothills, the watershed is composed of a dissected plateau of the Ellensburg and Thorp formations, which are weakly cemented gravels. The streams have cut valleys into this material. Generally these valleys have a relatively broad floodplain for the small stream size (floodplain width of 25 times channel width), or in many cases, a floodplain has been formed where there is little to no evidence of a current stream channel. These valleys are locally termed "hollows", from which Wide Hollow Creek gets its name. Side slopes on these "hollows" are generally somewhat steep, 30 to 50% or more. The stream channels in this area are generally low gradient, have low banks, and are composed of large gravels derived from the Ellensburg formation, adjacent floodplains are shallow silts over these same gravels. Flood flows during rain-on-snow events, especially when the soil profile is frozen, often occupy the entire floodplain, even in areas without a defined channel.

Downstream of the Plateau, the creek enters the broad bottom of the Moxee valley. From approximately 80th Avenue until 40th Avenue, the stream crosses a large alluvial fan composed of stream deposited silts; these soils are some of the most productive agricultural soils in the valley, but are now mostly being converted to residential and other urban uses. The many channels changes made to accommodate agricultural practices and irrigations were mentioned above and noted on Figure 4-8. The stream channel is fairly stable in this reach, has moderate sinuosity and is slightly incised.

Beginning at 48th Avenue, Wide Hollow Creek changes dramatically. At this location the creek receives groundwater input from springs, and also several Drainage Improvement District Drains that discharge directly to the Creek. Also at this location, the creek enters Missoula Flood Deposits. The stream channel (where it has not been straightened) is sinuous, slightly incised, with excellent vegetation on the bank. In several locations in this reach, the channel has been straightened and or armored. Straightening and armoring of the channel was usually done to increase agricultural land area, or align the creek on property lines. Straightening of the channel will usually result in channel downcutting and bank erosion (hence the armoring) during flood events. Straightened channel generally will tend to attempt to reform to a meandering channel, and therefore must be maintained over time. Once maintenance ceases (such as when an agricultural field is converted to residential or commercial use) these types of channels can change dramatically during flood events. As the creek crosses the airport it is severely incised with eroding and unstable banks, and again along Pioneer Lane in Union Gap it has been armored. Downstream there is yet another straightened reach through the Ahtanum Business Park.

Below Bay Street in Union Gap, there is a small reach of natural channel, and then below that the creek has been straightened through Union Gap until its confluence with the Yakima River. There is some debate whether the current creak is near its natural location, or used to flow into Ahtanum Creek. A reference showing Wide Hollow Creek flowing into Ahtanum Creek is a U.S. Department of Agriculture soils map from 1901 (Figure 4-13). One of the original purposes of the straightening of the creek was to serve a grist mill currently located on Main Street in Union Gap. As the creek approaches the Yakima River, it crosses several terraces, the Mill is located on the edge of the highest terrace and the fall generated at this location ran the water wheel. Original surveys show the presence of a creek below the terrace at this location, but no mention is made of Wide Hollow creek in any of the original surveys (1860s through 1890s) in this location. Due to the presence of a dam at the location of the mill, these straightened channels are artificially "perched" and lack flood conveyance capacity, resulting in repeated flood damage to adjacent businesses and homes.

Figure 4-13 1901 U.S. Department of Soils Map



FISHERIES AND WILDLIFE

According to the Ahtanum Creek Watershed Assessment, Ahtanum Creek provides potentially important habitat for Endangered Species Act (ESA)-listed summer steelhead (*Oncorhynchus mykiss*) and bull trout (*Salvelinus confluentus*) as well as coho (*Oncorhynchus kisutch*), spring chinook (*Oncorhynchus tschawytscha*) and a number of resident fish species. Bull Trout, Coho, and steelhead spawn and rear in Ahtanum Creek and spring chinook use the lower portion for rearing (Ahtanum Creek Watershed Assessment, 2004).

The 2004 Yakima Subbasin Plan identified four focal fish species as bearing ecological significance. These include spring chinook, fall chinook, steelhead / rainbow trout, and bull trout.

A significant portion of Wide Hollow Creek is fed by groundwater, which could provide good to excellent water quality for salmonids spawning and rearing. At the grist mill, near the mouth of Wide Hollow Creek, the dam that provides head to turn the mill wheel has been fitted with an Alaska Steep Pass fishway, which theoretically provides passage for adult salmonids, but not for juvenile or small resident fish. Passage at this facility by adults can be problematic as well as the ladder only operates efficiently at a relatively narrow range of flows or water surface elevations. Consequently, the use of Wide Hollow Creek for spawning and rearing by native anadromous or migratory species, such as steelhead or bull trout, is limited.

Spring Chinook

Spring chinooks are listed as threatened under the Endangered Species Act (ESA). Spring chinook return to the watershed in the spring at the average age of four, and spawn in late summer or fall. They are known to have historically spawned in Ahtanum Creek. Changes in flow regime since the 1940s have reduced summer flows needed for this species to hold (wait over the summer) prior to spawning in the fall. Current use of Ahtanum Creek is limited to rearing and migration in the lower portion of Ahtanum Creek (Yakima Subbasin Summary, 2001).

Steelhead/Rainbow Trout

Steelhead/Rainbow trout are listed as threatened under the ESA. Steelhead are anadromous, while rainbow remain in fresh water for their lifespan. However, the two interbreed, and offspring can be either anadromous or resident (Yakima Subbasin Plan, 2004). Historically, steelhead spawned in Ahtanum and Bachelor Creeks. Currently, steelhead are known to spawn in Ahtanum Creek, and their presence has been documented in Ahtanum, Bachelor, and Wide Hollow Creeks. Surveys conducted by the Yakama Nation between 1999 and 2003 suggest that steelhead spawning is increasing in Ahtanum Creek (Yakima Subbasin Plan, 2004).

According to the Ahtanum Assessment (2004), "Most fisheries overview studies, such as the Washington Conservation Commission Limiting Factors Analysis (Haring, 2001), have indicated that Ahtanum Creek would be a significant steelhead producer if habitat conditions and passage barriers (including barriers resulting from diversion of streamflows) were improved" (Ahtanum Assessment, 2004).

Bull Trout

Bull trout are listed as threatened under the ESA. The species is known for variability and adaptability to local conditions. They can be either migratory or resident (Yakima Subbasin Plan, 2004). Historic data for bull trout is sparse. The Washington State Salmonid Stock Inventory (1998) identified Rimrock Lake as having the only stable population of bull trout in the Yakima Subbasin. However, bull trout adults and spawning have been documented in Ahtanum Creek, in both the North and South Forks (Yakima Subbasin Plan, 2004).

Other Salmon Species

Fall chinooks are not listed under the ESA, and are not known to have spawned in the Ahtanum or Wide Hollow watersheds.

Coho salmon reproduce in the Yakima and Naches Rivers, largely as a result of reintroduction program for this species sponsored by the Yakama Nation. Ahtanum Creek does support spawning and rearing habitat for coho salmon, especially in the lower reaches.

Wide Hollow Creek also supports some coho spawning where the creek is accessible. Wide Hollow Creek could provide nearly ideal habitat conditions if fish passage near the mouth of the creek and at several irrigation diversions could be improved.

VEGETATION

Natural vegetative conditions can be inferred from soil maps and early surveys of the area. Large areas of the lower Ahtanum and Wide Hollow drainages (i.e. below 40th Avenue) were composed of greasewood, saltgrass and Basin Wild Rye communities, with riparian plant communities dominated by Black Cottonwood and Coyote Willow. Fingers of these plant communities followed all of the current streams and distributaries (Bachelor, Hatton, Spring Creek West, Wide Hollow) upstream. At approximately 48th Avenue on Wide Hollow, and Wiley City in the Ahtanum, soils become much less alkaline and plant communities likely changed to Basin Big Sage and Bluebunch Wheatgrass in the majority of the watershed, with Cottonwood, willows, Red Osier Dogwood, wild roses, etc. composing the riparian zone. It should be noted that Wide Hollow channels or vegetative communities are not mapped on the original surveys, although there is mention of a brook 3 links (2.33 feet) wide at the current location of upper Cottonwood Canyon Creek – the brook is not noted on the other section line a mile downstream. It is possible that there were no, or only intermittent areas of riparian vegetation in the Wide Hollow watershed upstream of the springs which begin at 48th Avenue and keep the stream perennial from that point downstream. The earliest air photos available of Wide Hollow Creek generally show this pattern. Ahtanum Creek is mapped in its entirety on the old surveys as it forms the boundary of the Yakama Indian Reservation, riparian vegetation extended for the entire length of Ahtanum Creek from its mouth to the forested areas upstream.

Currently, most of the mainstem Ahtanum Creek has a similar type of riparian vegetation to that which existed historically. Several areas of Ahtanum Creek in its lower portion, totaling over 2 miles, have had the riparian zone totally or mostly removed, these areas of lack of riparian vegetation are usually associated with channel straitening or incision which occurred prior to the 1947 air photos, likely in the 1890s. Based on the air photo record, riparian plant communities retaining native vegetation on the Ahtanum are currently less robust and extensive than natural historic conditions due to decrease in streamflows in Ahtanum Creek in all seasons of the year.

The lower 6 miles of Ahtanum Creek, the entirety of Hatton and Bachelor Creeks, and all areas of Wide Hollow Creek used for irrigation conveyance or spill exhibit a mix of native and invasive species in the riparian zone. While some remnants of native Cottonwood remain, the majority of these channels are dominated by stands of non-native and/or hybridized willows, with understory vegetation comprised of Reed Canarygrass (Phlaris aurundacia). These willows are likely White Willow (*Salix alba*) and Crack Willow (*Salix fragilis*), both of which have been described as existing in Washington State, with White Willow described in numerous locations in the Yakima Basin. Both are known to hybridize with Pacific Willow (Salix lucida ssp lasiandra). In Australia, (where there are no native willows) all 3 species are known to hybridize and colonize native habitats, especially in areas which exhibit altered stream hydrographs. The extent of willow invasion in Australia is severe enough that these willows have been listed as "Weeds of National Significance" and Noxious Weeds, Crack Willow is also listed as an invasive plant by the USDA Forest Service and is considered an invasive species by the states of Colorado, Illinois, Massachusetts, Michigan, Minnesota, Nevada, New York and Utah.

While there are acknowledged beneficial impacts of willow invasions (shade, variation in the landscape, suppression of other non-native species) the negative effects of willow invasion in Australia are documented as:

1. The aggressive growth habit of willows and their ability to colonize river and stream beds by vegetative and sexual reproduction has been shown to cause significant problems on the riparian and aquatic health of streams, and on the morphology of the bed and banks. Detrimental impacts include:
   - modification of stream morphology, hydrology and stability causing blockages/diversions, avulsion, increased bank erosion and decreased flood capacity;
   - accumulation of fine silt in the bed around root masses, including smothering of cobble and gravel bars, riffles and pools which may reduce habitat availability for aquatic bugs and fish;
   - increased water use where willow growth habit results in significant infestations in the stream bed. Preliminary studies on transpiration rates between willows on the stream bed compared to willows and native trees on stream banks indicated a large difference in water uptake (maximum daily transpiration 15.2 mm recorded for willows in the permanently inundated stream bed compared to only 2.3 mm for willows and 1.6 mm for river red gums on banks) (Doody et al 2006);
   - damage to infrastructure where willow debris obstructs stream channels during floods (for example, loss of bridges);
2. Alterations to ecological processes, including:
   - changes to nutrient cycling due to their deciduous nature;
   - water temperature modifications, particularly impacting on shading on fish and bugs during summer
   - changes in water quality by anoxic conditions (dissolved oxygen demand) produced during breakdown of massed autumn leaf fall;
   - suppression of native vegetation by intense shading, including exclusion of understory;
   - reduction in amenity values, for example reduced access for canoeists and swimming holes along infested reaches; and
   - loss of biodiversity when willows invade and displace native vegetation in riparian areas.

Many of these conditions are found in the Ahtanum and Wide Hollow watersheds, primarily in areas where channels have been maintained as irrigation or drainage ditches without riparian zones, or in the case of the lower Ahtanum, where riparian zones along the creek had been eliminated, and non-native species subsequently invaded. The willow trees achieve unusually large size (over 60 feet) and produce large amounts of both litter in the form of leaves and seeds, and also large quantities of small, medium and large pieces of stems and trunks. The large amounts of litter tend to be cohesive and coat the bottom of the channel in layers of muck as they break down, and the woody debris greatly increases channel roughness. Spread of these willow populations within a drainage is primarily through sprouting of the large amount of small and large woody debris generated by these trees. Hybrid trees also remain fertile and can produce large amounts of airborne seeds which can travel up to 15 miles to colonize other habitats. The negative effects of Reed Canarygrass and to a lesser extent, yellow-flag iris, are similar in terms of changes in bank form and sediment accumulation, increased water use, loss of native species, changes in DO concentration during the leaf / stem die-off etc.

Figure 4-14 Effects to channels due to hybrid willows.

These non-native plant communities can have a dramatic impact on channel shape and function over time – reducing flood conveyance, changing the nature of the channel substrate (more fines material and organics) and increasing channel roughness so that overbank flooding increases in frequency. This is a special concern in this watershed since it is composed of flat or undulating floodplains which can route shallow floodwaters across relatively large areas of the floodplain. The alteration of the basin since 1947 can be seen on Figure 4-16. The impact on channel roughness thereby increasing flood levels can be seen from Figure 4-17, which was assembled to support the FEMA flood mapping restudy. Example of channel constriction is shown in Figure 4-14. Effect on structure in Figure 4-15.

Figure 4-15 Effects to structures due to hybrid willows.

Figure 4-16

Wide Hollow Creek Vegetation

An example of the progression of willows.

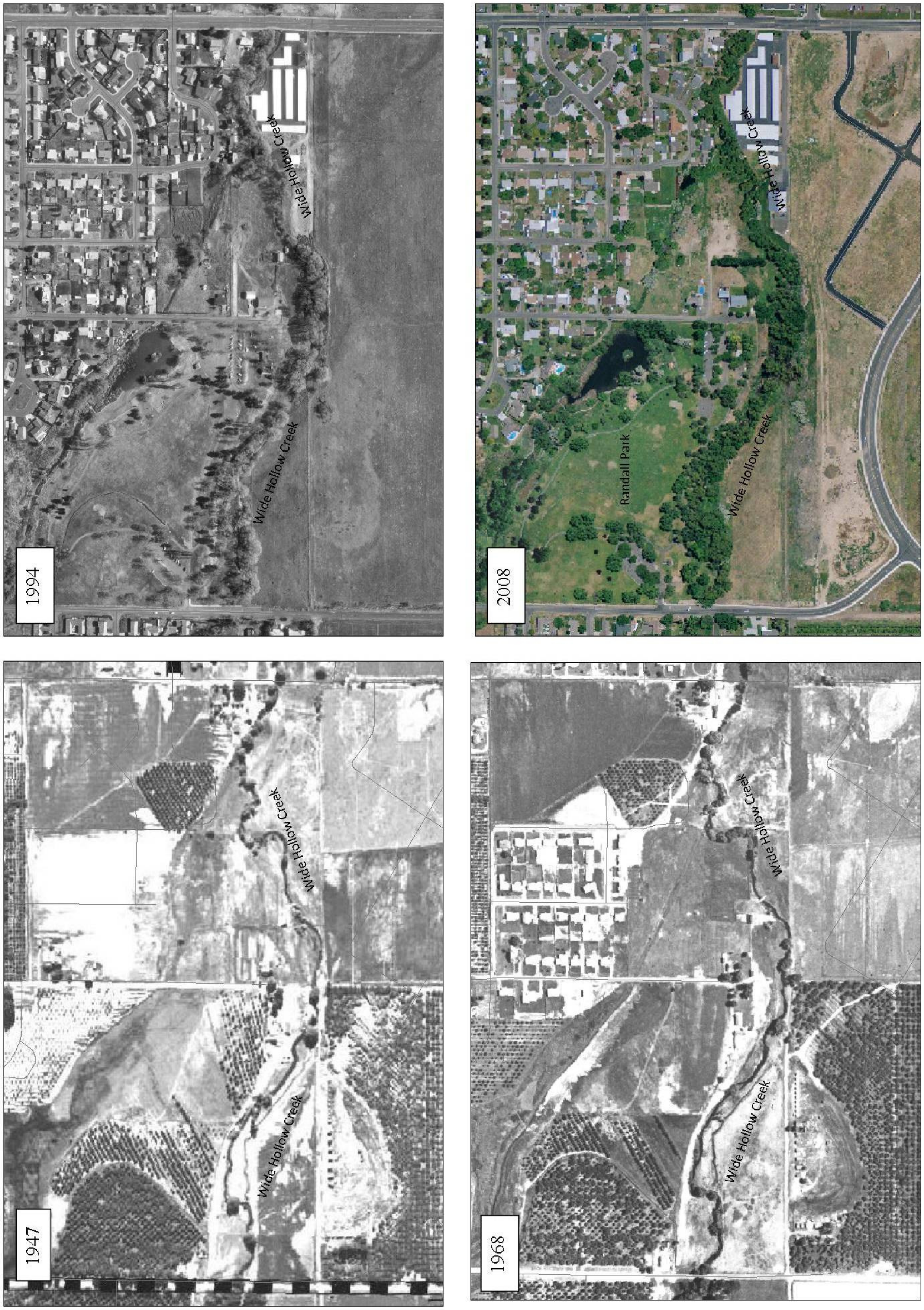


Figure 4-17A

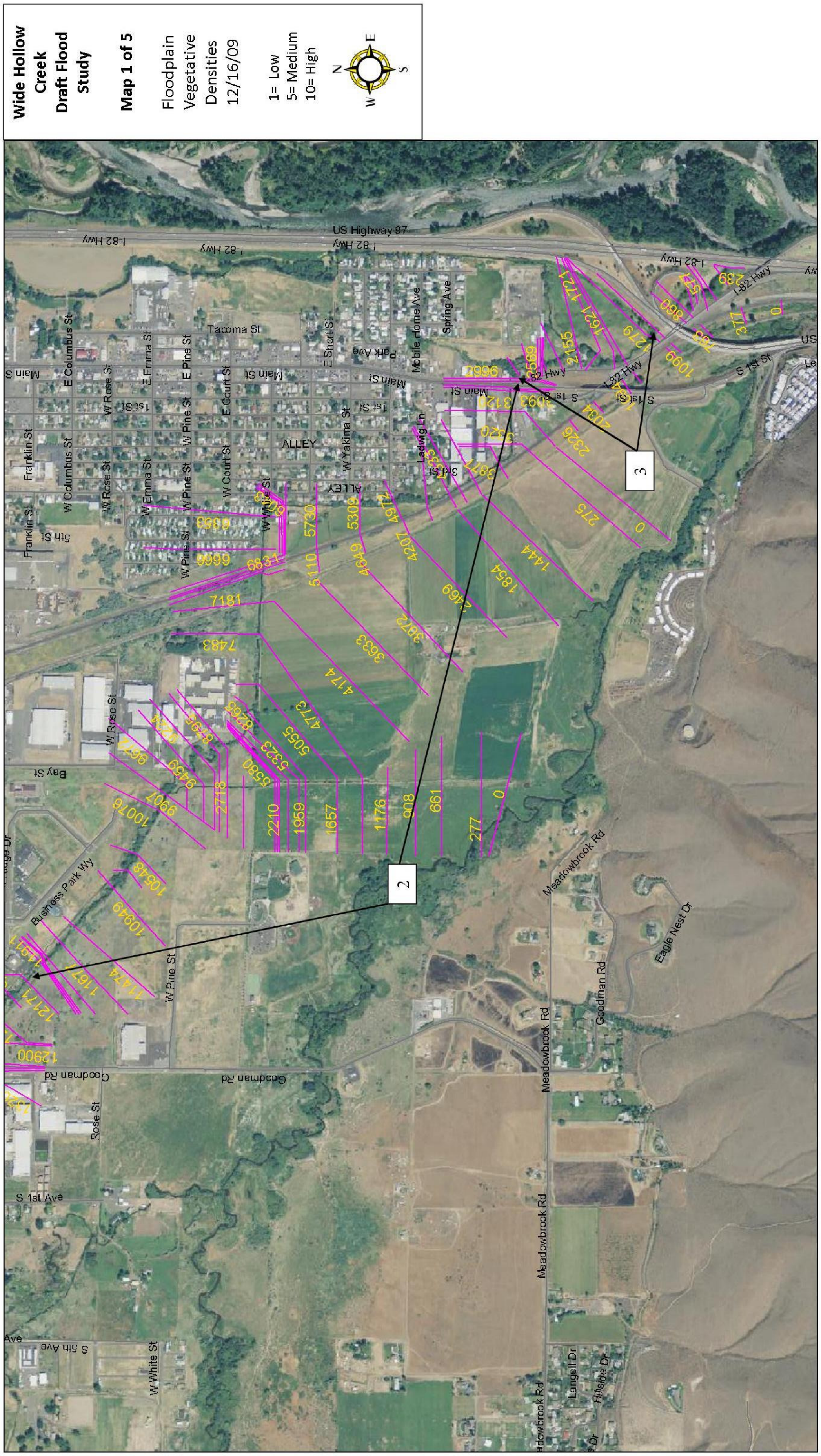

Wide Hollow Creek Draft Flood Study
Map 1 of 5
Floodplain Vegetative Densities 12/16/09
1= Low
5= Medium
10= High
N
E
S
W
2
3
US Highway 97
I-82 Hwy
Goodman Rd
Meadowbrook Rd
Business Park Wy
W Pine St
Main St
ALLEY

Figure 4-17B

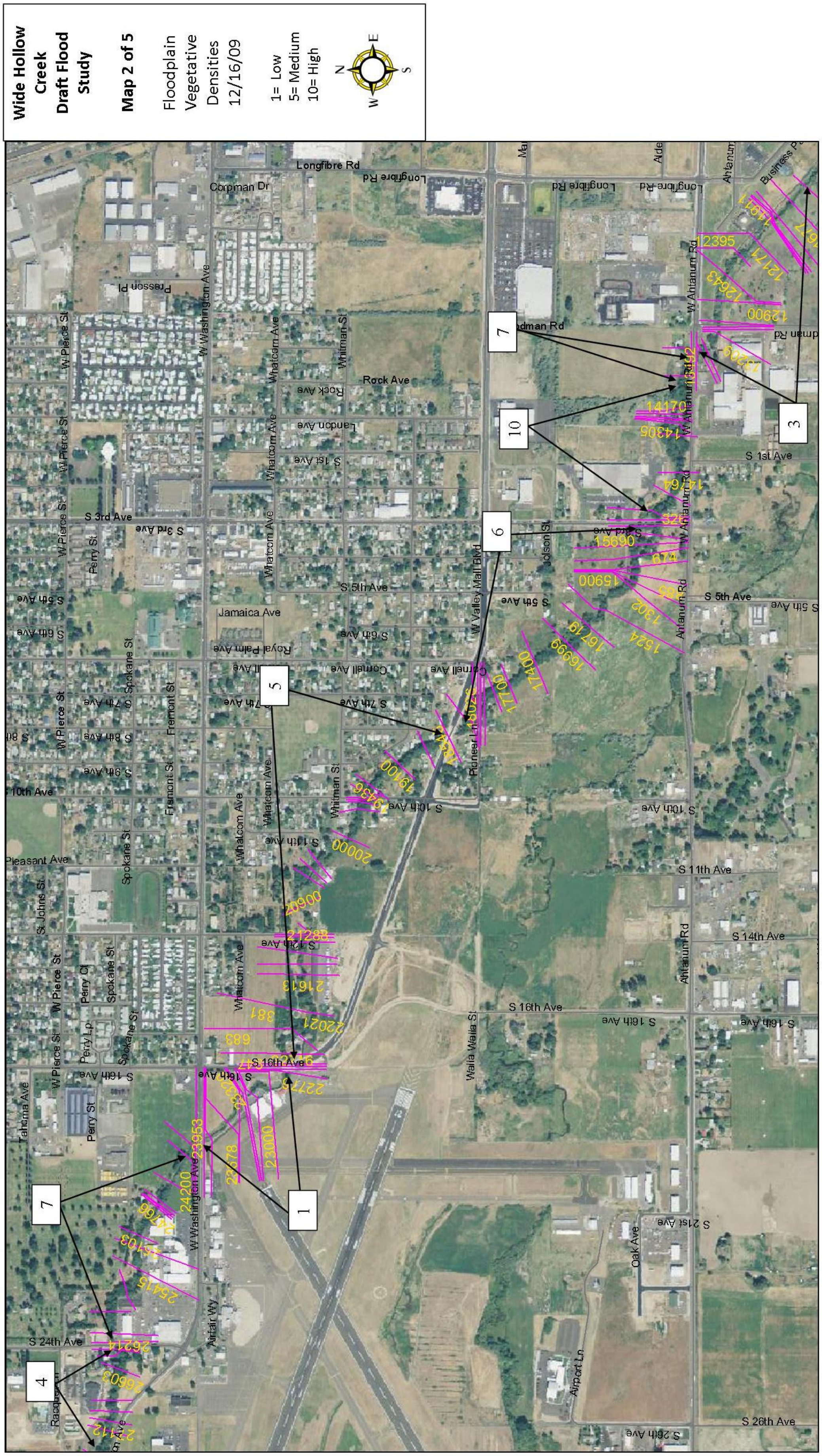

Wide Hollow Creek Draft Flood Study
Map 2 of 5
Floodplain Vegetative Densities 12/16/09
1= Low
5= Medium
10= High
N
E
S
W

Figure 4-17C

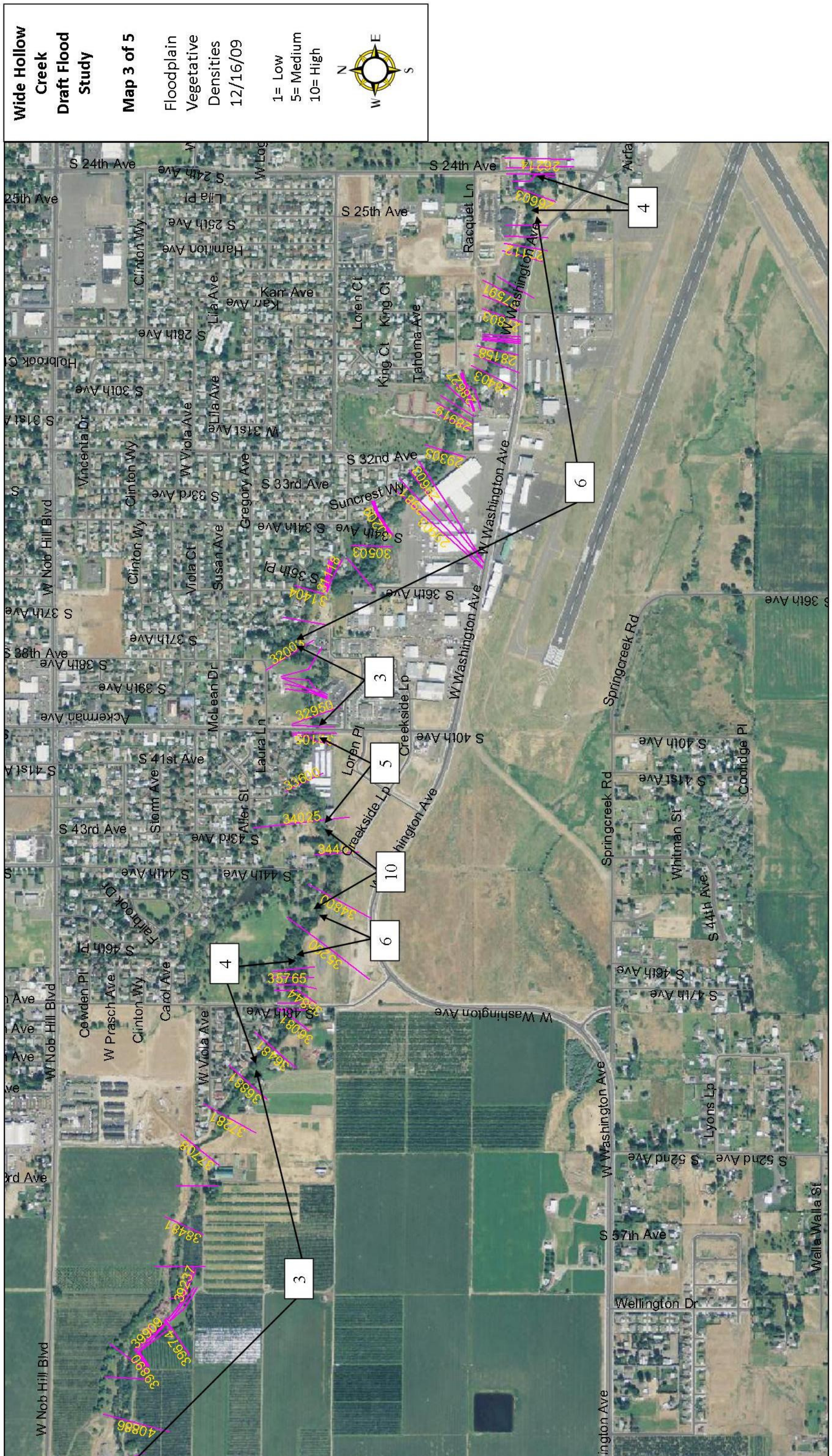
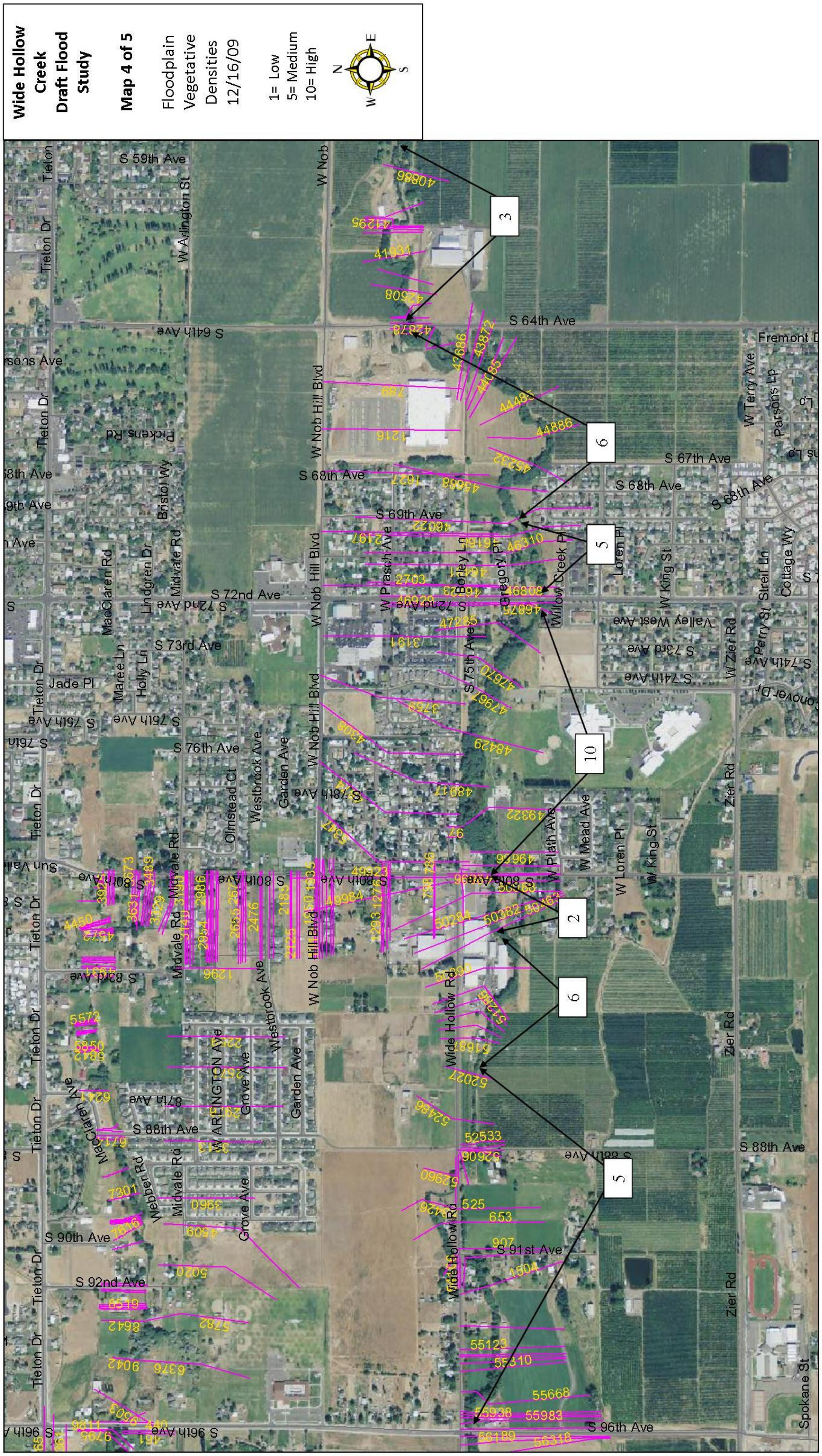
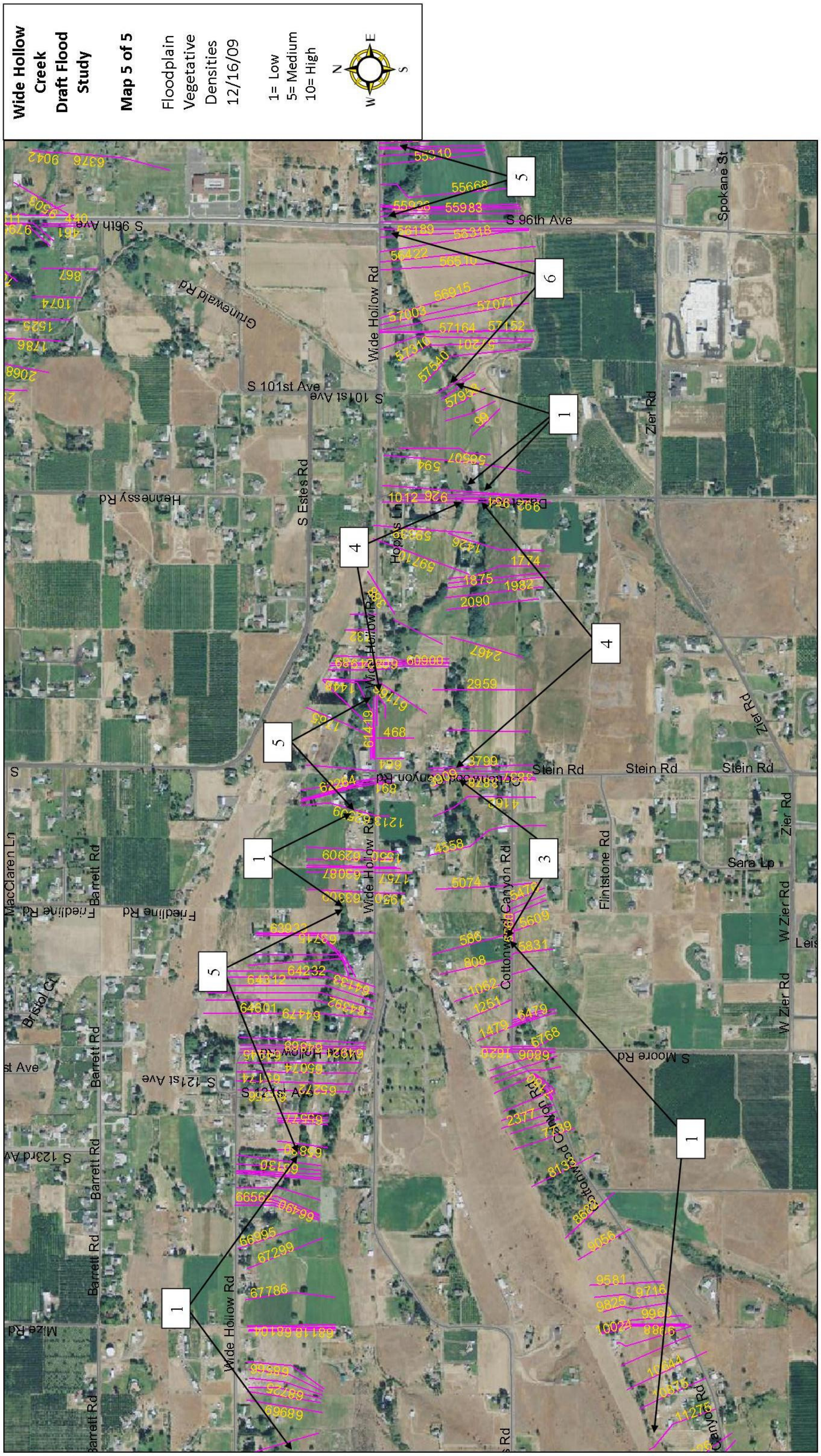

Wide Hollow Creek Draft Flood Study
Map 3 of 5
Floodplain Vegetative Densities 12/16/09
1= Low
5= Medium
10= High
N
E
S
W
S 24th Ave
S 25th Ave
S 32nd Ave
S 33rd Ave
S 36th Ave
S 40th Ave
S 41st Ave
S 43rd Ave
S 44th Ave
S 52nd Ave
S 57th Ave
W Washington Ave
W Nob Hill Blvd
Springcreek Rd
Creekside Lp
Wellington Dr
Walla Walla St
3
4
5
6
10

Figure 4-17D



Wide Hollow Creek Draft Flood Study
Map 4 of 5
Floodplain Vegetative Densities 12/16/09
1= Low
5= Medium
10= High

Figure 4-17E


Wide Hollow Creek Draft Flood Study
Map 5 of 5
Floodplain Vegetative Densities 12/16/09
1= Low
5= Medium
10= High
N
E
S
W
S 96th Ave
Wide Hollow Rd
S 101st Ave
Zier Rd
Hennessy Rd
S Estes Rd
Hopes Ln
Stein Rd
Cottonwood Canyon Rd
Flintstone Rd
Sara Lp
W Zier Rd
S Moore Rd
Friedline Rd
Barrett Rd
MacClaren Ln
Bristol Ct
S 121st Ave
S 123rd Ave
Mize Rd
Spokane St
Grunewald Rd

WATER QUALITY

Human development including both agricultural and urban, has modified water quality in the watersheds. The basin has been the subject of recent and ongoing studies to document such impacts (Chapters 3 and 8).

Both watersheds will be the subject of water quality improvement programs known as the setting of Total Maximum Daily Loads (TMDL). This process seeks to limit the amount of pollutants or sources of pollution (i.e. lack of shade) which reduce water quality. TMDL strategies may include setting permit limits and recommending best management practices (BMPs) such as fencing, planting trees, and ensuring buffers next to streams to limit non-point source contributions. These control actions are developed through a public involvement process, and TMDL progress is monitored to determine the effectiveness of the control actions. Change in management of the watershed as a result of the TMDL process should be may result in changes to vegetation, irrigation and other agricultural practices, which in turn may change flood patterns and flood hazard.

STREAM STRUCTURES

While formal flood facilities are uncommon in this CFHMP area there are a few flood facilities, as well as permitted and unpermitted berms of various ages and maintenance levels. Many of these have been abandoned. Most of these structures are of concern as they redirect flood water toward neighbors. Some structures were identified through personal interviews with residents, Yakima County and other agency staff, as well as Yakama Nation staff. Also, one week of field reconnaissance included additional personal interviews, verification of existing facilities, and verification of undocumented structures (i.e. levees and dikes) identified using LiDAR (Light Detection and Ranging) data. The following sub-sections outline additional interviews conducted and list additional facilities that were identified through interviews or field reconnaissance.

Compilation of Existing Information

The Yakima County GIS staff provided GIS layers of existing facilities and other information (boundaries, etc.) to be used as a basis for the facilities inventory. Table 4-2 summarizes information provided by the GIS Department.

Table 4-2. Existing Structural Information Utilized

Existing Facilities	Extent
Bridges, bridge photos	CFHMP area
Culverts	CFHMP area
Streets	CFHMP area
Streams	CFHMP area
Beaver Dams	Ahtanum, Bachelor and Wide Hollow Creeks
Bridges	Ahtanum, Bachelor, Wide Hollow, Cottonwood and Shaw Creeks
Diversions	Ahtanum, Bachelor and Wide Hollow Creeks
Outfalls	Ahtanum, Bachelor, Cottonwood, Wide Hollow Creeks
Reference points	Ahtanum, Shaw and Wide Hollow Creeks

Other information provided by Yakima County included aerial photos, various political and land use boundaries, and extents of various noxious weeds. This additional information was used for background review.

Private Levees

Yakima County and Golder Associates staff reviewed LiDAR data for unmapped hydraulic structures (i.e. private levees and dikes). This information was subsequently used as part of field verification and was incorporated into the GIS database. The review process identified 38 levees within the project area.

Personal Interviews

Yakima County staff interviewed the following people to gain additional information about existing facilities. The following people were interviewed:

George Marshall, Ahtanum Irrigation District (field work);
Washington Department of Natural Resources staff;
Joel Freudenthal, Yakima County wildlife biologist;
Ed Campbell, caretaker of the Ahtanum Mission;
Wapato Irrigation Project (WIP) staff;
Steve Simon, Spring (Chambers) Creek East area resident;
Yakama Nation staff;
City of Union Gap staff; and,
Other Yakima County staff.

A list of initial information identified through these interviews is provided in Appendix E. **Any comments pertaining to proposed causes or solutions to issues were provided by the interviewees and public input and were not verified.** Additional interviews were also conducted during field reconnaissance and are also included in Appendix E.

Field Reconnaissance

During the reconnaissance, County and Golder staff met with: Yakama Nation staff; Wapato Irrigation District staff (WIP); George Marshall from AID; Ed Campbell, caretaker of the Ahtanum Mission; Spring (Chambers) Creek area resident, Steve Simon; and others. Flood control and in-stream structures identified through interpretation of LiDAR data and other available GIS information was also inspected during this reconnaissance. A list of information gathered through field work is provided in Appendix E.

Inventory of Existing Facilities and Hydraulic Structures

The summary of inventoried information is presented in a series of GIS based maps (see Figures 4-18 thru 4-23). The maps cover the six geographic extents within the project area as follows: Ahtanum, West Valley-North, West Valley-South, Southwest Yakima, West Yakima, and Yakima/Union Gap. Within the project area there are 38 private levees; identified through review of LiDAR images. Additionally, there are 303 public and private bridges and culverts conveying water under roads in the Ahtanum and Wide Hollow drainages. This number only includes the bridges and culverts that were large enough to be included in the new flood map modeling. There are also numerous small private bridges and culverts that are below this threshold size. Yakima County has also identified 40 beaver dams, 69 diversions, and 56 outfalls.

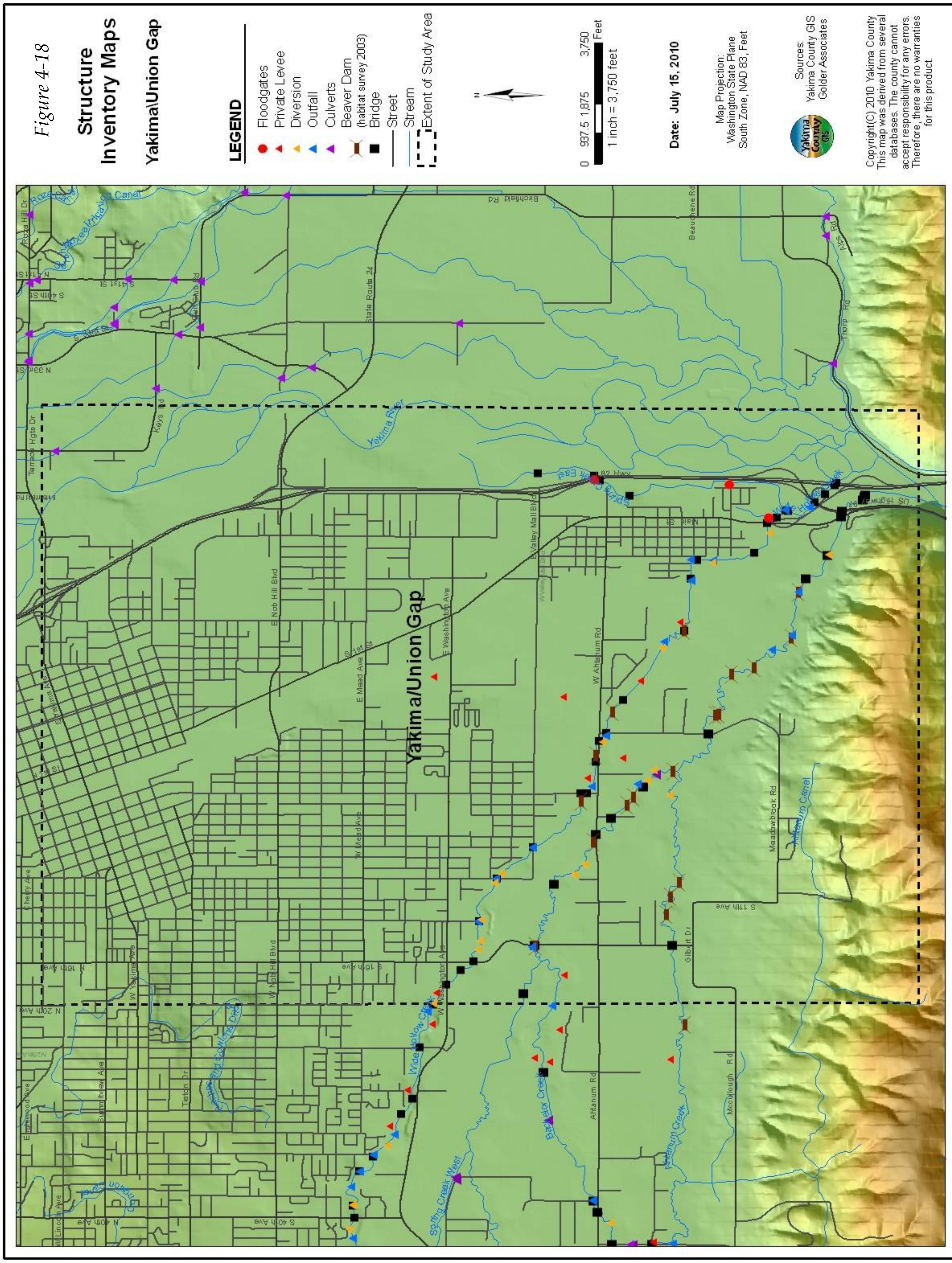
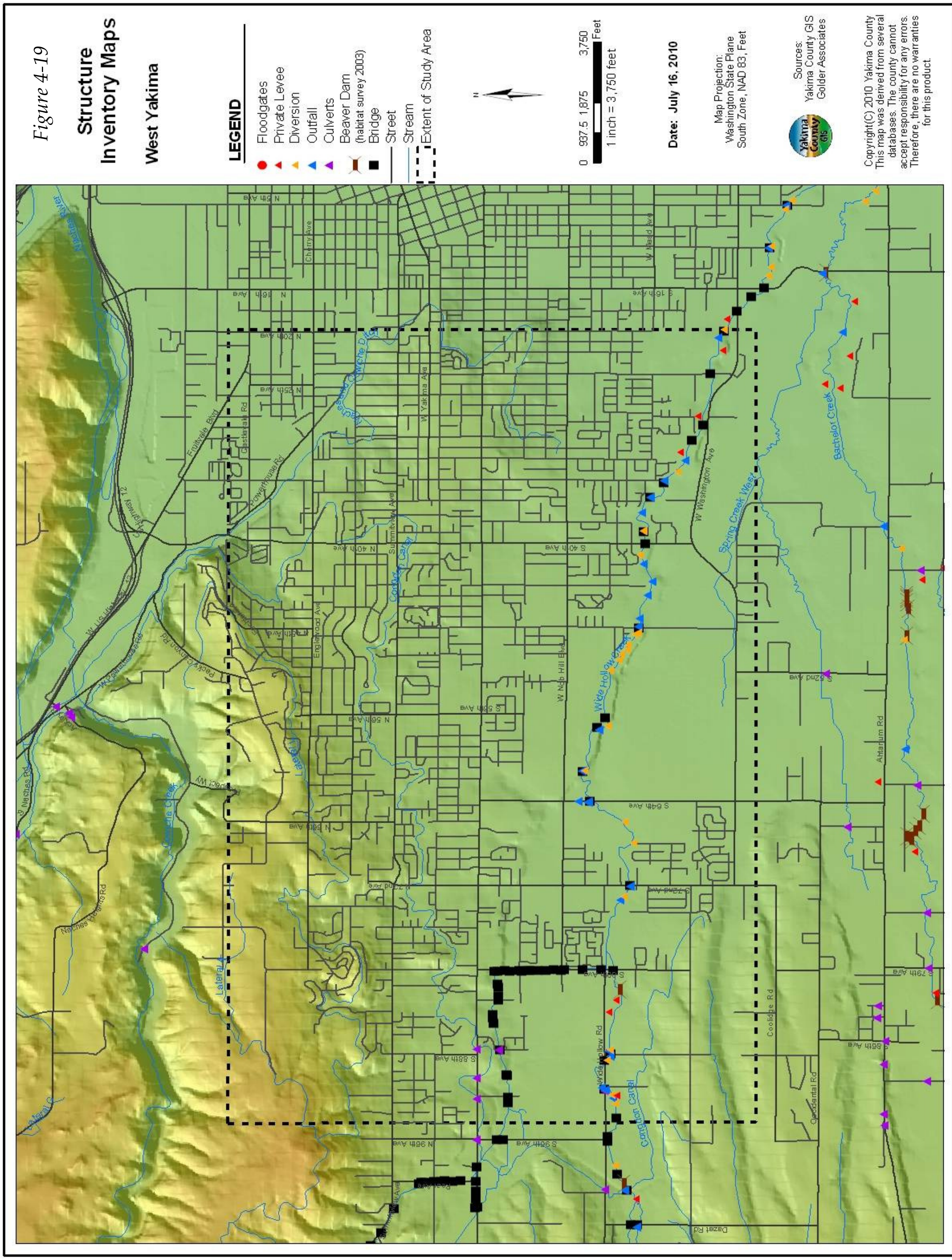


Figure 4-18
Structure Inventory Maps
Yakima\Union Gap
LEGEND
Floodgates
Private Levee
Diversion
Outfall
Culverts
Beaver Dam (habitat survey 2003)
Bridge
Street
Stream
Extent of Study Area
0 937.5 1,875 3,750 Feet
1 inch = 3,750 feet
Date: July 15, 2010
Map Projection: Washington State Plane South Zone, NAD 83, Feet
Sources: Yakima County GIS Golder Associates
Copyright(C) 2010 Yakima County This map was derived from several databases. The county cannot accept responsibility for any errors. Therefore, there are no warranties for this product.
Yakima/Union Gap
Yakima River
Wide Hollow Creek
Bachelor Creek
Ahtanum Creek
Spring Creek West
Ahtanum Canal


Structure
Inventory Maps
West Yakima
LEGEND
Floodgates
Private Levee
Diversion
Outfall
Culverts
Beaver Dam
(habitat survey 2003)
Bridge
Street
Stream
Extent of Study Area
N
0 937.5 1,875 3,750
Feet
1 inch = 3,750 feet
Date: July 16, 2010
Map Projection:
Washington State Plane
South Zone, NAD 83, Feet
Sources:
Yakima County GIS
Golder Associates
Copyright(C) 2010 Yakima County
This map was derived from several
databases. The county cannot
accept responsibility for any errors.
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for this product.
Wide Hollow Creek
Bachelor Creek
Spring Creek West
Ahtanum Rd
W Washington Ave
W Nob Hill Blvd
W Yakima Ave
Summitview Ave
Naches River
Cowiche Creek
Naches Heights Rd
Powerhouse Rd
Fruitvale Blvd
Castlevale Rd
Englewood Ave
Cherry Ave
Coolidge Rd
Occidental Rd
Dazet Rd
Congdon Canal
Wide Hollow Rd

Figure 4-19

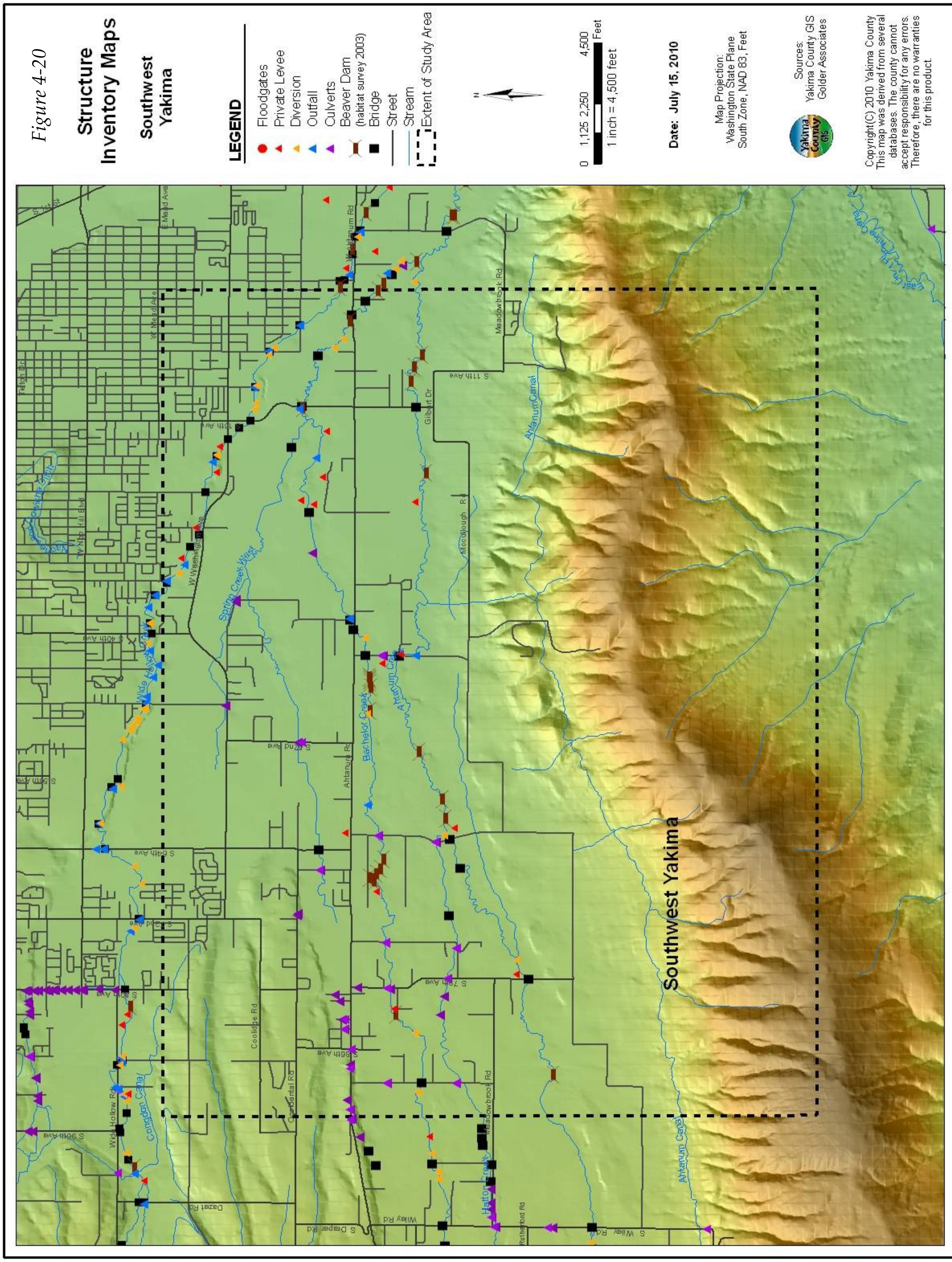
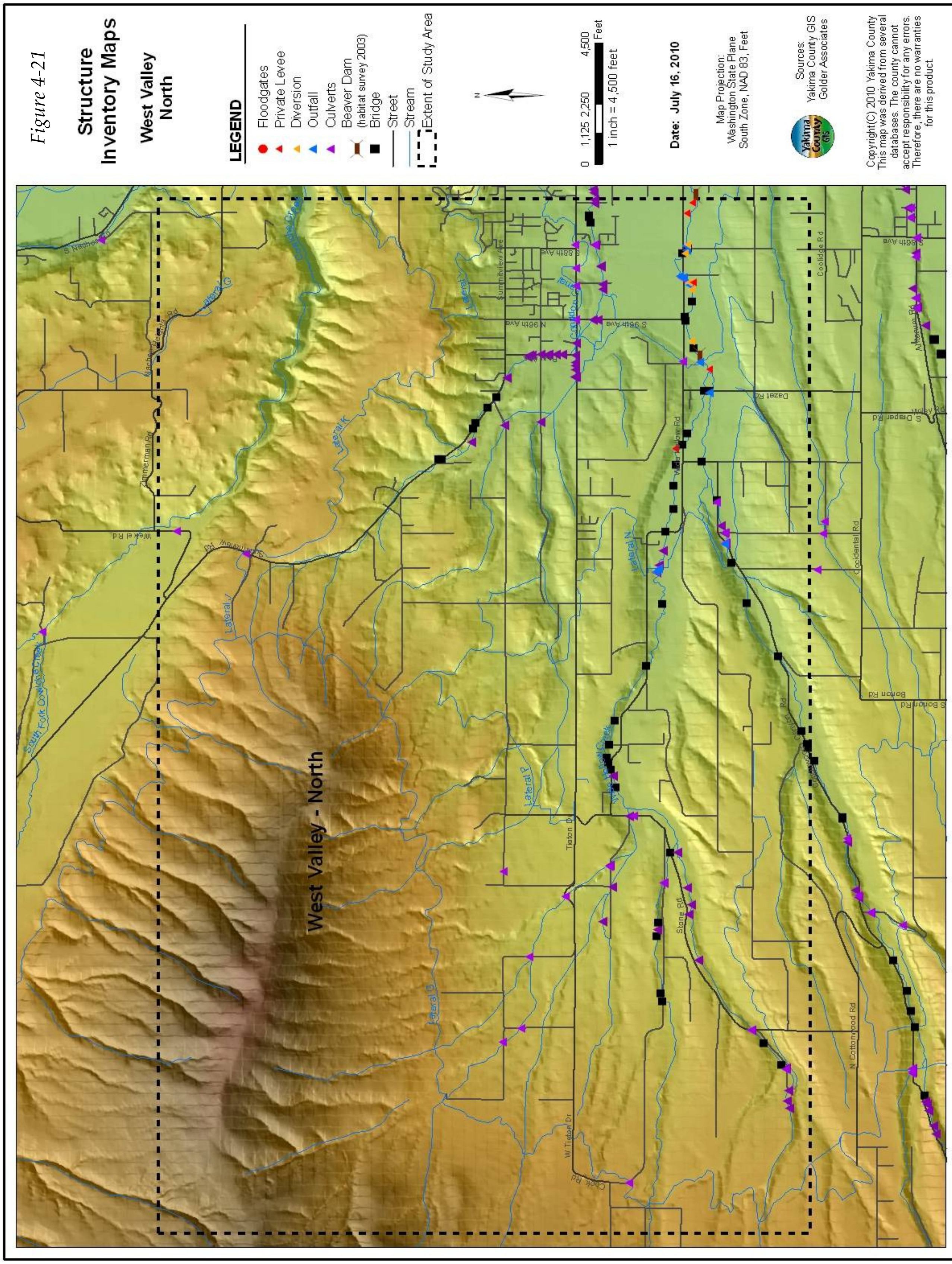


Figure 4-20
Structure Inventory Maps
Southwest Yakima
LEGEND
Floodgates
Private Levee
Diversion
Outfall
Culverts
Beaver Dam (habitat survey 2003)
Bridge
Street
Stream
Extent of Study Area
0 1,125 2,250 4,500 Feet
1 inch = 4,500 feet
Date: July 15, 2010
Map Projection: Washington State Plane South Zone, NAD 83, Feet
Sources: Yakima County GIS Golder Associates
Copyright(C) 2010 Yakima County
This map was derived from several databases. The county cannot accept responsibility for any errors. Therefore, there are no warranties for this product.
Southwest Yakima



Structure Inventory Maps
West Valley North
LEGEND
Floodgates
Private Levee
Diversion
Outfall
Culverts
Beaver Dam (habitat survey 2003)
Bridge
Street
Stream
Extent of Study Area
0 1,125 2,250 4,500 Feet
1 inch = 4,500 feet
Date: July 16, 2010
Map Projection: Washington State Plane South Zone, NAD 83, Feet
Sources: Yakima County GIS Golder Associates
Copyright(C) 2010 Yakima County
This map was derived from several databases. The county cannot accept responsibility for any errors. Therefore, there are no warranties for this product.
West Valley - North

Figure 4-21

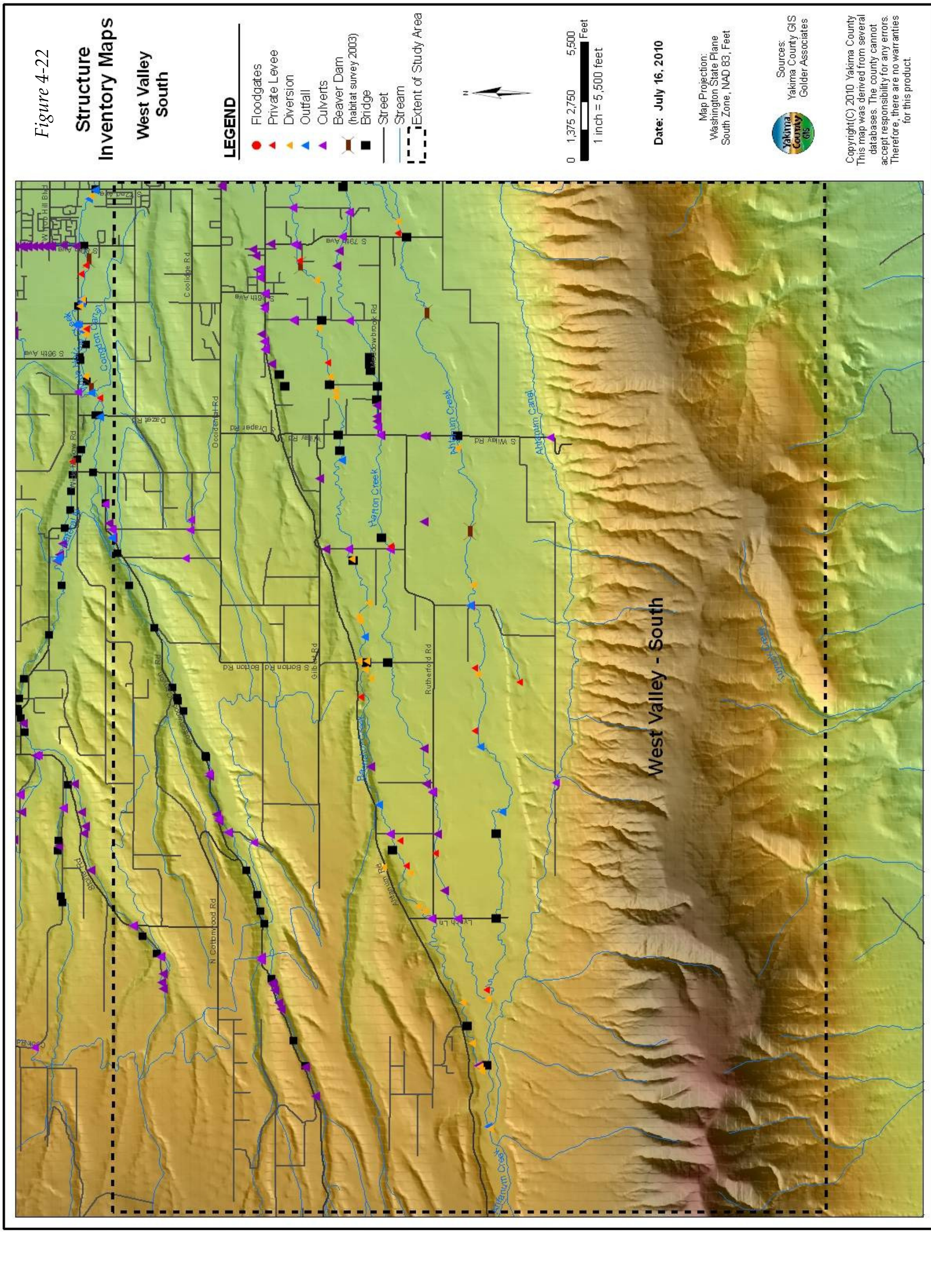


Figure 4-22
Structure Inventory Maps
West Valley South
LEGEND
Floodgates
Private Levee
Diversion
Outfall
Culverts
Beaver Dam (habitat survey 2003)
Bridge
Street
Stream
Extent of Study Area
N
0 1,375 2,750 5,500 Feet
1 inch = 5,500 feet
Date: July 16, 2010
Map Projection: Washington State Plane South Zone, NAD 83, Feet
Sources: Yakima County GIS Golder Associates
Copyright(C) 2010 Yakima County This map was derived from several databases. The county cannot accept responsibility for any errors. Therefore, there are no warranties for this product.
West Valley - South
Wide Hollow Creek
Congdon Canal
Cottonwood Canal
Ahtanum Canal
Ahtanum Creek
Hatton Creek
Bachelor Creek
Coolidge Rd
Occidental Rd
Draper Rd
Dazet Rd
S Wiley Rd
S 96th Ave
S 80th Ave
S 72nd Ave
Meadowbrook Rd
S Bonlon Rd
Gilbert Rd
Rutherford Rd
N Cottonwood Rd
Lynch Ln

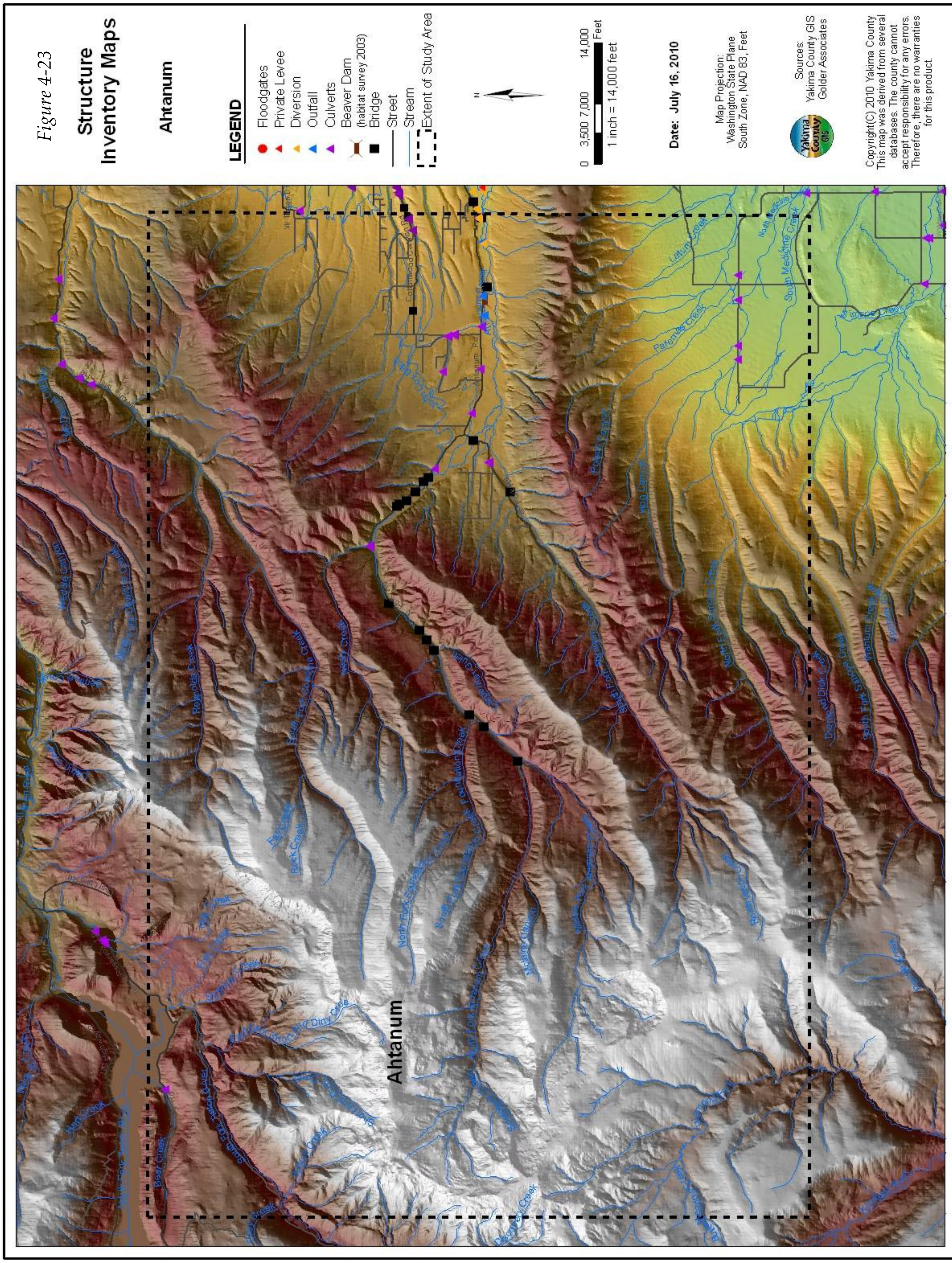


Figure 4-23
Structure Inventory Maps
Ahtanum

Lower Wide Hollow Flood Control Structure

A flood control structure was reported on Wide Hollow Creek just west of downtown Union Gap at a weir near the Burlington Northern Railroad Bridge. Further discussion with Union Gap and field investigation demonstrated there is no flood control structure in this area.

Wide Hollow Flood Gate at the Mill

The Mill at the south end of Main Street in Union Gap used Wide Hollow Creek to power a grist mill from the early 1900s to 1990s. Additional information about the mill is discussed in the recommendation to relocate the mouth of Wide Hollow Creek in Chapter 9. The south end of Main Street is also the beginning of U.S. Highway 97. In 1932 WSDOT initiated a project which constructed a bridge over Wide Hollow Creek at this location. They also constructed flood gates after 1940 to divert flows into concrete culverts during flood events. Current understanding is the flood structure is owned and maintained by the property owner of the mill. No agreement with WSDOT regarding this structure has been located to date.

In addition to the flood facility, WDFW constructed an Alaska Steep Pass in 1989 to provide fish passage around the diversion for the mill. At that time they also shored-up the flume for the mill owner and repaired the WSDOT flood facility. WDFW's policy is that property owners are responsible for operation and maintenance of fish passage structures. Staff from the WDFW fish screen shop removes the control boards directing flows into the fish ladder on an intermittent basis. A recommendation in this plan encourages the relevant parties to formalize the operations and maintenance of the flood facility and fish ladder to ensure effective operations during flood events.

Spring (Chambers) Creek East Flood Gate

Prior to 1985, Spring (Chambers) Creek East flowed westerly from the Yakima River through a culvert under Interstate 82, and then southerly through the eastern portion of Union Gap. A floodgate installed in March 1985 near the Valley Mall Boulevard interchange now prevents floods smaller than or equal to the 100-year flood from entering Spring (Chambers) Creek. However, the 500-year flood overtops Interstate 82 and flows into Spring (Chambers) Creek.

Previously at River Mile 0.5, the majority of Spring (Chambers) Creek flow continued south to its confluence with Wide Hollow Creek, but a small portion of the flow ran easterly to rejoin the Yakima River through a culvert with a flapper gate under Interstate 82. The flapper gate downstream of the floodgate was permanently plugged in 1985 in order to prevent Yakima floodwater from entering Spring (Chambers) Creek and diverting all flow to Wide Hollow Creek. The plugged culvert prevents backwater flooding from floods smaller than or equal to the 100-year flood, but does not prevent the 500-year flood from causing backwater into Wide Hollow Creek and Spring (Chambers) Creek. Spring (Chambers) Creek is now affected only by the 500-year flood from the Yakima River.

During the 1995 November-December flood events, various crews inspected water control facilities along the Yakima River, including the upper floodgate at Spring (Chambers) Creek. This gate was routinely inspected and then closed on November 30, 1995. The gate was also closed during the February 1996 flood. The screw flood gate installed in 1985 is owned and managed by Yakima County. Refer to Figure 4-17 for locations of floodgates.

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