

3. Preliminary Field Study Results

In the spring of 2003, a preliminary survey was conducted throughout the Upper Carson River Assessment Area. Goals were to familiarize the assessment team with existing physical and biological conditions, delineate stream reaches, develop a general understanding of impacts and restoration opportunities, and to define areas that would be reviewed during the second, detailed field phase. Results of the preliminary study were described in “White Paper One” submitted on September 17, 2003 to the Alpine Watershed Group and the Sierra Nevada Alliance. This chapter provides information regarding the preliminary review.

3.1 *Methods and Data*

The field-based portion of the preliminary survey consisted of the assessment team reviewing much of the watershed via visual surveys. Access sites were restricted to bridges, along roads, or through publicly accessible meadows. Written landowner permission was not required to conduct the preliminary survey. Some landowners were contacted verbally to explain the nature of the project and to gauge their willingness to participate should it be necessary.

3.1.1 **Reach Delineation**

Given the size of the assessment area and the focus on restoration of channel form and function, a reach approach was used to characterize the stream corridor (Rosgen 1994; Rosgen 1996). Two broad sets of criteria were used to delineate stream reaches. One consisted of channel and valley morphology using parameters such as gradient, sinuosity, valley confinement, and dominant substrate (Dunne and Leopold 1978; Wolman 1954). The other consisted of land uses that influence channel and floodplain function, such as road development, urbanization, and recreation. These criteria were implemented through a combination of aerial photo analysis and the assessment of key watershed locations.

The preliminary assessment took advantage of the multidisciplinary skills of each team member. Final reach delineations were adjusted based on field observations and interpretations of landforms, vegetation, and land use. Following the delineation of end points, each reach was assigned a unique identifier. The identifier included letters designating the stream name, and a number, assigned sequentially to each reach, beginning with the furthest downstream segment and moving upstream.

3.1.2 **Field Data Collection**

Some reaches along the lower East Fork Carson were not visually assessed during the preliminary survey due to limited access. For these reaches, local knowledge of the area and aerial photos were used to determine key descriptors (Way 1978). This is sufficient to assess relative impacts and assign the priority of reaches for in-depth characterization. For visually assessed reaches, three categories of field data were collected: channel morphology, riparian health, and land use. A field form was used to collect relevant data based on input from all team members. Each team member also took field notes and photos to further describe channel conditions and document specific points of interest. In addition to visual surveys of the riparian corridor, adjacent land use and watershed conditions was assessed to identify landscape conditions such as human versus natural erosion rates, land use impacts, dominant hydrologic characteristics, and impacts to water quality (Dunne 1997; MacDonald et. al. 1991).

3.2 Reach Summaries

Each of the 32 reaches delineated as part of the preliminary survey is described below.

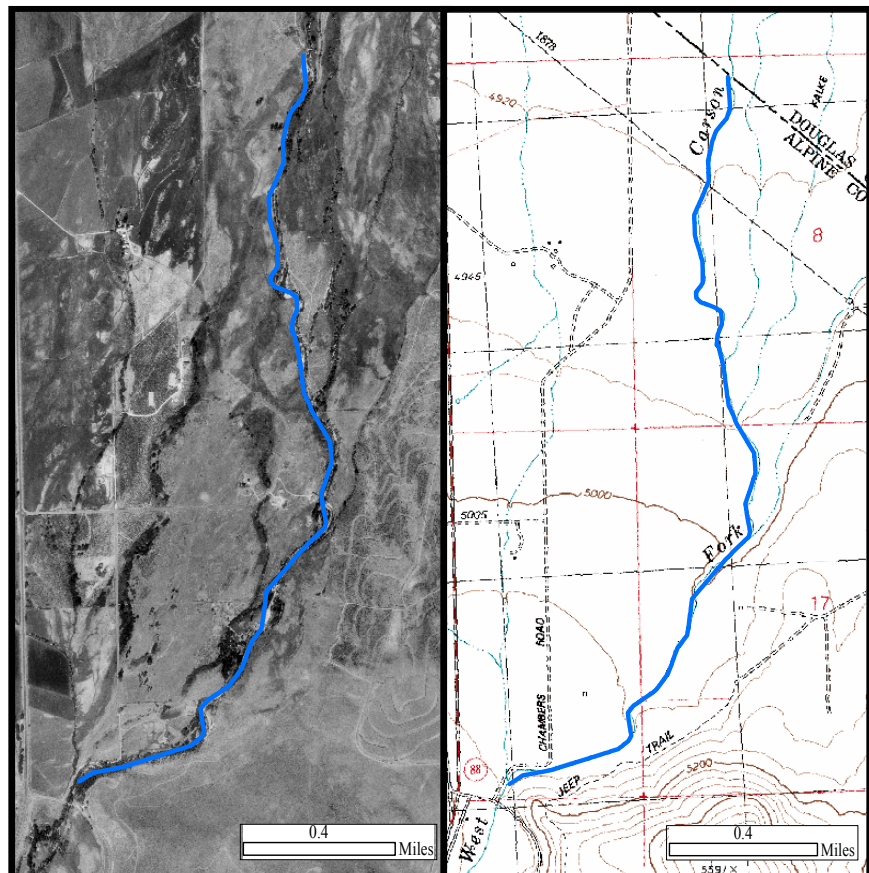
3.2.1 West Fork Carson River

3.2.1.1 Reach WF1

Reach WF1 starts at the California-Nevada state line and ends approximately 300 feet downstream of the Paynesville Bridge. The upstream end of the reach is coincident with a large alluvial fan that has formed at the mountain front as it transitions to the Carson Valley floor. The channel is highly confined and is generally a Rosgen B-type. The banks and bed are composed of large particles, from cobble to boulder in size, and are generally resistant to erosion.

Land uses include water diversions that deliver irrigation water to pasture lands. Some pastures are irrigated with treated effluent supplied by the South Tahoe Public Utility District (STPUD). Rural residential development is replacing pasturelands across portions of the fan surface. Because the current channel is entrenched into the fan surface, the risk of flooding to those residential properties is relatively low. Potential concerns for aquatic ecosystem health in this reach include water diversion and groundwater contamination from septic systems.

Riparian vegetation is fairly continuous along this reach. Black cottonwood (*Populus balsamifera* ssp. *trichocarpa*) and Pacific tree willow (*Salix lucida* ssp. *caudata*) are relegated to the top of bank. Among the black cottonwood, young age classes (seedlings, saplings) are present in a narrow band along the main channel. Assorted willow species occur along the bank slope. Willow species seem healthy and some younger age classes are present.

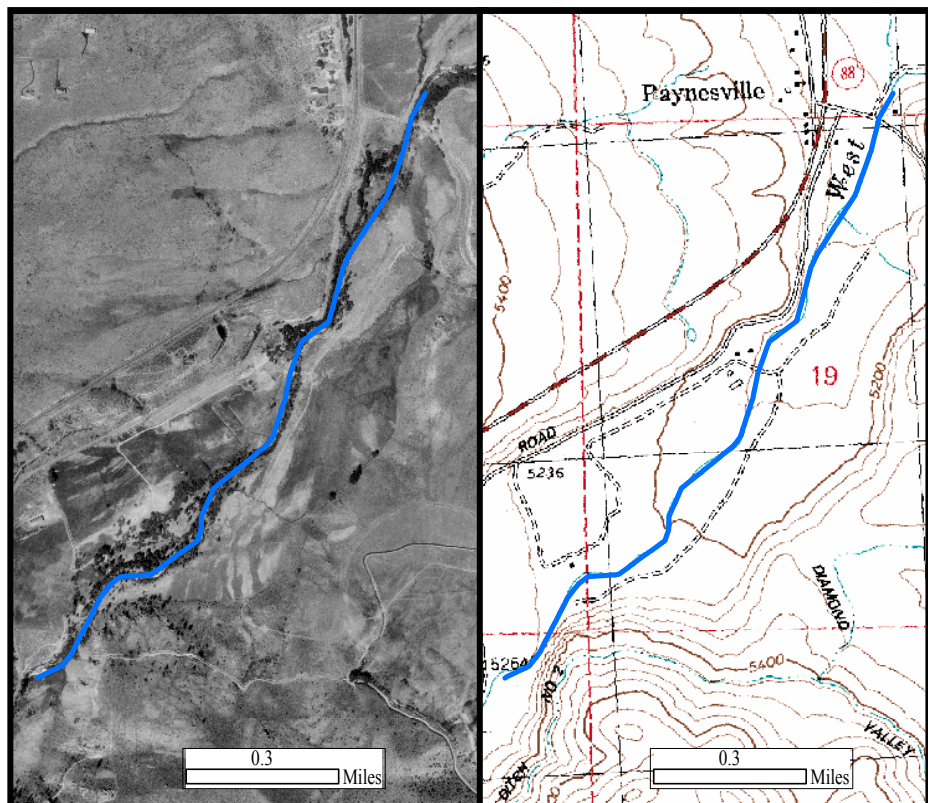


3.2.1.2 Reach WF2

Reach WF2 starts at the Paynesville Bridge and ends at the upstream end of Carson Valley. This reach was separated from Reach WF1 since it has a steeper gradient, generally coarser substrate, and is not located on an alluvial fan. The channel along Reach WF2 is still relatively confined (Rosgen B-type). Boulders are found throughout the banks and streambed, and the channel is resistant to erosion.

Irrigated pastureland is the primary land use along the reach, with a few scattered ranch buildings. Dewatering for irrigation and the use of treated effluent as irrigation water are the primary potential impacts to the stream and aquatic habitat.

Vegetation along the reach is similar to WF1. This is due to the confined nature of the channel and floodplain along both reaches. Riparian vegetation is fairly continuous with black cottonwood and Pacific tree willow relegated to the top of bank. Some stinging nettle (*Urtica dioica*) and horsetail (*Equisetum* sp.) are present as components of the herbaceous understory. A few young age classes (seedlings, saplings) of black cottonwood are present in an adjacent pasture located on the west side of the river. Willow species appear healthy. Young saplings are evident among the sediment in-filled bank boulder cover.



3.2.1.3 Reach WF3

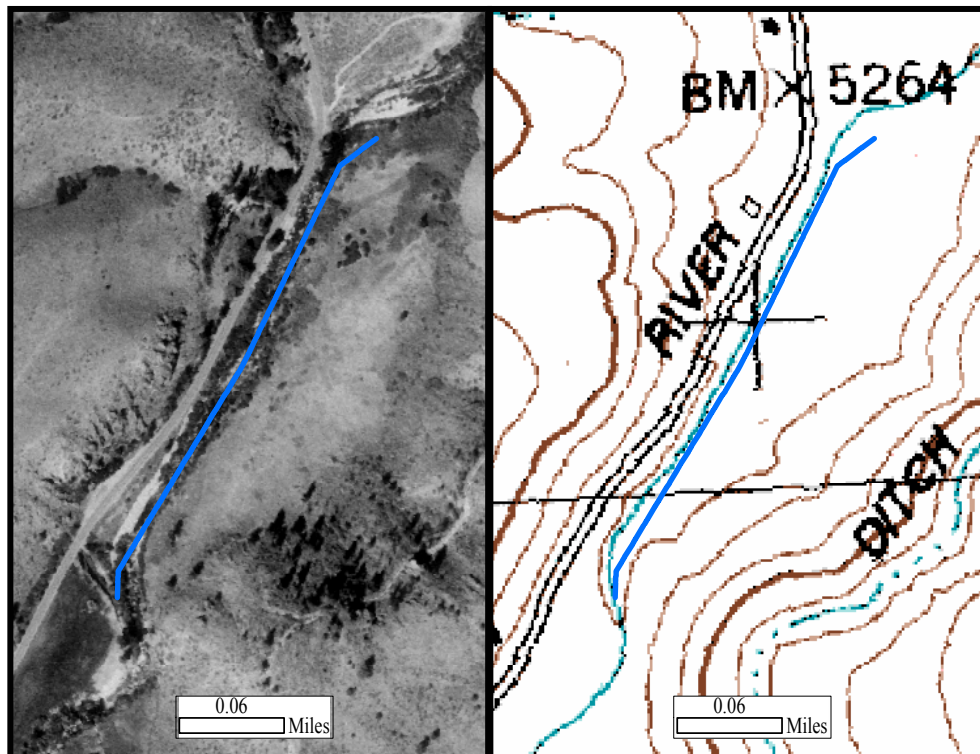
Reach WF3 consists of a short, narrow, confined reach that separates Carson Valley from a meadow northwest of Diamond Valley. The channel is relatively steep, well-confined, and the beds and the stream banks (composed of large boulders and cobble) are generally well-vegetated and stable. The general Rosgen classification is B-channel.

A paved rural road constricts the channel in a few locations. Some areas of bank erosion appear to have occurred during the 1997 flood. Bank protection, consisting of placed and grouted rock, has been constructed in these areas. Some undercutting of the bank protection has occurred, and the grout limits riparian regeneration.



Riparian vegetation is not contiguous along this reach. The tree layer (black cottonwood and Pacific tree willow) observed in downstream reaches is no longer present. Where present, two shrubby species of willows provide the dominant riparian cover.

Sparse grasses or forbes form the limited understory. Surrounding uplands are vegetated with heavy shrub cover consisting primarily of mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) and antelope bitterbrush (*Purshia tridentata*).



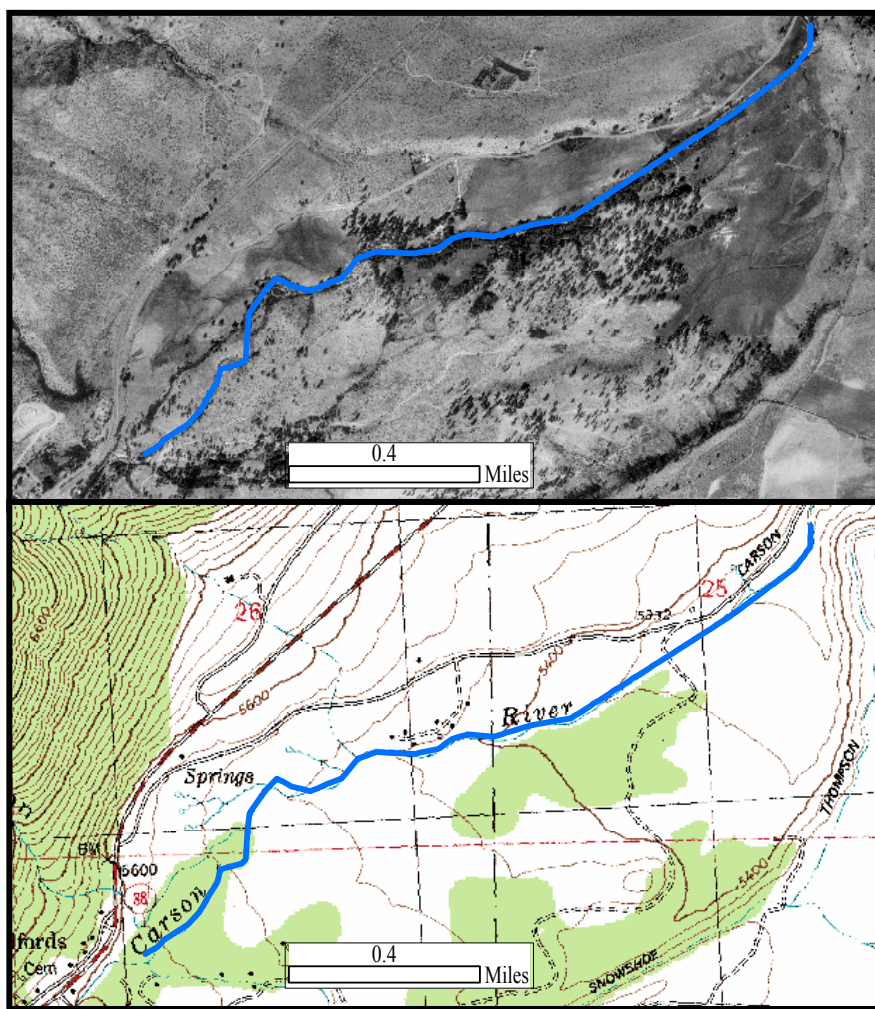
3.2.1.4 Reach WF4

Reach WF4 flows northwest of Diamond Valley to Woodfords. The valley consists of a restricted fan surface that is much steeper than the fan surface present in Reach WF1. Reach WF4 is located at the mouth of the West Fork gorge where extensive debris flow and glacial outwash deposits have accumulated. The channel is incised into these deposits. Bed and stream banks consist of boulders and cobbles, and are generally stable.



Pastureland is the dominant land use through this reach. This channel type is resistant to long-term effects due to the dominance of coarse substrate material and its resistance to bank erosion. Any impacts are likely to be short term in nature.

Riparian vegetation along Reach WF4 consists of fairly continuous shrubby willow species located near the ordinary high water elevation and along the lower bank slopes. Intermittent black cottonwood and Pacific tree willow represent overstory components at the top of bank. In pasture areas, where access to the elevated stream terrace occurs during high flow events, the tree layer tends to expand.



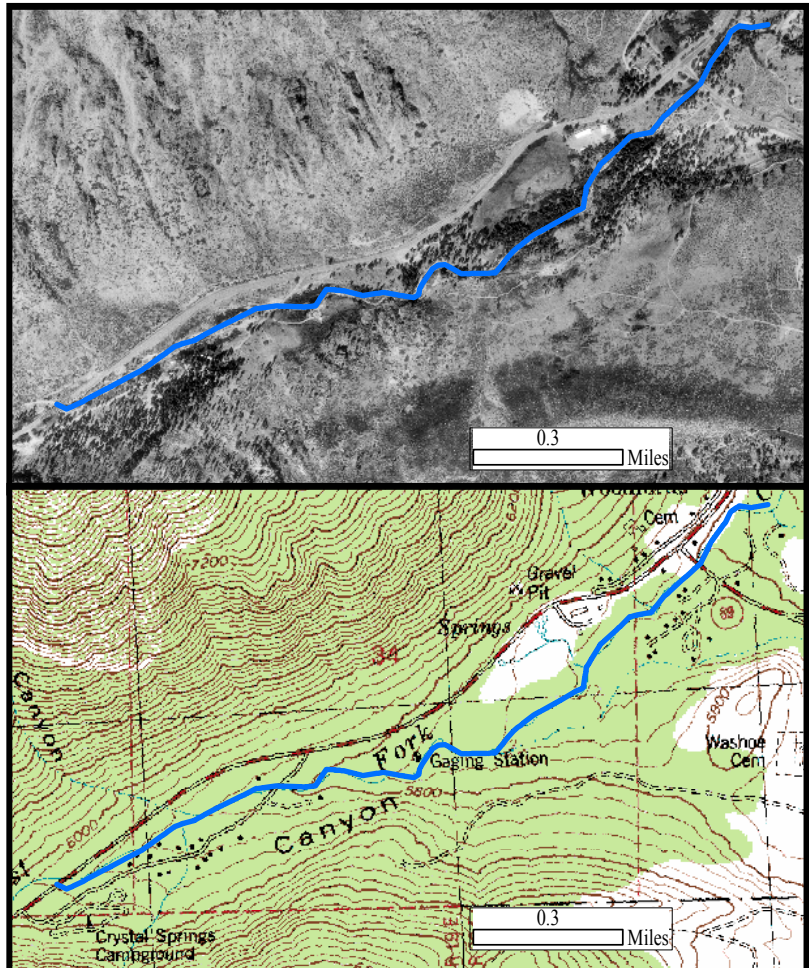
3.2.1.5 Reach WF5

Reach WF 5 is similar to Reach WF4. The channel is entrenched in debris flow and outwash deposits. Canyon walls restrict the channel more than in Reach WF4, but less than in Reach WF6. The channel gradient is relatively steep, and the bed is composed primarily of boulders and cobble (Rosgen B-type).



The highway is located on terraces and hill slopes well away from the channel, except at a crossing near the upstream end of the reach. Although the bed and banks are generally resistant to erosion, substantial bank erosion occurred downstream of the crossing during the 1997 flood. The bridge may have contributed to erosion by concentrating flows. The Snowshoe Thompson ditch was damaged and may be damaged again during similar large floods.

The riparian canopy provides fairly continuous woody cover throughout Reach WF5. This canopy is restricted to a narrow band where the road limits expansion of the riparian zone. Mountain alder (*Alnus incana* ssp. *tenuifolia*) and Pacific tree willow are the dominant forms of shrub cover, and two willow species are located along the bank slopes and at the ordinary high water mark. Black cottonwood is located intermittently at the top of bank. Creeping wildrye (*Leymus triticoides*) is a common understory grass. Surrounding upland vegetation varies between open coniferous forest dominated by Jeffrey pine (*Pinus jeffreyi*) and white fir (*Abies concolor*), clusters of incense cedar (*Calocedrus decurrens*) on moister sites, and shrub dominated slopes (mountain big sagebrush, antelope bitterbrush, and manzanita [*Arctostaphylos patula*]).



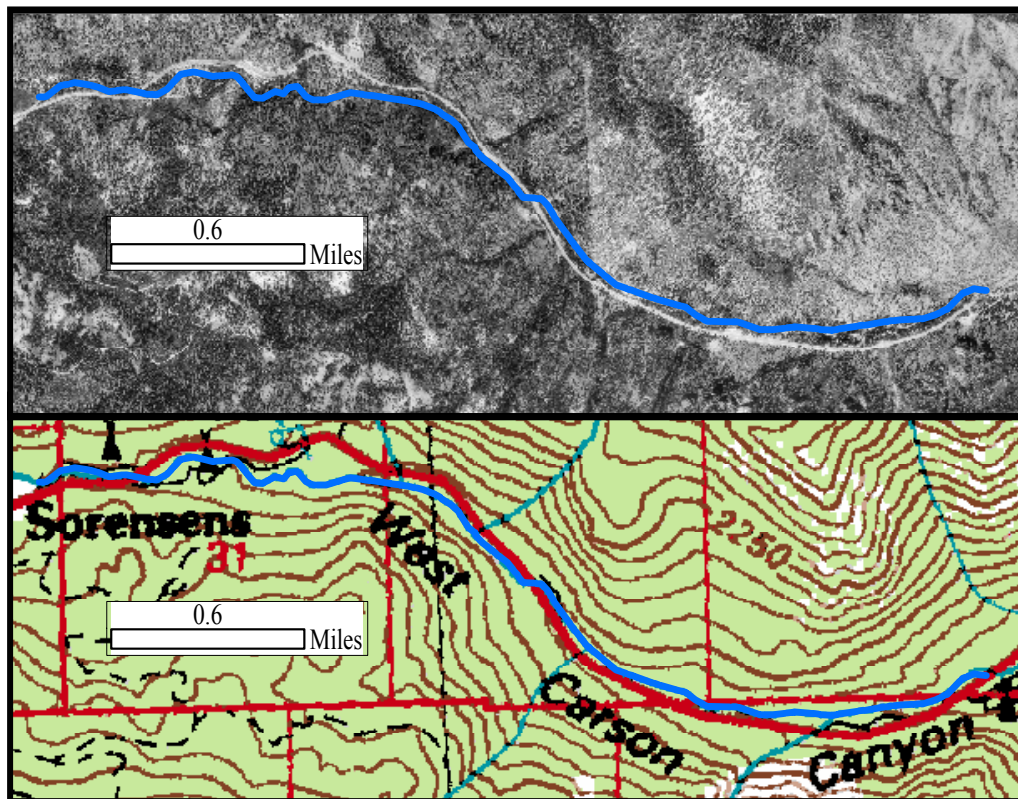
3.2.1.6 Reach WF6

Canyon walls restrict the channel and floodplain to a very narrow area along Reach WF6, whose upstream end is located near Sorenson's Resort. Debris flow chutes are found on both sides of the canyon wall. They likely deliver sediment directly to the channel during rain-on-snow events. The channel is steep (Rosgen A-type in locations) and is composed of very large boulders. The bed and banks are highly resistant to erosion.



Because the valley floor is so narrow, the highway is close to the channel throughout the reach. However, because the channel is so resistant to erosion, the road has had limited influence on the stream. A potential impact of the road is sand delivered to the stream during winter maintenance operations. Some light recreation occurs in this reach at developed campgrounds, but these activities have only a minor impact due to the stable nature of the channel.

Similar to Reach WF5, the riparian canopy provides fairly continuous woody cover throughout Reach WF6. The road restricts this canopy to a narrow band, which expands where flooding of adjacent elevated stream terraces occur. Mountain alder and Pacific tree willow are the dominant forms of shrub cover, and two willow species are located along the bank slopes and at the ordinary high water mark. Black cottonwood cover increases in backwater channels. Under story and upland vegetation is similar to that observed along Reach WF5.



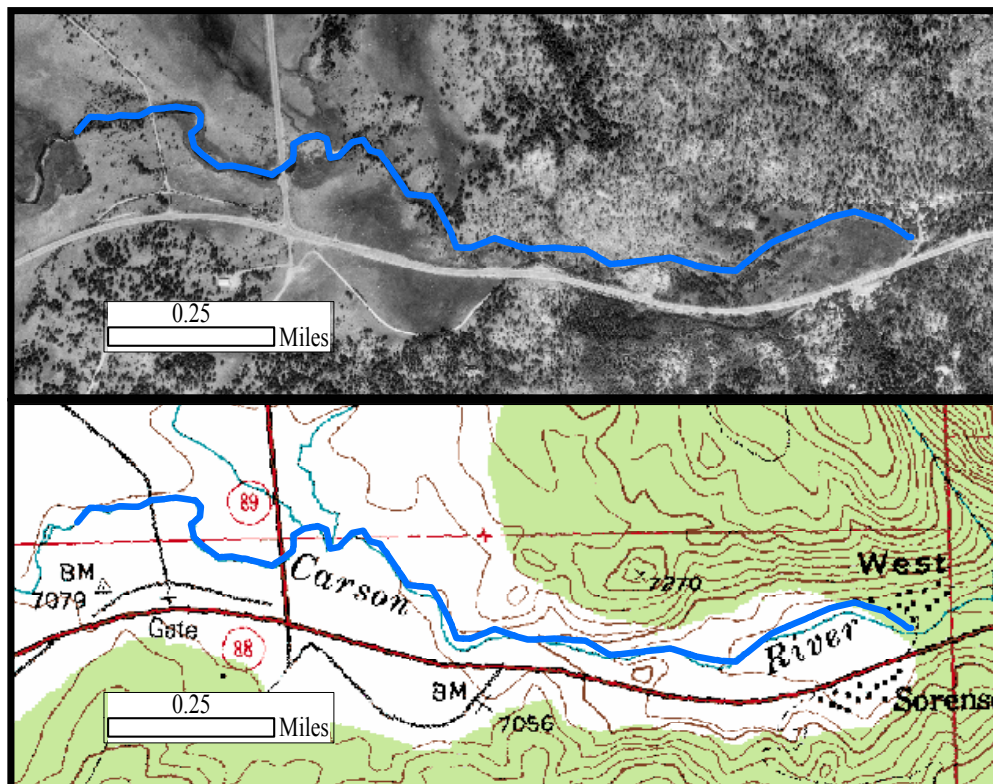
3.2.1.7 Reach WF7

Reach WF7 is transitional between Hope Valley meadow reaches (upstream) and West Fork gorge reaches (downstream). The reach starts at the Hope Valley Resort and ends at a terminal moraine located just upstream of the Hwy 89 Bridge. The upper portion is entrenched in terminal moraine deposits (a Rosgen B-channel). The lower end is composed of coarse material typical of areas influenced by rain-on-snow events and debris flow deposits. Floodplain development has occurred in some areas and the channel trends toward a Rosgen C-type.

Grazing occurred on meadows around this reach between the 1850s and the 1980s. Today, the dominant land use is recreation, particularly fishing and winter activities, mostly skiing. Several stream banks in this reach are unstable. Factors that could contribute to this instability include highway construction, historic grazing activities, or other watershed characteristics.



Within Reach WF7, willow cover is present intermittently at ordinary high water elevations and along bank slopes adjacent to the river. Graminoid dominated meadow vegetation is predominant on the surrounding river terraces. Remnant channels support stands of dense willow cover, particularly evident in the floodplain across from the Hope Valley Resort. Black cottonwood is present in the overstory near the downstream portion of the reach. Terminal moraine debris supports upland vegetation consisting of occasional lodgepole pine (*Pinus contorta*) and sagebrush.



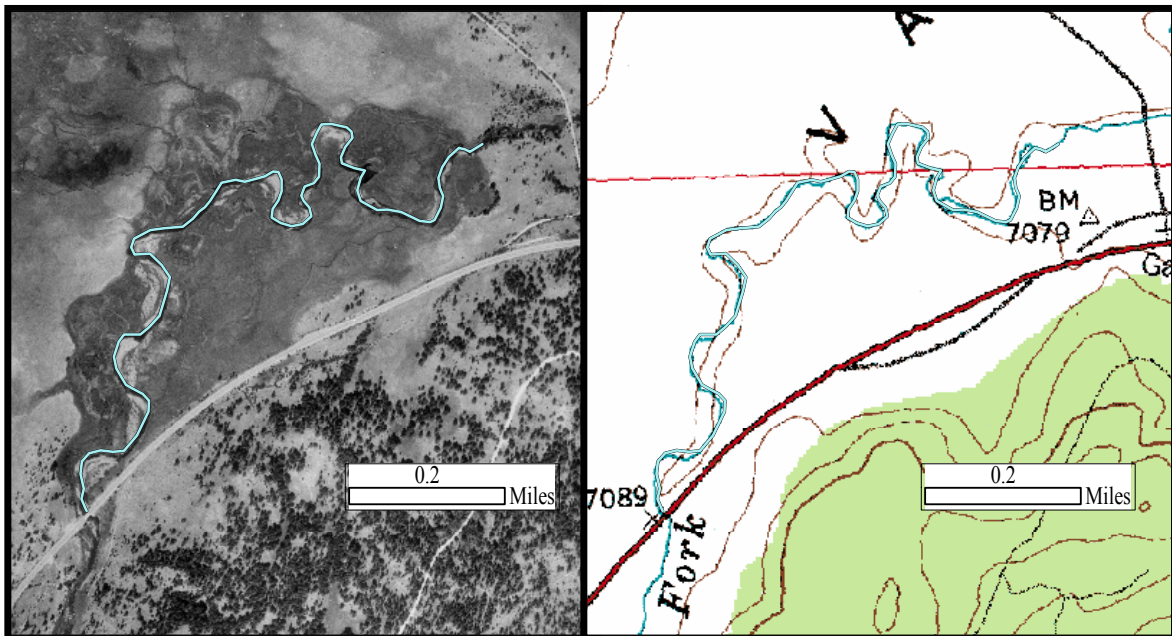
3.2.1.8 Reaches WF8 and WF10

Reaches WF8 and WF10 make up the meadow system known as Hope Valley and are separated from one another by a confined reach (WF9). Deposition of terminal moraine deposits resulted in the creation of two structural basins through which reaches WF8 and WF10 extend. Over time, weathering and deposition of finer-grained material has produced meadow soils. The low-gradient channel in these meadows meanders, with a bed composed primarily of gravel and sand.

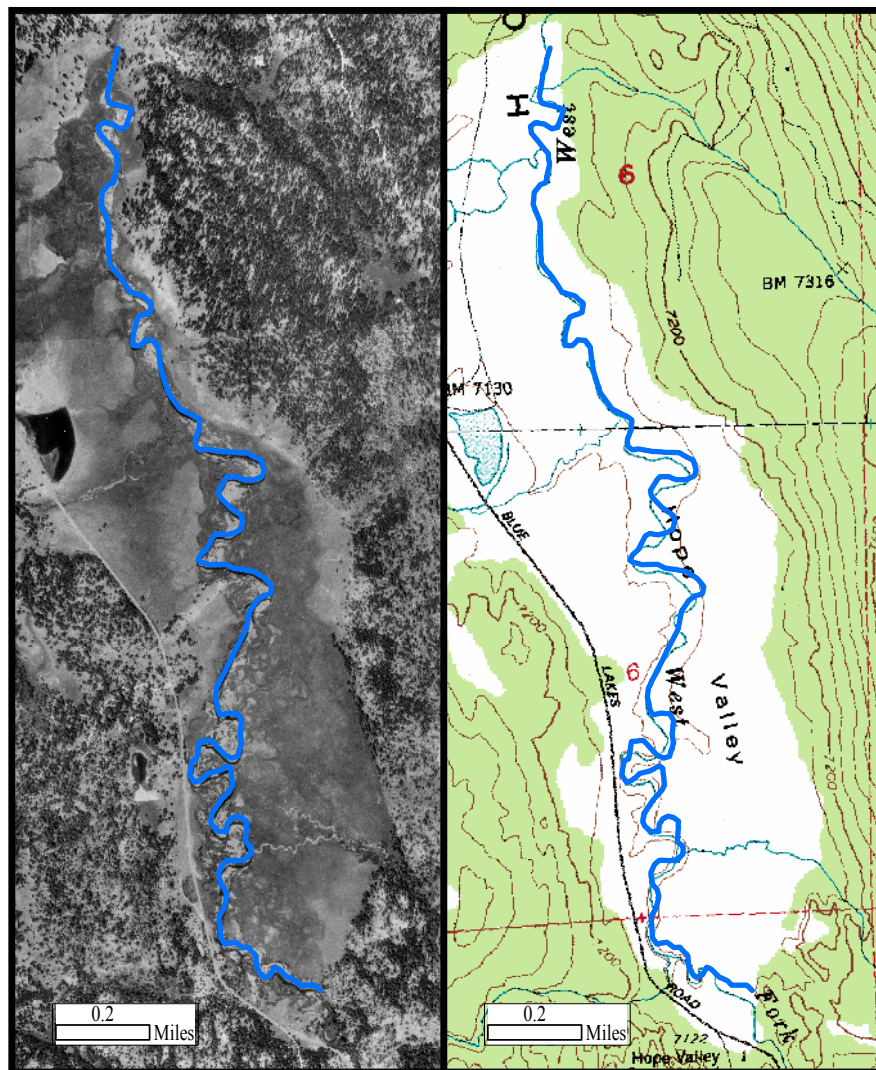
Although the stream exhibits geomorphic characteristics expected of such an area, stream banks in reaches WF8 and WF10 are relatively high and unstable. Furthermore, an arrested head cut is present at the upstream end of Reach WF10, blocked from further movement upstream by a terminal moraine. This suggests that incision or down cutting may have occurred throughout both meadow reaches. As a result, the floodplain, which would be flooded frequently in such a meadow environment, is inundated only during large flood events. Incision is a typical response to many land-use impacts including channel straightening, constriction by bridges, or intense grazing.

The riparian canopy in reaches WF8 and WF10 is discontinuous. Willow recruitment occurs on point and mid channel bars, and where bank material has sloughed. Portions of the abandoned floodplain in reach WF10 support willow complexes in topographically low spots such as older river channels. The river terrace is a wet meadow dominated by sedges and grasses. Occasional thistles are present in the meadow associated with Reach WF8. Adjacent uplands support a lodgepole pine dominated woodland. A sagebrush shrub cover is present in the understory.

West Fork 8



West Fork 10



3.2.1.9 Reach WF9

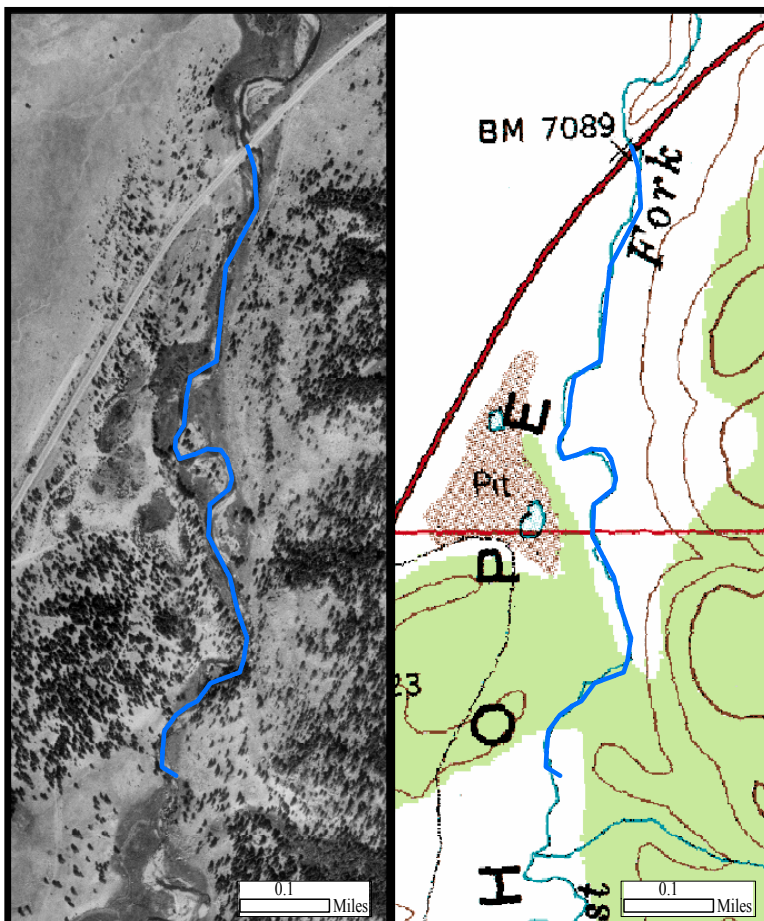
Reach WF9 consists of a relatively confined, low gradient channel that has incised through a large terminal moraine separating structural meadows found in reaches WF8 and WF10. The confinement and entrenchment through the moraine has resulted in a channel with coarser bed material (due to erosion of the moraine deposits), less sinuosity, and higher bank stability and resiliency (Rosgen B-type). Stream banks are relatively stable in Reach WF9, and there is no evidence of the incision apparent in upstream and downstream meadows.



It is likely that the relatively stable nature of the streambed and banks made this portion of the stream less responsive to conditions that caused incision in other areas. Also, the rocky terrain of the moraine probably limited the extent of the historic land use that may have occurred in Reaches WF8 and WF10. Land use today is predominantly recreation.

Observations regarding vegetation along Reach WF9 are made based on the examination of a single location and on the interpretation of aerial photographs. These data indicate that bank slopes and bars along this reach support an intermittent riparian canopy; sapling and mature willows are present.

Similar to WF7, remnant channels support dense stands of willow. Graminoid dominated meadows are found adjacent to the river.



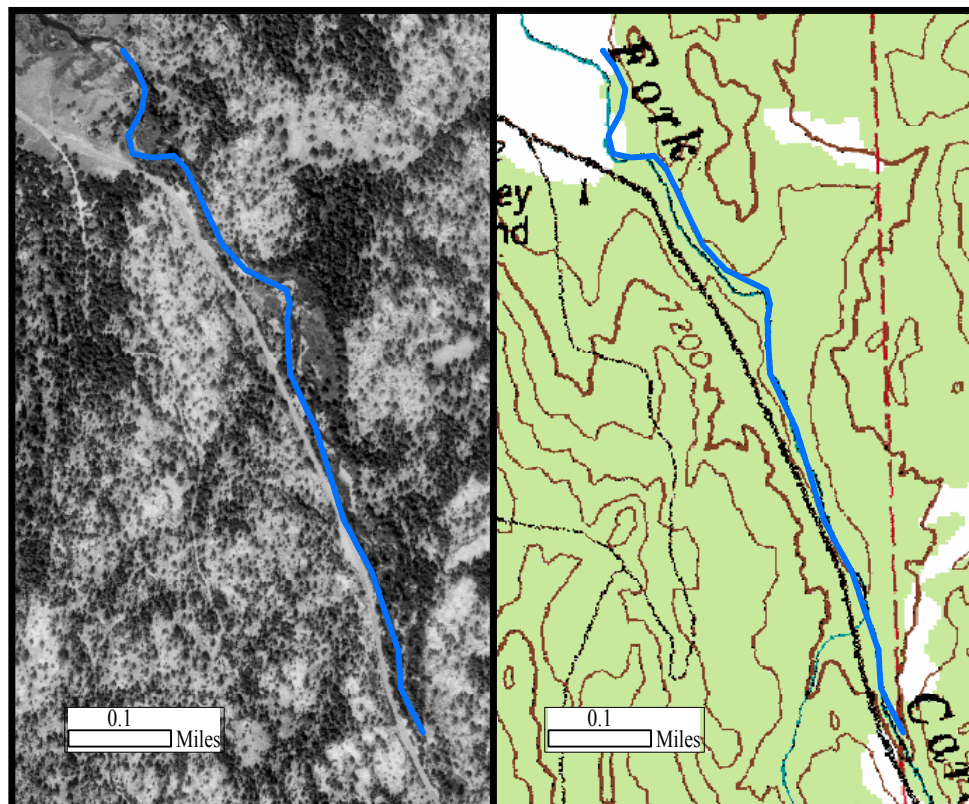
3.2.1.10 Reach WF11

Reach WF11 consists of a short, low gradient segment of channel characterized by several small structural meadows, interspersed by morainal deposits. This reach was split out from Reach WF10 because it is more functional in terms of channel-floodplain interactions and is more confined (the meadows are significantly smaller). In the meadow areas, the channel is meandering and has a gravel bed (Rosgen C-type), while the channel is straighter and bed substrate is larger in the short segments flowing through moraines (Rosgen B-type). Stream banks are relatively stable throughout this reach.



The canyon is narrow along this reach and as a result the Blue Lakes Road is near the channel in many locations. While the road had little direct effect on the channel, it does affect riparian and meadow vegetation in some locations. Dispersed camping is common, and some campsites have affected riparian vegetation along stream banks.

The riparian canopy is fairly continuous along Reach WF11 with willow species and some mountain alder present on shallow bank slopes and at the ordinary high water mark. A dense layer of wet meadow graminoids and forbs are also present in the understory. Black cottonwood is evident in the adjacent floodplain meadows, and all age classes of willows and cottonwood are represented.

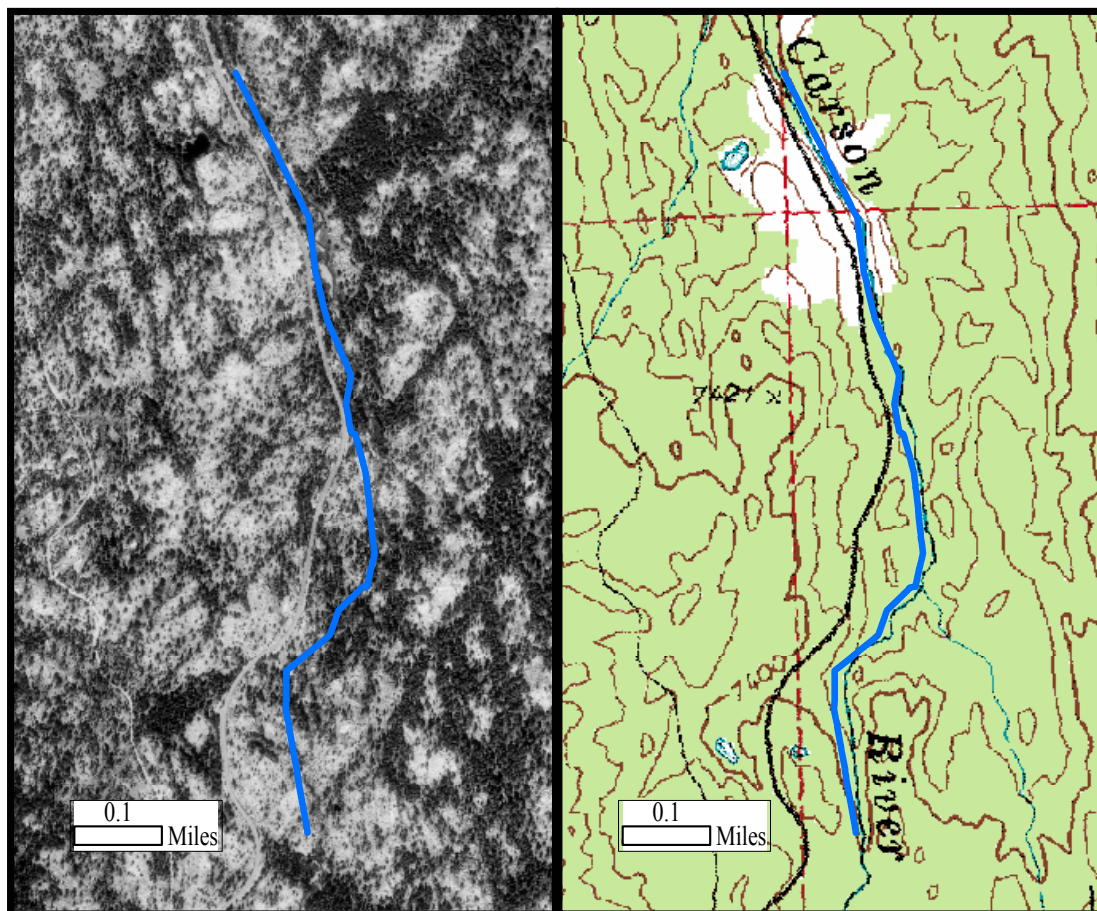


3.2.1.11 Reach WF12

Reach WF12 consists of a steeper, more confined, bedrock dominated valley. Boulder and cobble dominate the streambed and banks. The channel is straight and relatively entrenched (Rosgen B-type). Stream banks are stable throughout this reach.

Because the valley is narrow, the Blue Lakes Road is often directly adjacent to the channel. In some locations, bank protection measures have been employed to maintain the road. Because this channel type is inherently stable, road modifications have had little effect on riparian or channel function. The steep, rocky terrain limits dispersed camping.

Woody riparian plants similar to those observed along Reach WF11 are present along Reach WF12, but are confined to a fairly continuous, narrow band along bank slopes. The herbaceous component of graminoids and forbs is sparse due to lack of soil needed for plant establishment.

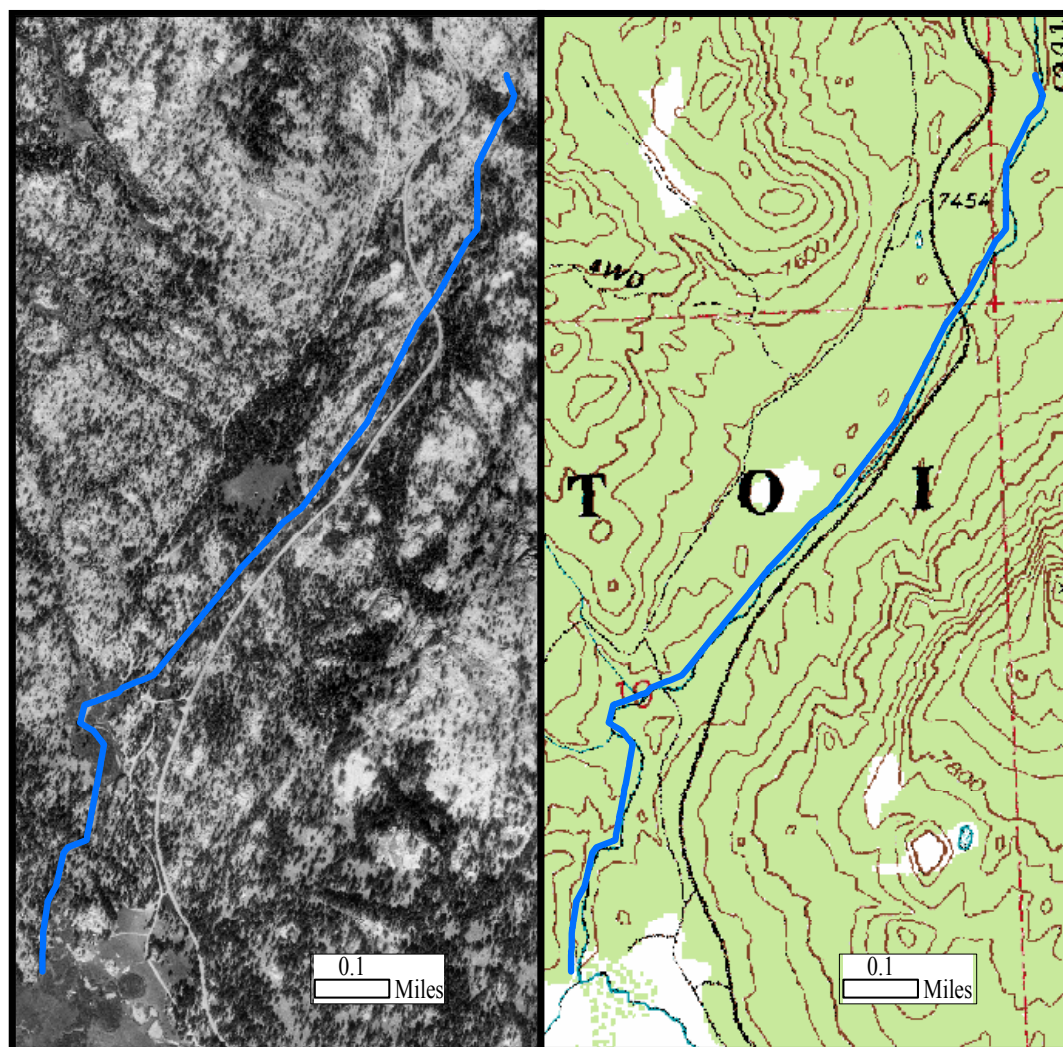


3.2.1.12 Reach WF13

The channel flattens out considerably through Reach WF13 when compared to Reach WF12, though the channel form and function appear to be similar due to the confining nature of the underlying bedrock. Reach WF13 is slightly more meandering, as this reach contains more alluvium on the valley floor. The Blue Lakes Road is not as constricting through this reach, though several road crossings are present. A large amount of woody material is present through this reach, providing a considerable amount of structure for pool formation.

Land use impacts appear to be minimal due to the resiliency of the bedrock-boulder dominated channel and banks. The upstream end point for this reach is the Faith Valley meadow system.

Reach WF13 is similar to WF11 in that where channel confinement occurs, the riparian canopy is relegated to fairly continuous willow shrub cover along both bank slopes. In meadow areas adjacent to the river, wet meadow graminoids are dominant. Dense stands of shrub willows occur in topographic lows.



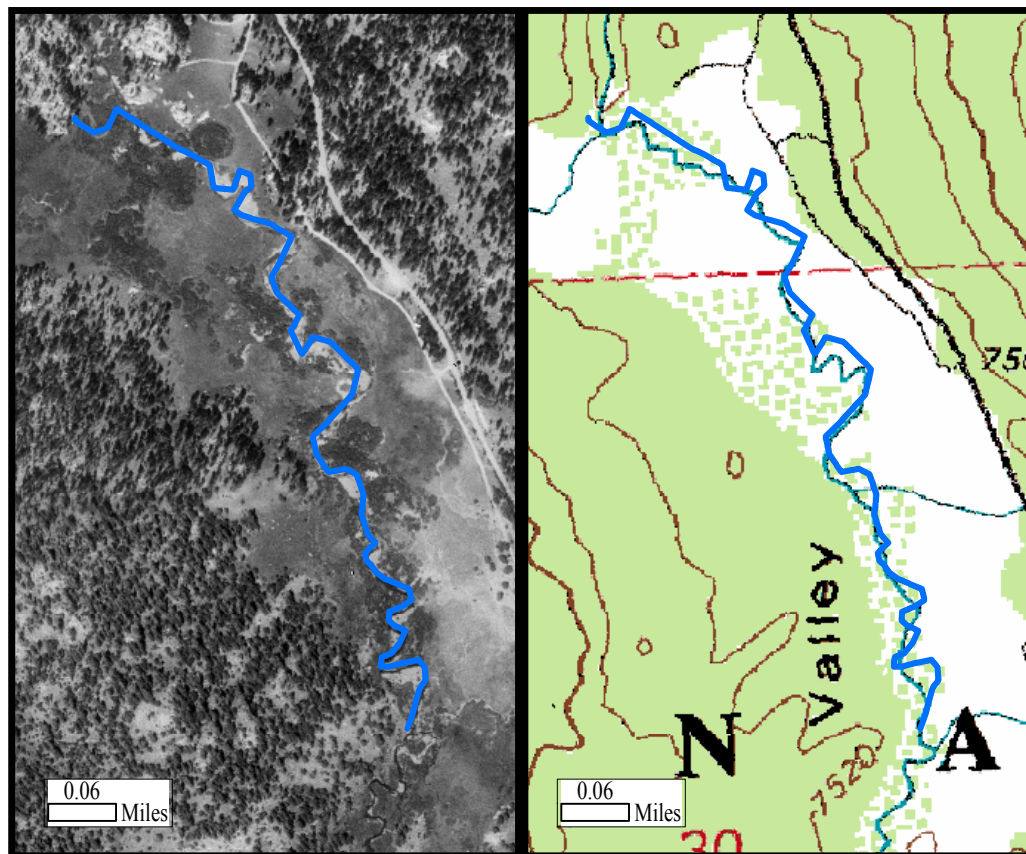
3.2.1.13 Reaches WF14 and WF15

Reaches WF14 and WF15 encompass the upstream end of the West Fork Carson assessment area and contain the entire main stem river channel through the Faith Valley meadow complex. The meadow is structurally formed at what appears to be the line of contact between granitic and volcanic strata. The stream is relatively unconfined and meandering, with lower gradient and smaller substrate (Rosgen C-type). Beaver dams appear to have a significant influence on channel morphology and floodplain function in the upper reach.

The meadow system was split into two reaches based on field observations and aerial photo analysis. These data suggest significant differences in channel conditions downstream (WF14) of a large tributary entering from the East, as compared to upstream (WF15). The tributary appears to be delivering a large amount of coarse bed load, resulting in unstable stream banks in the downstream reach. During the 1997 flood, the culvert carrying the tributary under the Blue Lakes road apparently clogged and portions of the road may have washed out.



Reach 14

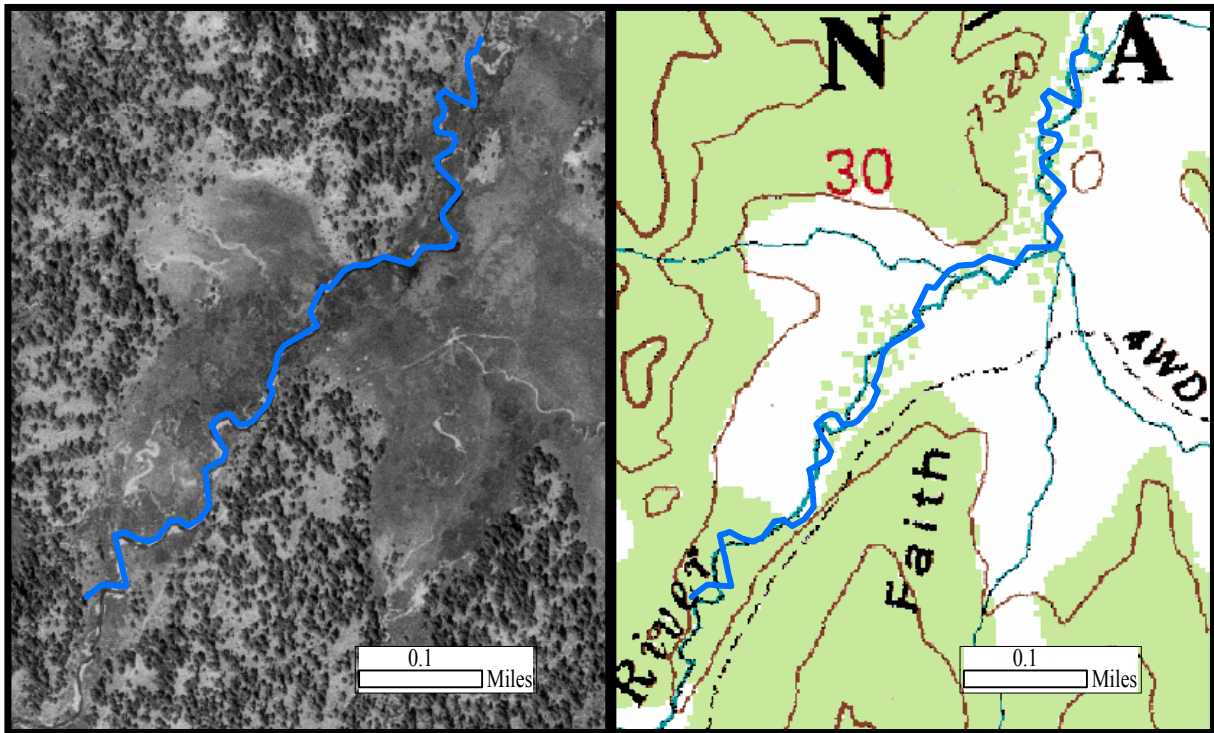


Morphology of the tributary upstream of the culvert suggests that channel modifications have occurred. These modifications may have been attempts to stabilize the road crossing in the face of high upstream sediment loads. Alternately, the modifications themselves may be at least partly responsible for high bed load transport at the culvert. Dispersed recreation is common in this area, and some impacts to riparian vegetation are evident.

In terms of riparian canopy cover, well-established continuous stands of Lemmon's willow (*Salix lemmonii*) are present along the stream banks. Young willow recruits are present on bars in Reach WF14. This canopy becomes discontinuous along the channel upstream in reach WF15 where the saturated sedge meadow becomes the dominant vegetation feature. However, willow stands are still evident in less saturated areas of the meadow providing a mosaic effect. Adjacent uplands support stands of lodgepole pine with an understory varying from shrub dominated to grasses and forb dominated.



Reach 15



3.2.2 East Fork Carson River

3.2.2.1 Reaches EF1, EF2, EF3, and EF4

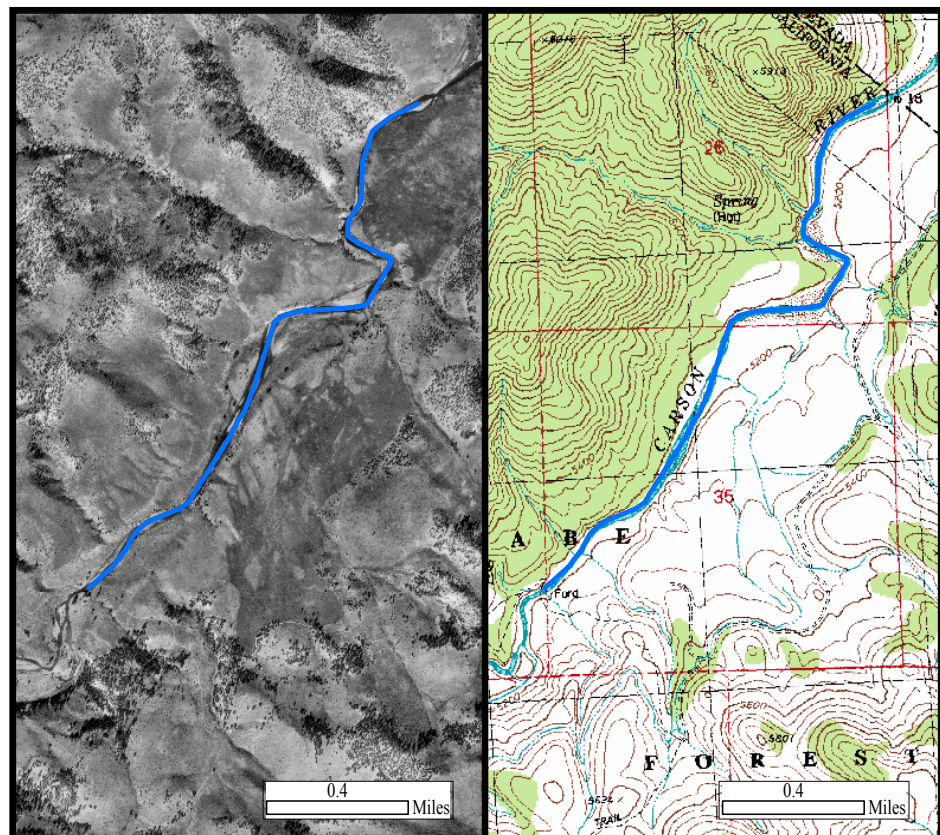
Reaches EF1 through EF4 were not visually observed during the preliminary survey due to limited access. Information regarding these reaches was obtained from aerial photos and discussions with Bureau of Land Management and U.S. Forest Service personnel familiar with the area. The downstream end point of this area is the California-Nevada state line and the upstream end point is Hangman's Bridge, approximately one mile upstream of the confluence with Markleeville/Hot Springs Creek.

The East Fork of the Carson River in the lower portions of the assessment area flows through a deep, inaccessible canyon. Reach breaks are based on the relative confinement of the valley as evidenced by the presence of a braided channel and bar and floodplain development. Aerial photos suggest that Reaches EF1 and EF3 are narrow and straight. Reach EF2 has more developed floodplain surfaces and bar features, at least partly due to less confinement by the valley walls. Throughout these reaches, the stream is likely either a Rosgen B- or C-type channel.

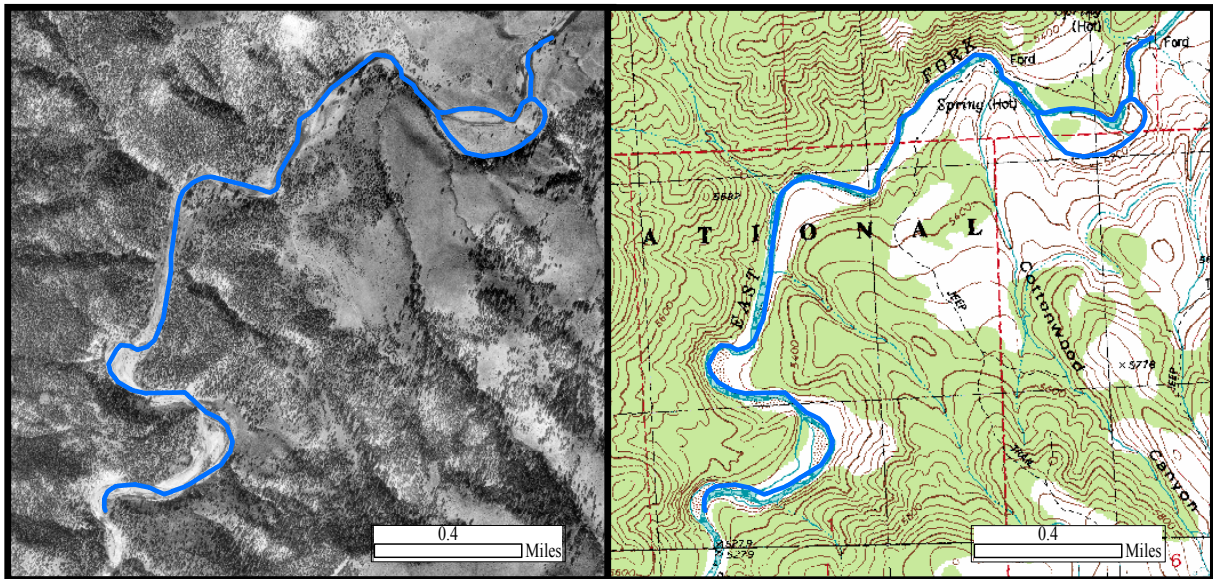
Bar formation is especially evident in Reach EF4. The west side of the reach is not confined by steep valley walls. It is also immediately downstream from Hangman's Bridge and the long, confined canyon upstream from this point. Because the canyon is so narrow upstream of this location, much of the sediment produced by the watershed upstream of Hangman's Bridge is likely transported to Reach EF4. Here, where the canyon broadens somewhat, deposition of the bed load occurs, resulting in an actively mobile channel, somewhat braided, with extensive bars.

Current land use is primarily grazing and some recreation. In the 1800's, logs were transported to Carson City through these reaches.

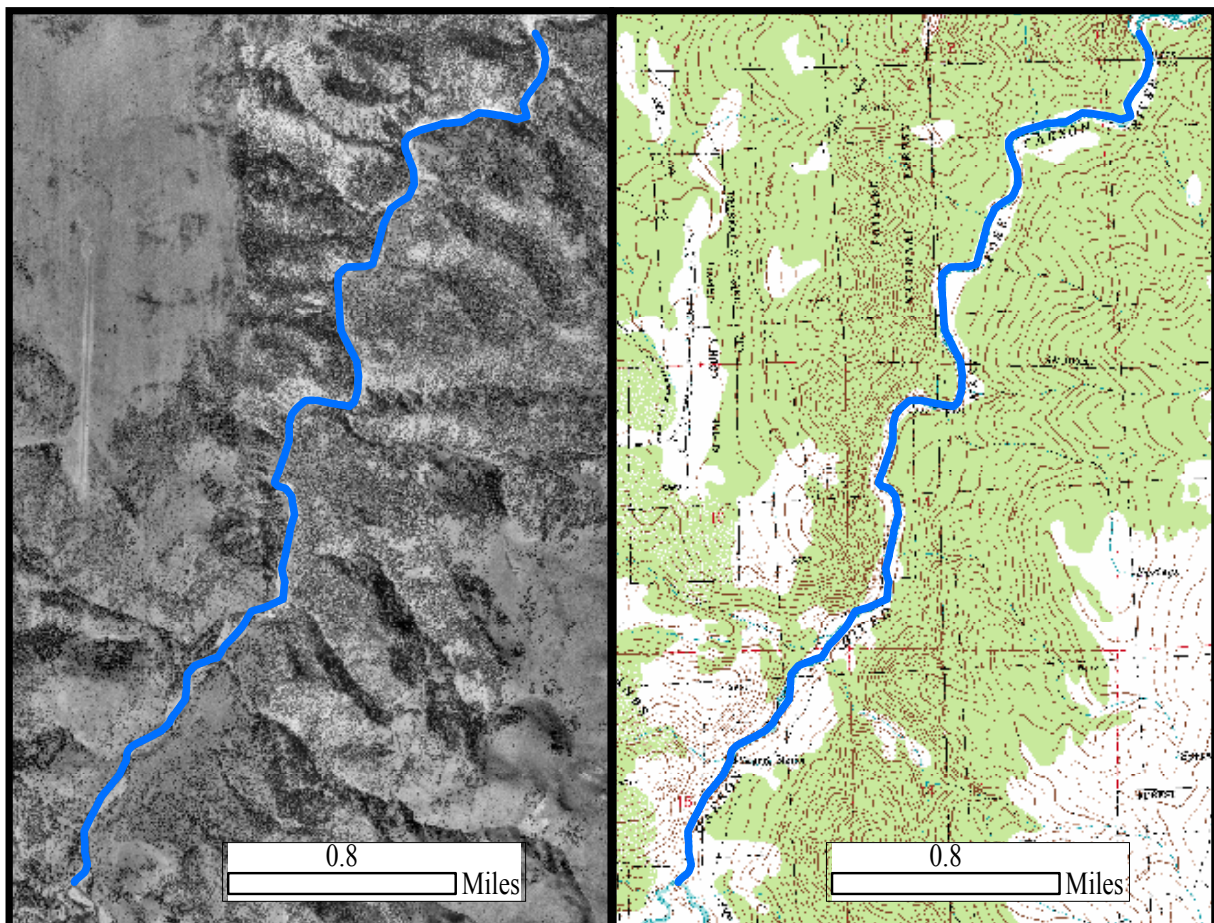
East Fork 1



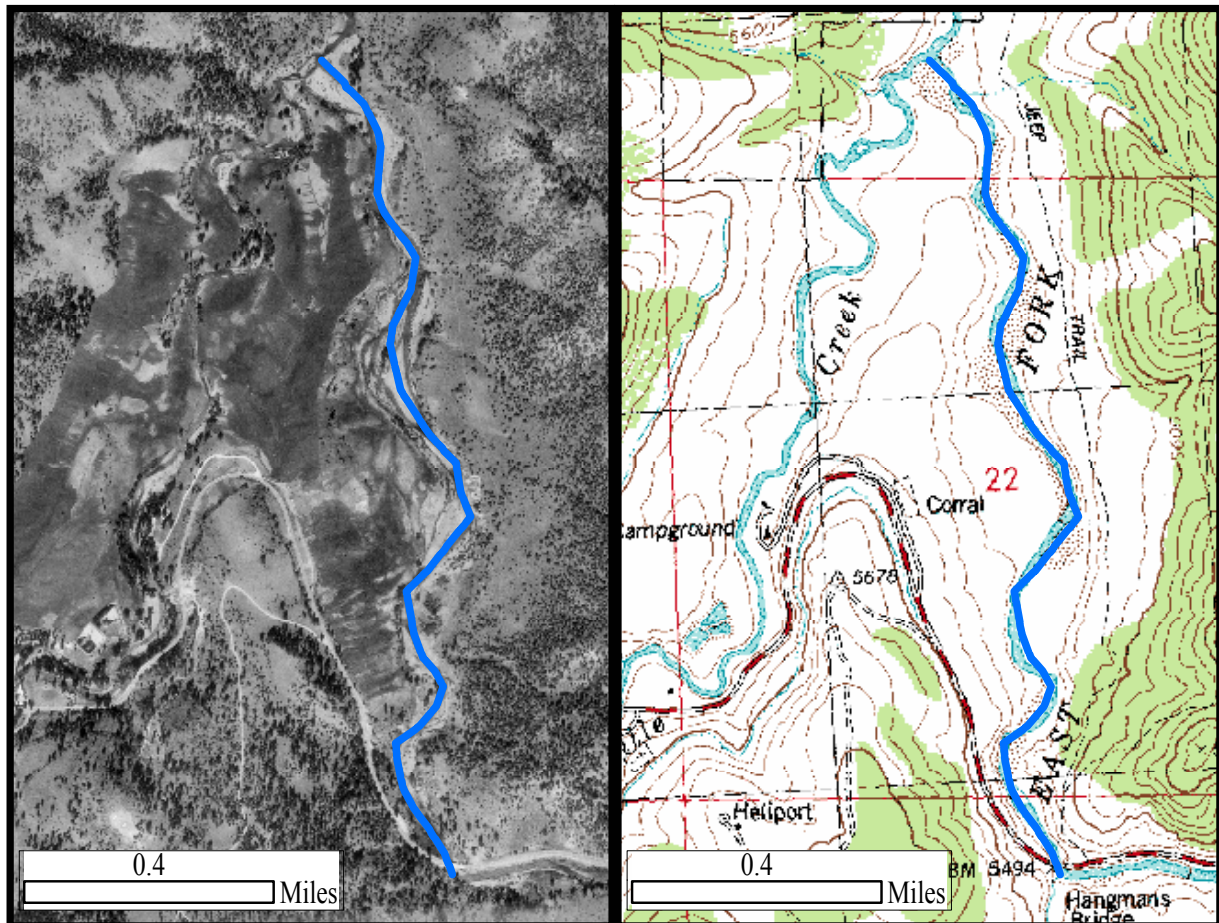
East Fork 2



East Fork 3



East Fork 4



3.2.2.2 Reaches EF5, EF7, and EF9

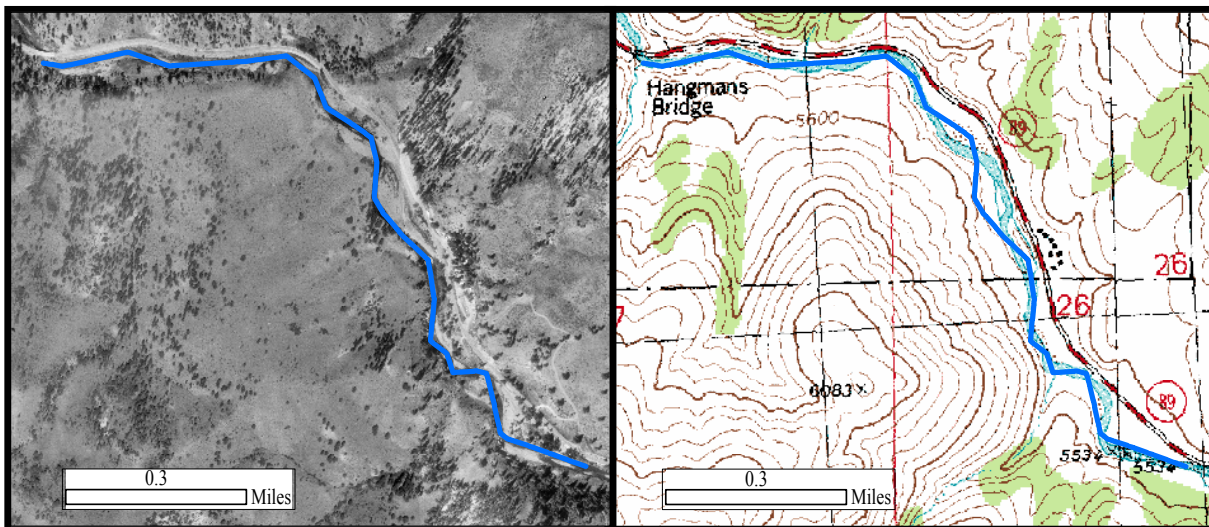
Geomorphically, the East Fork of the Carson River from Hangmans Bridge to its confluence with Wolf Creek, is fairly homogeneous. This entire stretch of channel occurs within a confined canyon that is dominated by processes external to the channel, such as debris flows and tributary fans. The channel and banks consist of coarse debris flow deposits and the valley has low sinuosity with pockets of floodplain. Morphological features, such as bars and secondary channels, form during low frequency, high intensity rain-on-snow events. During these events the channel is completely reshaped. During annual snowmelt events, these deposits are reworked to create in-channel features that define the low flow channel. All of these reaches experience naturally high bed load rates due to the steep volcanic terrain.

These reaches were split out from Reaches EF6, EF8, and EF10 based on the influence of the adjacent highway, which has a substantial impact on channel form and function. In Reaches EF5, EF7, and EF9, the highway is present within the floodplain. Some natural meanders were cut off during highway construction. Throughout these reaches, substantial portions of the historic floodplain have been taken over by the highway, reducing floodplain area (especially during larger floods), eliminating riparian vegetation, and requiring levees, groins, and revetments to protect the road from undercutting or over wash. Additionally, along Reach EF5, recreational facilities (camping, some structures) have been built in the historic floodplain.

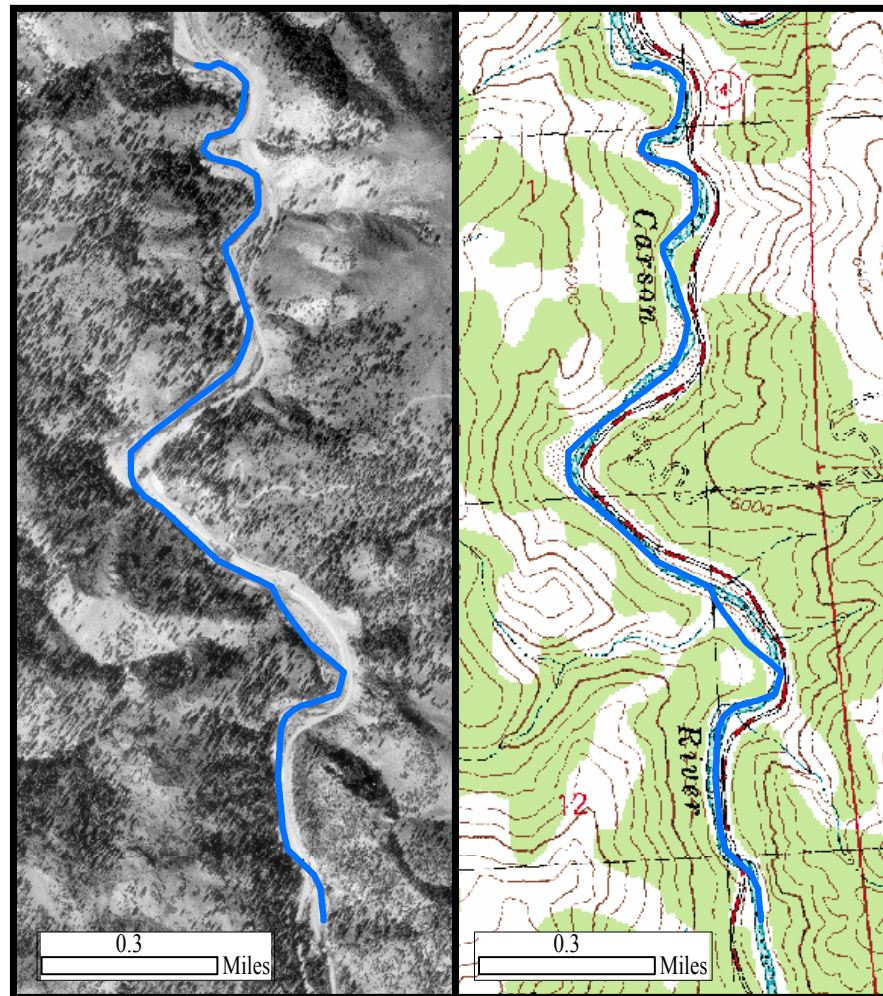
The intermittent, fairly open riparian canopy in reaches EF5, EF7 and EF9 is provided by willow species including coyote willow (*Salix exigua*). Fremont cottonwood (*Populus fremontii*) are found where a connection to the floodplain occurs along bank slopes. Infrequent young age class willows are present on depositional surfaces, while only older cottonwoods are evident as a result of disconnection from the floodplain.



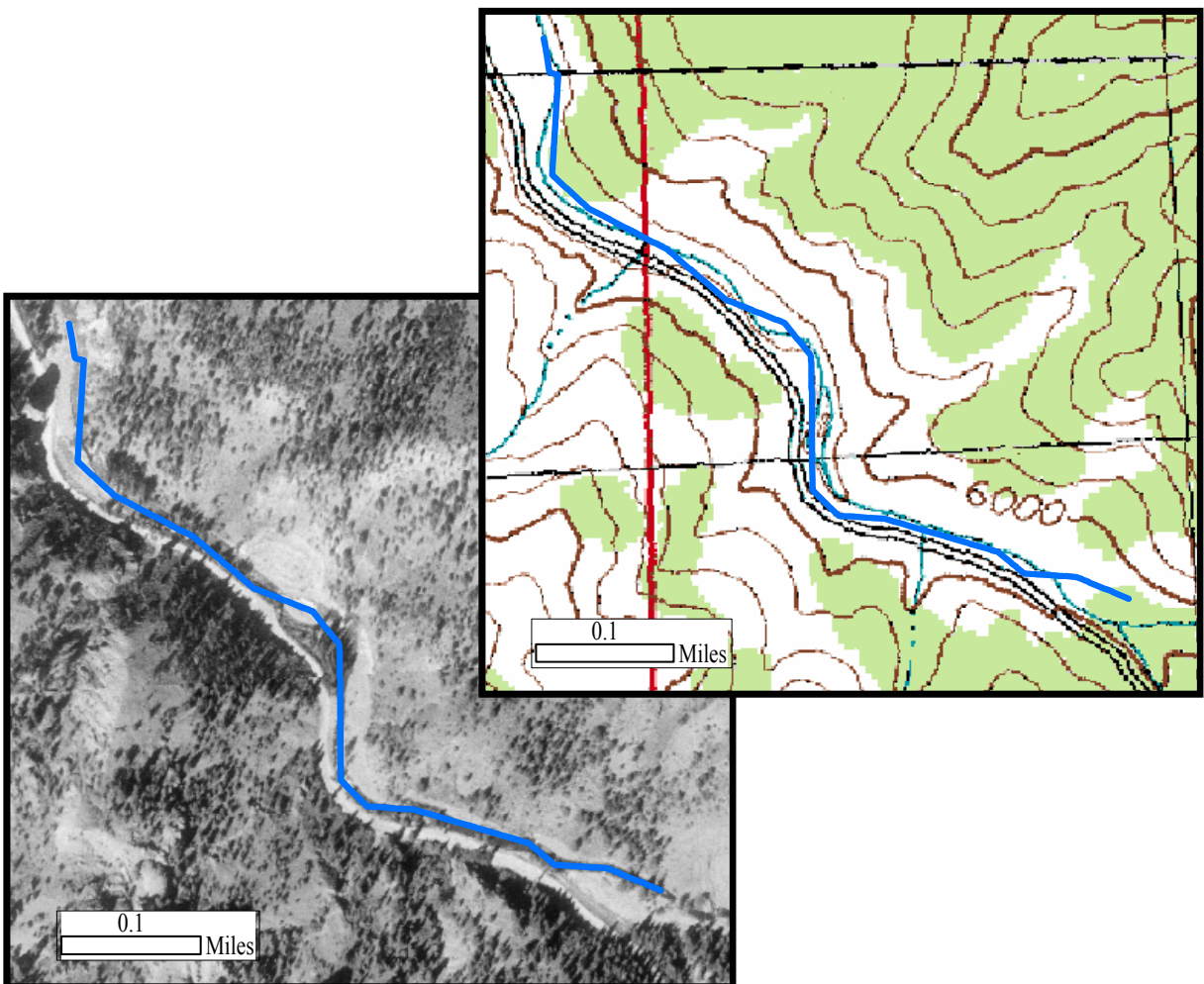
East Fork 5



East Fork 7



East Fork 9



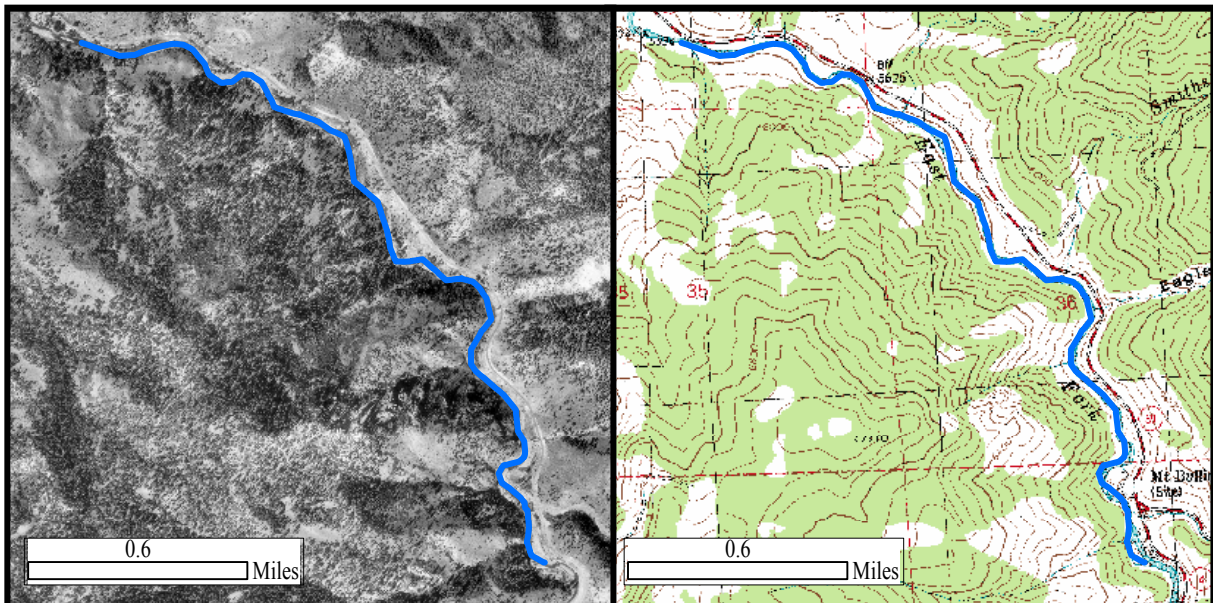
3.2.2.3 Reaches EF6, EF8, and EF10

Although reaches EF6, EF8 and EF10 are similar geomorphically to reaches EF5, EF7, and EF9, the road was constructed on adjacent hill slopes and as a result does not affect the floodplain. These reaches could provide reference conditions for the comparison of geomorphic and vegetation conditions with reaches where road-related impacts are apparent.

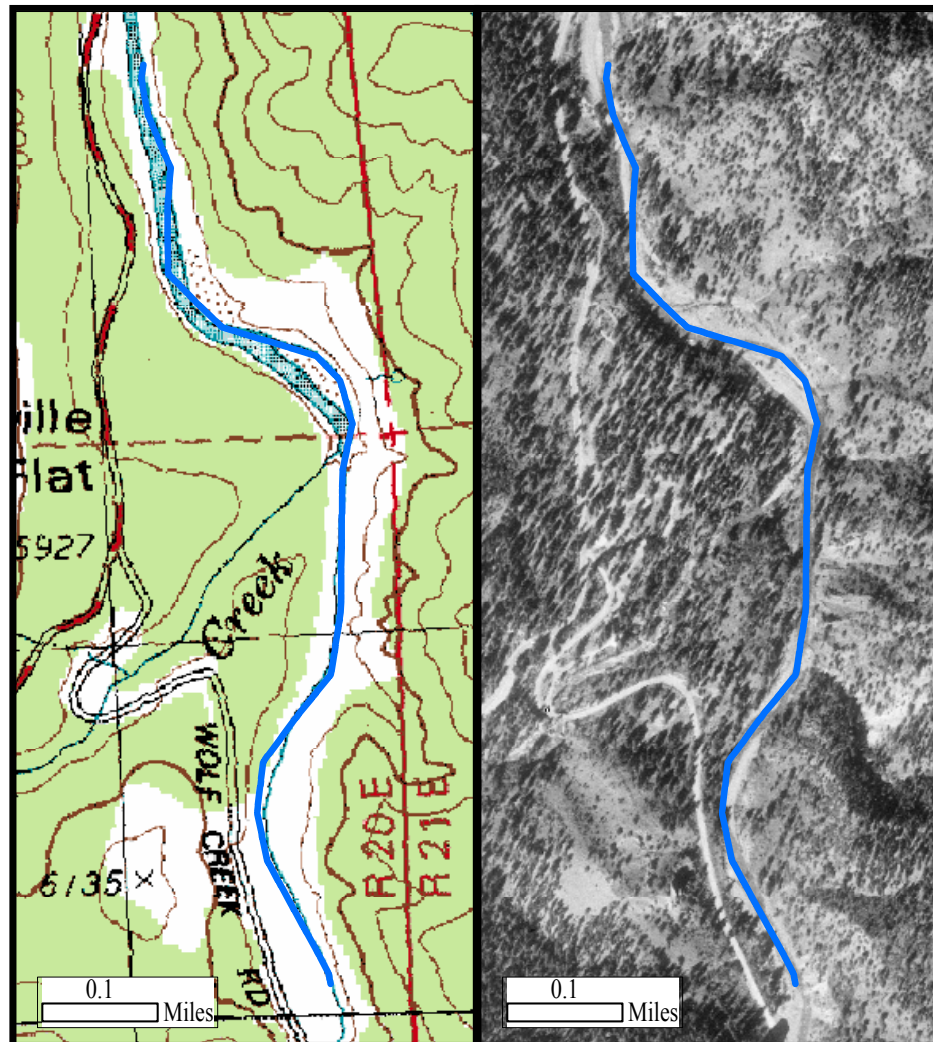
Plant species are comparable to those found along reaches EF5, EF7 and EF9. The riparian canopy is somewhat denser, although not continuous due to active channel cutting, and due to the presence of rock formations in these reaches. Multiple age classes of willows and cottonwoods are present, and connection to an active floodplain is intermittently available. Plant successional regimes are very evident and bear further scrutiny as reference information documenting more “natural” conditions.



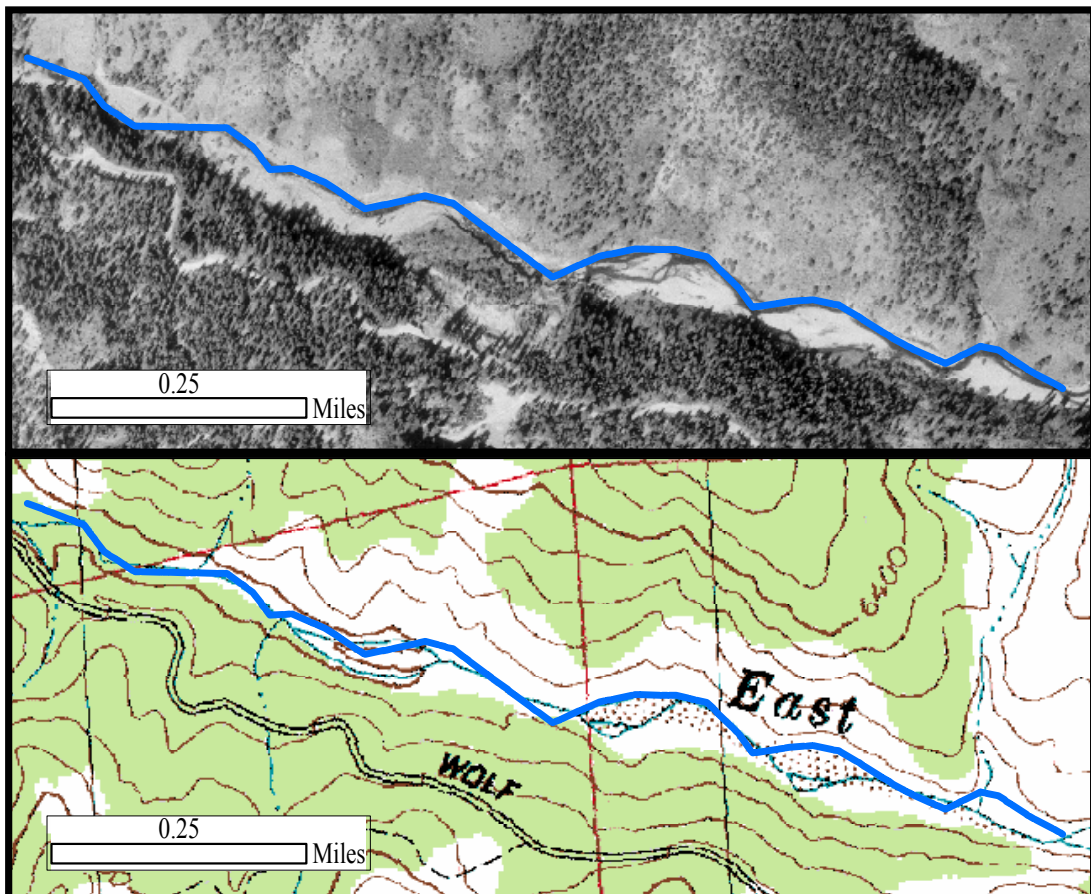
East Fork 6



East Fork 8



East Fork 10



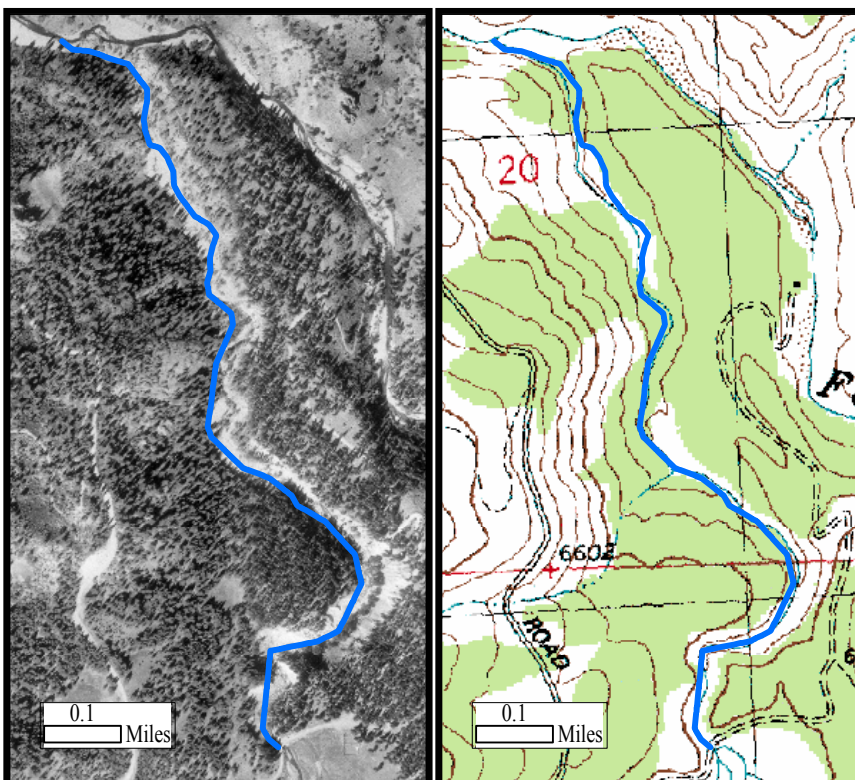
3.2.3 Wolf Creek

3.2.3.1 Reach WC1

Reach WC1 consists of a narrow, steep gorge. Reach end points are the confluence with the East Fork of the Carson River on the downstream end, up to the downstream end of the Wolf Creek meadow. Wolf Creek has cut through a terminal moraine at the upstream end of this reach, and is transitioning to the much deeper valley of the East Fork. Land sliding has occurred on both canyon walls, producing high natural sediment loads with substantial coarse bed load. The bed is composed of large boulders, which form step pool sequences with very little floodplain development.

Erosion in this canyon is predominantly the result of natural geomorphic processes. The East Fork is a much larger watershed, and has carved a deeper canyon both through fluvial and glacial processes. This steep reach represents a discontinuity between the relative rates of valley erosion in the East Fork and Wolf Creek. A gravel road near the canyon has little influence over erosion in this area.

The gradient at the upstream boundary of Reach WC1 is fairly gradual and the riparian canopy consists of dense willows located adjacent to the stream. The gradient steepens abruptly as one moves down the reach. Only one observation point provided an overview of this steeper portion of the reach. The riparian canopy is intermittent and sparse. Willow species are located on bank slopes adjacent to the creek and



infrequently in small depositional micro-sites. The few cottonwoods present are set far back from the active channel. Presumably they regenerate only during high flood events. Little opportunity exists for an herbaceous understory to develop.

3.2.3.2 Reach WC2

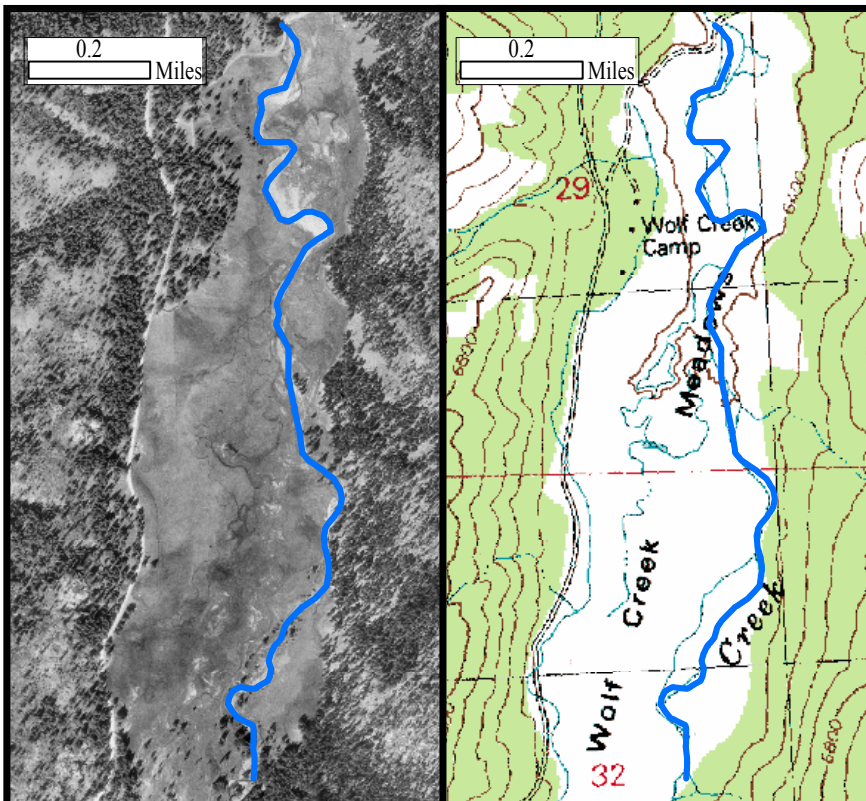
Reach WC2 encompasses the entire privately owned portion of the Wolf Creek meadow. The assessment team viewed the reach from publicly accessible points at the upstream and downstream ends of the meadow. The meadow is structural in nature, formed by a large terminal moraine at the downstream end. Throughout much of the reach, the stream channel is unconfined and meandering with relatively low gradient and a gravel bed (Rosgen C-type). However, stream banks may be more unstable and higher than would normally be expected. Similar to Hope Valley, the stream may have incised within the meadow, as aerial photo analysis of older meander scars throughout the meadow suggest that the meanders have increased in size, and the channel has widened and straightened.



Dominant land use in the area is grazing. Although grazing and irrigation may have contributed to incision, effects of large floods and bed load transport from upstream are also important factors.

The riparian canopy along WC2 is sparse and discontinuous. Where present, willows appear to be fairly young, perhaps having become established as a result of the 1997 flood event. Vegetation on elevated stream terraces adjacent to the channel consists of wet meadow dominated by graminoids.

It is unknown whether down cutting has allowed the establishment of willows on depositional features and at bank sloughing locations. It is possible that a saturated meadow that precludes establishment of willow cover is normal for this meadow system.



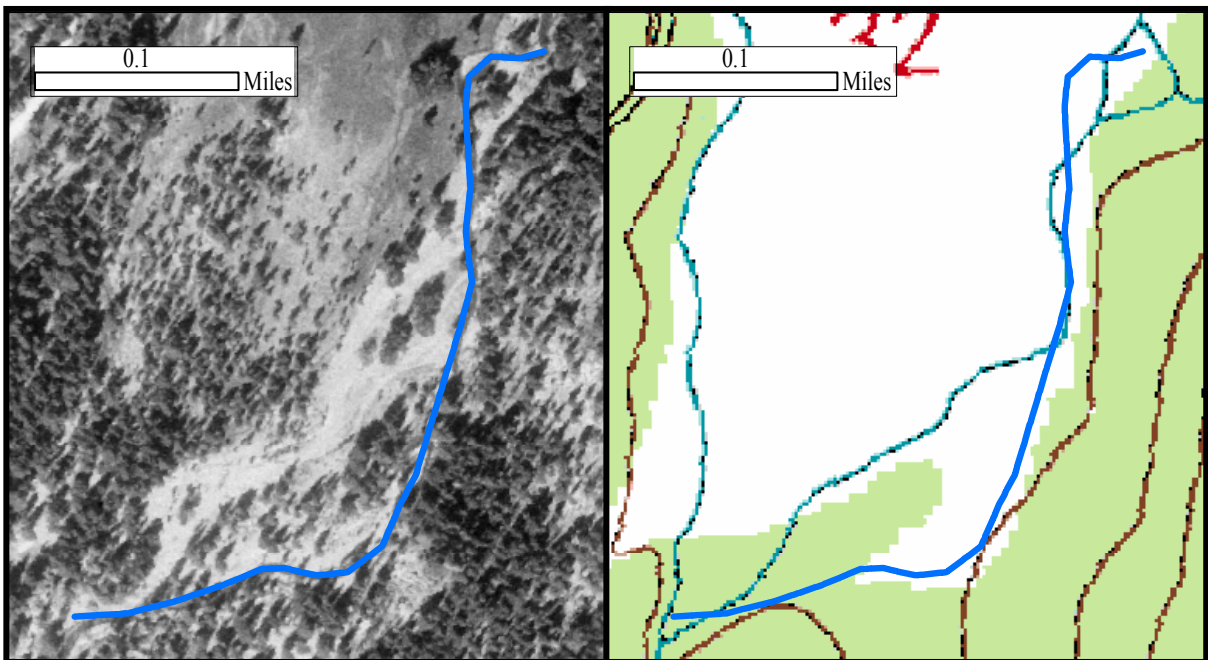
3.2.3.3 Reach WC3

Reach WC3 starts at the upstream end of the Wolf Creek meadow and continues up to the wilderness boundary. The lower portion of the reach consists of an active alluvial fan. This fan is built up of bed load transported out of the narrow upstream canyon and deposited at the head of the meadow. The channel is braided, with extensive bars. The assessment team's visit coincided with peak annual snowmelt conditions. Under these conditions the water spreads out across the valley with no clear channel present for several thousand feet. It is likely that much of the evident bed load deposition occurred during the 1997 flood, which probably changed the channel from single-thread to braided plan form.



Although the 1997 flood caused extensive changes to the channel in this area, there is evidence that similar events have occurred in the past. For example, the floodplain is hummocky and uneven, suggesting that splays of gravel are an important part of floodplain formation. Large rain-on-snow floods occur fairly regularly in the area, and may often result in channel changes like those seen in 1997. Area land uses, predominantly grazing and irrigation, may also play a role.

Riparian vegetation was not assessed during the preliminary survey as defined channels were not observed due to the presence of flood flows. Current conditions include the existence of mature conifers only slightly elevated above and adjacent to the braided channels. This suggests that spring runoff does not impair their health or longevity. It is assumed that more typical riparian vegetation is present along the main channel stem that was inaccessible during the preliminary survey.



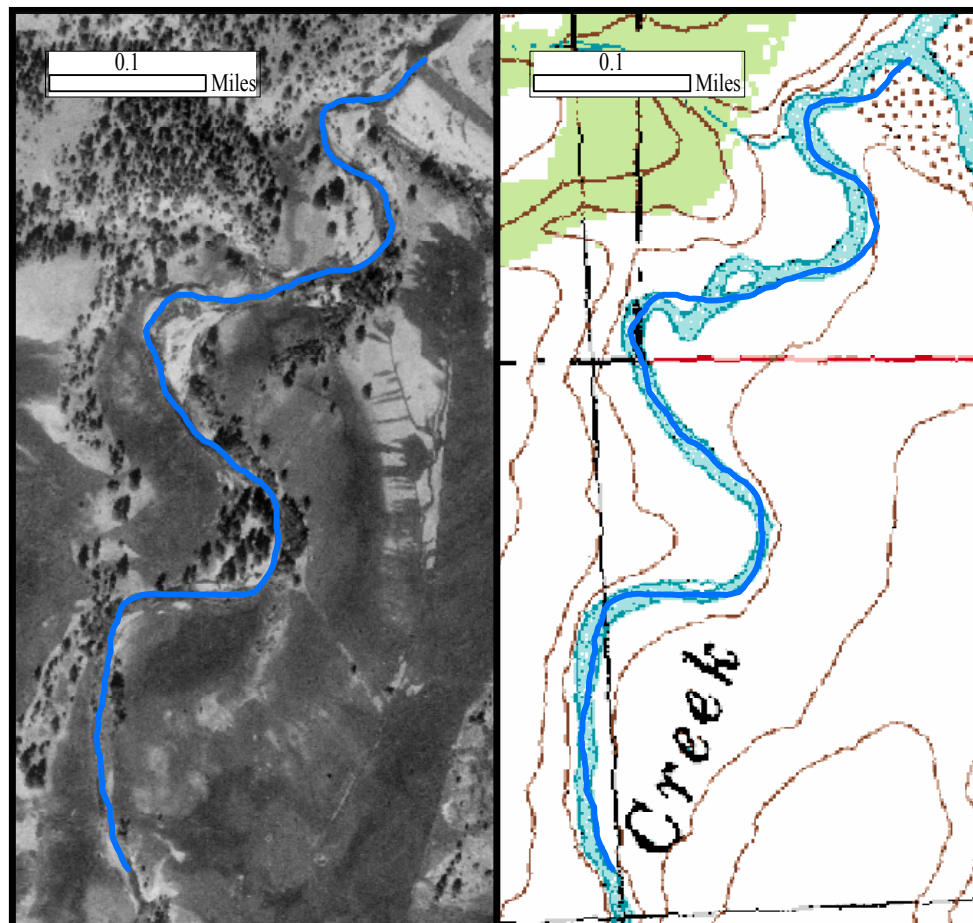
3.2.4 Markleeville/Hot Springs Creek

3.2.4.1 Reach MC1

Reach MC1 extends from the confluence with the East Fork Carson River upstream to the town of Markleeville. The reach has a moderate gradient, a gravel and cobble streambed, and is somewhat confined by surrounding hill slopes (Rosgen B-type or possibly some C-type).

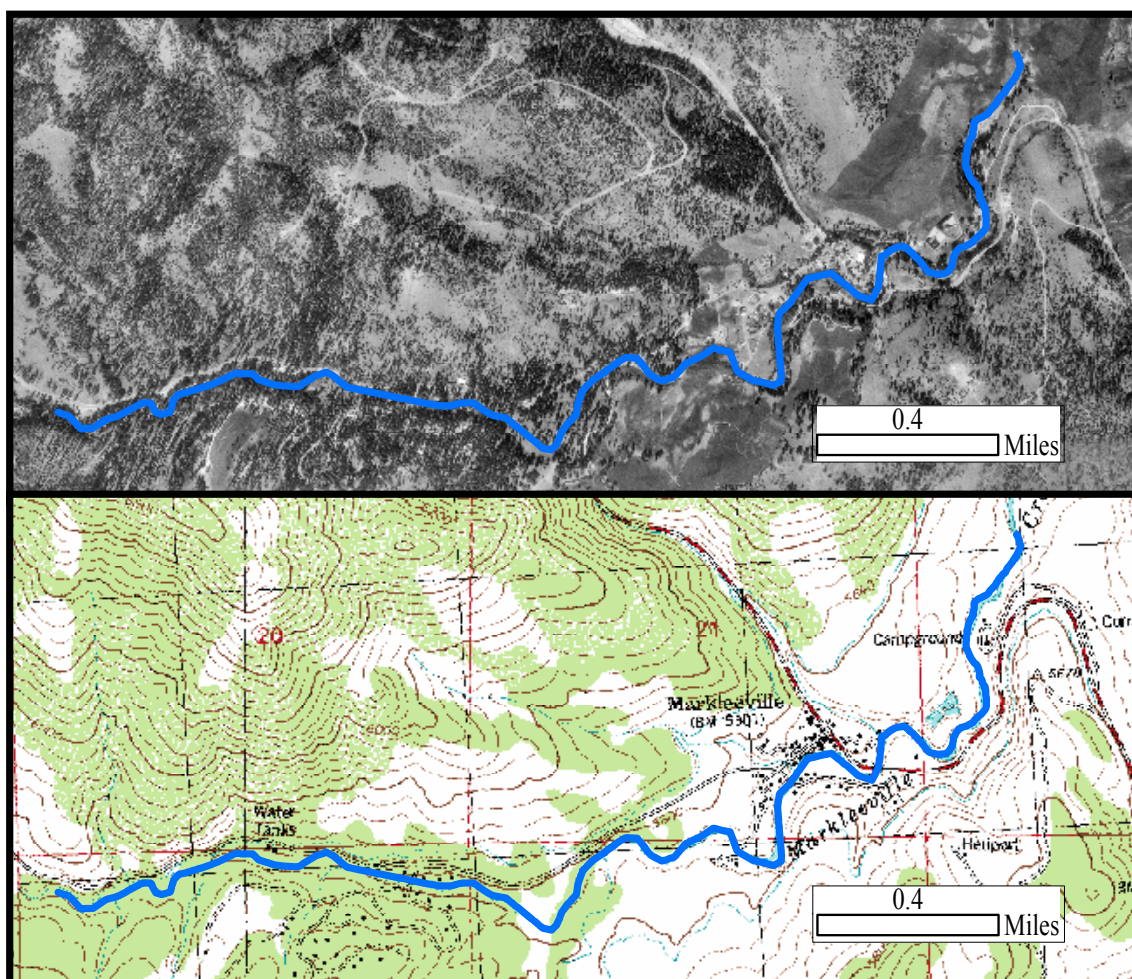
Hill slopes adjacent to the stream are pasturelands irrigated with water diverted from Markleeville Creek within Reach MC2. Due to access constraints, the assessment team was not able to directly observe this reach during its preliminary survey.

Analysis of aerial photographs suggests that more than one willow species provides discontinuous canopy cover adjacent to the stream along Reach MC1. An intermittent deciduous tree overstory, presumably black and/or Fremont cottonwoods is evident in portions of the adjacent floodplain.



3.2.4.2 Reach MC2

Reach MC2 consists of an alternating pattern of short, steep, confined, bedrock sections interspersed with wider, flatter, alluvial reaches where debris flow material transported through the narrow reaches is deposited and reworked during later floods. The short, steep segments may be areas where geologic (bedrock) confinement increases, or could in some cases be the toe of side canyon debris flow deposits. Wider segments are areas where valley wall confinement is reduced, and deposition tends to occur. There is evidence throughout this reach that sediment loads are relatively high. Fill terraces present throughout the wider, alluvial segments are evidence of high rates of sediment transport, which may be driven by periodic fire and subsequent intense rain-on-snow events.



Stream banks along fill terraces are relatively unstable. Depending on their location, erosion of the fill terraces may have either natural or human causes. In such areas, some adjustment of gradient and pattern would be expected after large sediment transport events. However, land use activities have also affected the river and watershed. Logging and road-building have occurred throughout the area. The river has been modified in some locations to facilitate irrigation diversion, and there has been some modification of the floodplain for residential development.

Highway 89 crosses the creek within this reach. This bridge may be undersized (see the hydraulic analysis in Section 4.3.3 of this report). Just downstream of the bridge, the USFS Guard Station occupies floodplain on the left bank. A flood wall has been constructed to protect the station, substantially reducing the floodplain area. Downstream of the station, the left bank eroded significantly in the 1997 flood, requiring bank stabilization to protect a sewer line.

The alternating confined and alluvial sections along Reach MC2 result in a mosaic of riparian vegetation communities. Along the confined reaches, at least two willow species and mountain alder provide a fairly continuous riparian canopy along the bank slopes near the water's edge. More open reaches (characterized by alluvial deposition) support a primarily black cottonwood overstory in the upper part of this reach, with both Fremont and black cottonwood present in the overstory as one approaches Markleeville. Both young saplings and older cottonwoods are present, suggesting a healthy, viable cottonwood population. Supporting evidence is provided in the form of willows that are actively recruiting along point and mid bars. More stable surfaces are vegetated with willows, mountain alder and wild rose (*Rosa woodsii*), while the understory contains numerous grasses and forbs. Surrounding native upland vegetation consists of Jeffrey pine forest on steep slopes.

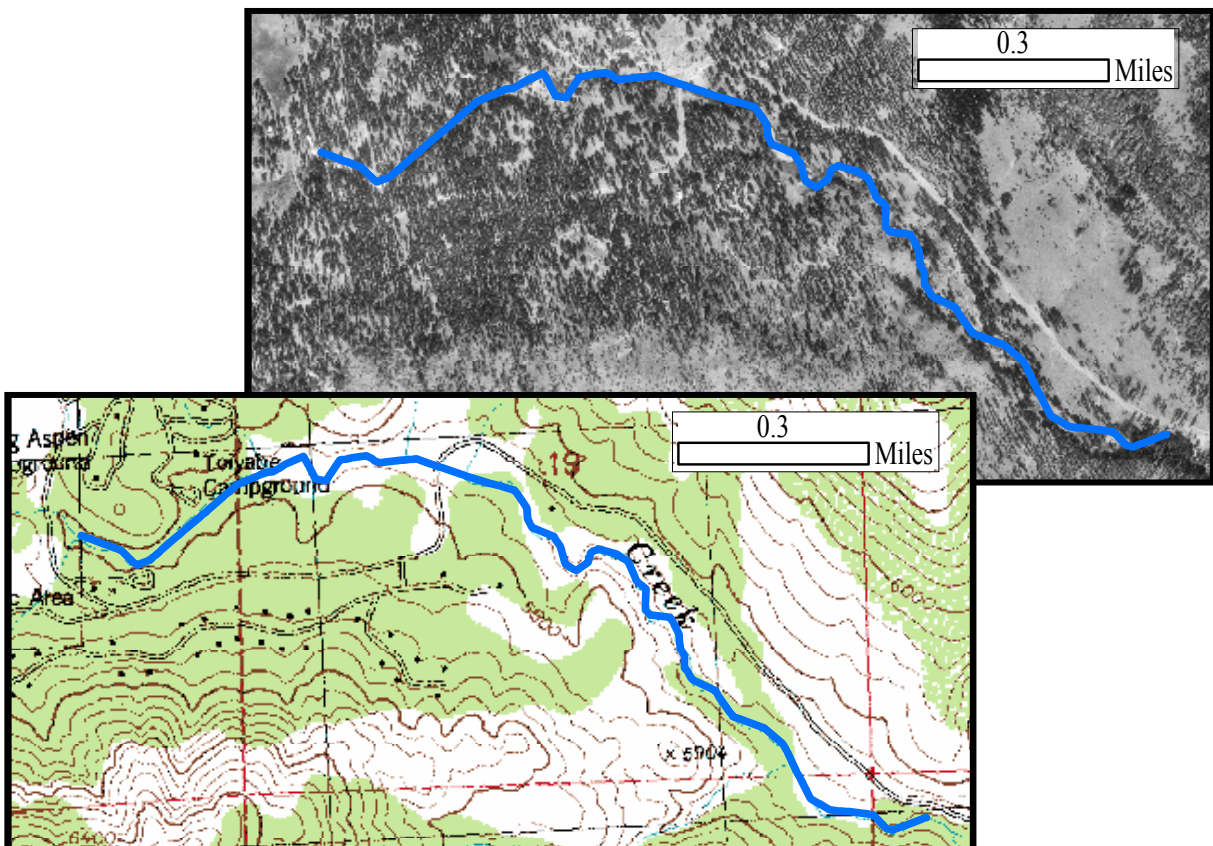
3.2.4.3 Reach MC3

Reach MC3 is somewhat more confined by canyon walls, and may have a lower gradient than Reach MC2. However, it has a similar morphology, with straighter, more confined segments interspersed with wider areas dominated by fill terraces. It appears to be transitional between morphologic conditions described in Reach MC2 and the meadow type stream channel present in Reach MC4. Stream banks in wider portions of Reach MC3 appear to be actively eroding, especially after the 1997 flood.

There is some encroachment from residential development. A fairly dense network of dirt roads parallels the channel with several crossings.



Along the upper portion of Reach MC3, riparian vegetation is confined to a narrow band adjacent to the stream. The riparian canopy is fairly continuous unless interrupted by boulders and bedrock. Common woody species include mountain alder, at least two types of willows, and creek dogwood (*Cornus sericea*). Incense cedar and lodgepole pine are found occasionally in proximity to the riparian canopy, while surrounding uplands are more commonly vegetated with Jeffrey pine and white fir forest. The lower portion of the reach contains some dense willow and wild rose thickets adjacent to the stream.



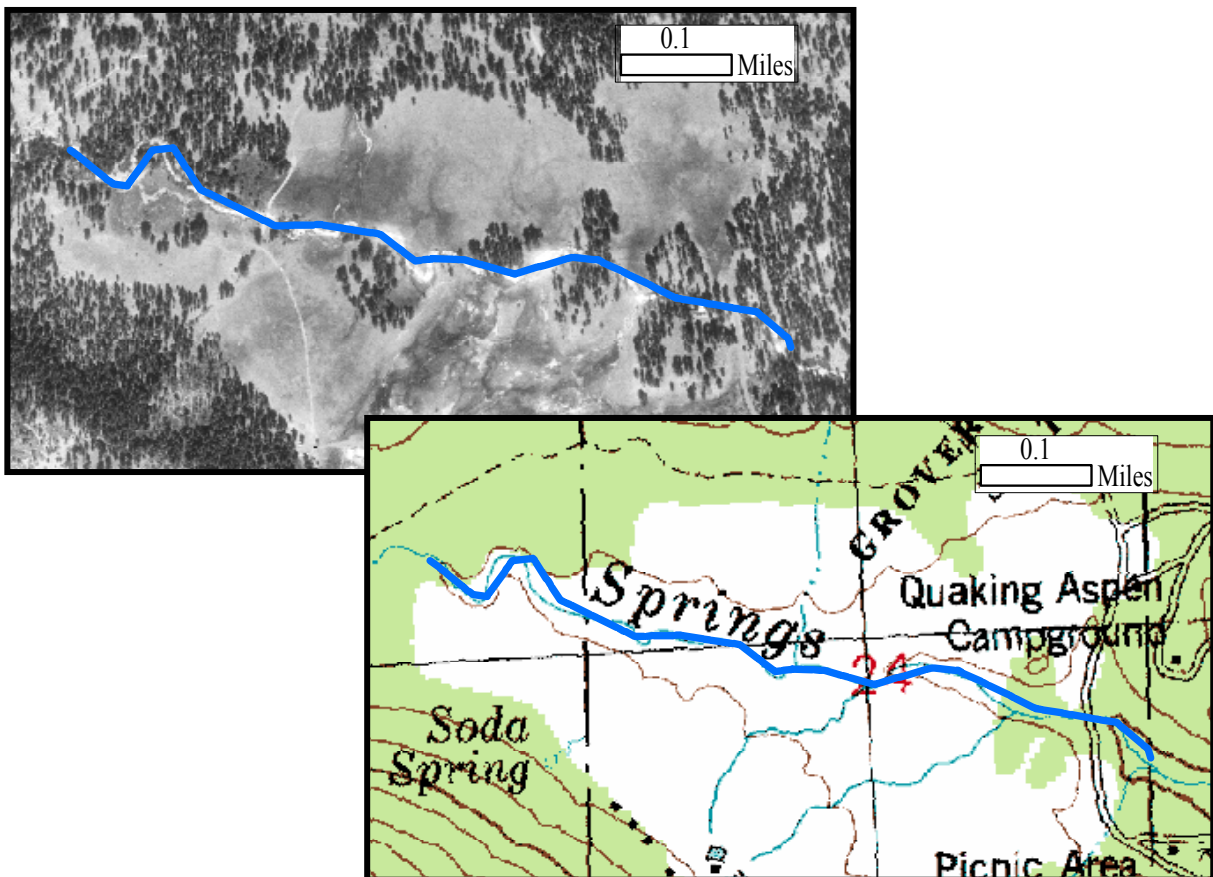
3.2.4.4 Reach MC4

Reach MC4 flows through the meadow area adjacent to Grover Hot Springs and consists of a meandering channel incised within the meadow. The channel is meandering and has a relatively low slope. Woody material and other large roughness elements such as boulders play an important role in development of habitat such as pools and undercut banks. The dominant substrate within this reach is gravel. Stream banks are relatively high, and many show signs of recent erosion. The 1997 flood appears to have substantially increased erosion in this reach.

Historic land use includes grazing and recreation. The channel is somewhat incised, which could result from past land use impacts, naturally high sediment yield from the watershed, or both.



The riparian canopy is fairly consistent throughout the Reach MC4 meadow. It is comprised of at least two willow species and mountain alder. Young willows are present at the ordinary high water elevation on depositional bars adjacent to the channel. The herbaceous understory consists of sedges and moisture loving forbs and grasses. The elevated stream terrace adjacent to the channel supports an herbaceous meadow dominated by graminoids, although some forbs are present. Lodgepole pine occasionally shades the stream as well.



3.3 Preliminary Study Results

Based on the examination and consideration of data collected during the preliminary assessment, the project team developed a list of impacted and reference areas. Impacted areas selected for detailed geomorphic analysis included the following:

- Reach WF8, an incised meadow in Lower Hope Valley;
- Reach WF10, an incised meadow in Upper Hope Valley;
- Reach WF14, a meadow in Faith Valley;
- Reach WF15, a meadow in Faith Valley;
- Reach EF6 (reference reach), flood plain;
- Reach EF7, road and levee area;
- Reach MC2, cut and fill area;
- Reach MC4, meadow near Grover Hot Spring; and,
- Red Lake Meadow (reference reach).

Bridges selected for hydraulic analysis included the following:

- Highway 89 bridge over the West Carson (Reach WF5/6);
- Highway 88 bridge over the West Fork (Reach 8/9);
- Centerville Flat Bridge, Highway 4 over the East Fork (Reach EF7/8); and,
- Markleeville Bridge over Markleeville Creek (Reach MC2).