Assessment of Riparian and Aquatic Habitat Associated with the upper Gunnison River, Gunnison County, Colorado.

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Executive Summary

Riparian zones are important for their value in providing a variety of benefits often called ecosystem services, defined as "the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life" (Baron and others, 2003). Specifically, riparian zones, including those bordering the Gunnison River, provide the following services:

- water storage and release;
- aquifer recharge;
- maintaining a higher groundwater table;
- streambank stability;
- maintaining water quality;
- and reduction of the power of floods.

Riparian areas also provide wildlife habitat, support the ecology of the Gunnison River fishery, maintain microclimatic conditions, provide marketable goods, and serve as migration corridors for a variety of organisms. Additionally, riparian zones provide many human services such as aesthetic values and places for recreation, housing and agriculture. With these functions and values in mind, we assessed the quality and function of the riparian and stream habitat of the Gunnison River between the Town of Almont and the McCabe's Lane Bridge (County Road 32), Gunnison County, Colorado in 2010.

During this assessment, we focused on riparian areas directly associated with the Gunnison River channel and divided this reach of the Gunnison River into 12 "Assessment Segments" based on similar landscape and reaches that were most effective for analysis. We mapped the riparian community from present and historical aerial photographs to determine changes; produced a soil map to indicate areas of plant community types, potential water storage/recharge zones and to determine recent historical condition; determined the extent of the active floodplain for potentially reducing the impacts of floods; and identified many of the diversion structures for reducing riparian impacts from maintenance. We assessed the riparian community for changes from historical condition, impacts that affect the ability of the riparian community to provide its functions and then prioritized some regions for protection, conservation or restoration.

We found that the Gunnison River in these assessed sections is primarily dependent upon riparian vegetation to control the morphology of the stream, prevent streambank erosion and associated land loss yet these areas have moderate to very high sensitivity to disturbance. The wide floodplain and soil types indicate that these areas have potential for water storage during high flow yet slowly release water back to the stream over the course of the summer. This is especially of value during the drier seasons where groundwater releases from riparian areas

and other shallow aquifers augments where otherwise flows would decline and water temperatures would rise as snowmelt contributions to water quantity diminish.

Overall, we found that about 83% of the linear riparian areas are still healthy and are capable of functioning and providing most, if not all, of their benefits. However, we did document a loss of approximately 50% of the riparian forests areas from 1950 to 2005 primarily as a result of increased housing and we also documented several segments constituting about 17% of the linear streambank riparian zones within this reach that have lost or impaired functions.

In our study area, agricultural and undeveloped lands tended to have the highest scoring, best and most functional riparian zones whereas regions of concentrated or dispersed housing had the least functional and most impacted riparian zones. In agriculturally dominated areas, the riparian zones were often large and generally maintained the characters of functional hydrology, functional vegetation communities and balanced erosion and deposition. The primary impacts to riparian zones in these areas were from maintenance of diversion structures and in some instances the overgrazing of streambanks resulting in an absence of portions of the plant community, streambank erosion, land loss and increased sedimentation downstream.

Areas that had high density or dispersed housing adjacent to the river corridor often included riparian zones that have lost much of their functions such as streambank stabilization, water quality protection, hydrological connection and microhabitat maintenance. The impacts were primarily the result of removal of all or most riparian vegetation with the streambank later being armored to prevent further streambank erosion and property loss. These changes often displaced stream energy and caused eroded areas on downstream riparian areas. Regions of high housing densities also had a decline in overall riparian condition through fragmentation of the riparian zones.

Riparian functions and human activities are often not congruent, however efforts can be directed to protect or restore strategic nodes to maximize riparian functions and values. Based on this, we propose that the highest priority areas for conservation and maintenance are:

- The large intact ranches and land primarily upstream of Highway 135 but below Almont Canyon that have large riparian zones. The riparian areas are some of the best in the study reach and by being upstream function to dissipate flood energy, maintain water quality and provide some degree of water storage for areas in the vicinity and downstream. Maintaining these riparian zones prevents streambank erosion and maintains healthy stream morphology while providing lateral connections between the associated groundwater that supports a higher groundwater table in the adjacent meadows. These sites also act in maintaining the stream continuum and supporting a healthy riverine ecology.

- The Van Tuyl Ranch has a riparian zone and associated wet meadows in a valley with low slope that provides a valuable groundwater recharge for area residents and provides a potential area to dissipate flood energy immediately upstream of the City of Gunnison.

- Large riparian zones throughout the study reach but also those downstream of the City of Gunnison and upstream of McCabe's Lane that function as "nodes" of large, intact riparian vegetation in valleys with low slope. These areas provide the array of riparian functions and protect regions downstream to, and including, Blue Mesa Reservoir.

- Also working with landowners to manage riparian grazing by domestic livestock so that riparian function is maintained. Recent studies have shown how important these are to healthy stream functions as well.

The highest priority areas for restoration are:

- The Van Tuyl Ranch was listed above as an area for conservation but it is also in need of restoration. Based on aerial photographs from 1950 to the present, this area has lost much of its riparian forest and thus some of the functions of a riparian area. To maximize this publicly owned land for these benefits, we recommend the restoration of the riparian community, restoration of active side channels and overland high water flow in this area to maximize the benefits of water storage, aquifer recharge, water quality protection, a productive riverine/fisheries ecology and additional flood protection for the City of Gunnison and downstream.

- Diversion structures and their associated headgates areas are found consistently throughout the study area and have impaired riparian zones and often caused downstream impacts due to diverting and concentrating stream energy. We recommend designing and engineering diversion structures for willing landowners that minimize impact to the riparian zone and reduce maintenance costs while also ensuring water supply to the diversion users.

- The riparian vegetation near the confluence of Ohio Creek and the Gunnison River has been historically altered and the change required the use of concrete and rubble to prevent streambank erosion and property loss. In doing so, this removed much of the function and benefits that a healthy riparian community provides. We recommend working with willing landowners to reach an acceptable means to restore this riparian area and to diversify the in-stream habitat that has also been historically homogenized.

- Restore wet meadows at McCabe's Lane wetlands to increase the diversity of wetlands in this area. Soils in this area indicate that the area is conducive to wet meadows and

possibly were historically a wet meadow but when the wetlands were created as mitigation for the Gunnison- Crested Butte airport expansion only pond type wetlands were created.

- There has been a removal of a large cottonwood gallery forest immediately downstream from Van Tuyl ranch. Restoration or mitigation possibly on Van Tuyl Ranch for this loss should be considered. Additionally, planning for riparian protection within the City of Gunnison should be considered. Urban riparian forests such as these protect water quality and may help reduce the impacts from floods.

- Cooperate with the diverse group of housing owners who own property in the riparian zones to design and restore areas near housing along the riverbanks to provide both aesthetic values and those of a functioning riparian zone. Primary focus should be placed on maintaining or replacing riparian vegetation within six meters of the riverbank.

Some current regulations protect riparian areas and associated wetlands. These include regulations through the Gunnison County Land Use Regulation (LUR) which protects the removal of live riparian vegetation from new development and the Clean Water Act which protects wetlands which may occur in riparian zones. However, these may be inadequate to protect all of the values and functions of riparian areas along the upper Gunnison River. Based on the best available science, and in order to protect all values of the riparian areas along the Gunnison River, riparian habitat buffers should range from 75 to 300 feet with corrections for land use intensity, wetland category and slope of surrounding landscape. These buffers will help to protect water storage, water quality, flood energy dissipation and ecological functions in the Gunnison River. More restrictive regulation or, more importantly, education of land managers, developers and property owners to the importance of conservation of riparian areas that exist along Gunnison County water bodies would be valuable in providing protection of these areas and their functions into the future. Additionally, educational efforts directed at preventing or reducing streambank armoring should be considered.

Riparian areas are very complex systems that require working across many scales and land ownerships to maintain their functions; of whose importance has only begun to be understood within the last few decades. Ultimately, protecting riparian zones in the upper Gunnison Basin provides inexpensive water storage, maintains water quality, supports the fisheries and increases the recreation and quality of life values. We recommend that the Upper Gunnison River Water Conservancy District remain an active participant in scientifically based land use planning, restoration, conservation and management, especially on ranchlands, in housing developments and within the City of Gunnison, so that the riparian areas along the Gunnison River maintain their functions and remain resilient to protect against future changes.

We hope that this document provides a reference condition to which future changes, either positive or negative, can be measured through an ongoing monitoring and assessment program. We also hope that the assessment and recommendations provided here provide valuable tools to the stakeholders in this region and to the Upper Gunnison River Water Conservancy District (UGRWCD) so that they may continue their stewardship as described in both their "Mission Statement" and "Values Statements."

Contents

Introduction to Riparian Ecology and Functions

Riparian zones are defined in various ways and these definitions are often context specific. In xeric (=drier) regions such as in the Gunnison River watershed, we define the riparian zone as an ecotone (=transitional zone or interface) between the aquatic area and the terrestrial area with a plant community dominated by shrubs such as willow and alder. Riparian vegetation can be classified into three types: Hydroriparian, Mesoriparian and Xeroriparian (Johnson and others, 1984). Hydroriparian systems occur on sites with hydric soils or substrates that are almost never dry (i.e. perennial or near perennial rivers or streams), Mesoriparian systems occur on sites with non-hydric soils and substrates that are seasonally dry (i.e. intermittent reaches of streams), and Xeroriparian systems occur on sites that only infrequently experience moisture in excess of precipitation (i.e. ephemeral streams)(Lichvar and others, 2004) . Along the Gunnison River, the riparian vegetation is exclusively Hydroriparian and Mesoriparian. Additionally, often in a management perspective and separate from an ecological definition, the riparian zone is defined as the width of the riparian buffer or a defined distance from a water body that is used to protect the aquatic or riparian habitat.

The riparian vegetation is often distinct from the surrounding vegetation within a watershed such as the Gunnison River and it is visibly more green and lush compared to the surrounding forests, shrublands, sage steppe and grasslands. This vegetation has a variety of functions including providing nutrients and energy in the forms of organic matter from leaf fall, woody material and other organic carbon sources along with other nutrient inputs that are released into the stream. These materials often “drive” the stream’s ecology as well as providing habitat and substrate for aquatic animals such as bacteria, fungi, aquatic insects and fishes.

The riparian vegetation provides a change in microclimates along the stream such as shading the stream, altering the temperature regime, decreasing wind speed and maintaining humidity. Recent studies (Loheide and Gorelick, 2006) have further elucidated and quantified these connections in western U.S. streams by remotely measuring stream, riparian and meadow temperatures (Figure 1).

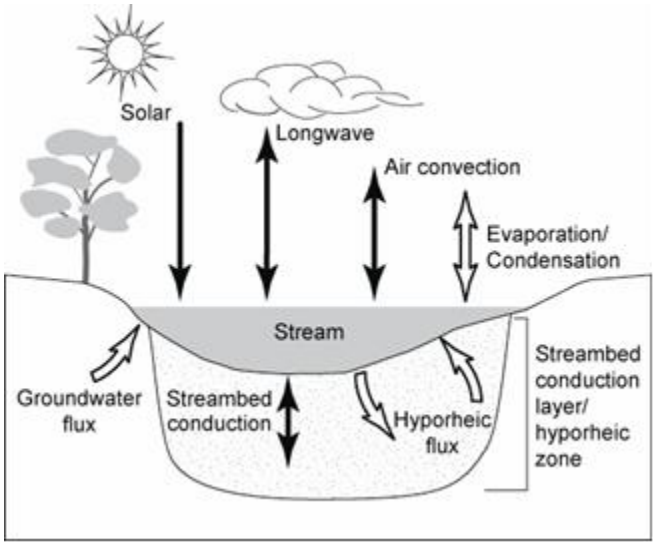


Figure 1. Heat exchange mechanisms affecting stream temperature. (from Loheide and Gorelick 2006).

All of these vary seasonally as the riparian vegetation changes. The riparian vegetation also can contribute to bank stability and help dissipate the energy of moving water to reduce erosion especially during flood events and protects humans and other organisms.

In particular, both large and small woody debris that predominately originates in riparian areas, provides geomorphic structure to the stream. The woody debris contributes to channel stability, diversifies the instream habitat, forms pools and provides habitat for a variety of species. This habitat is important to organisms seeking refuge from predators, provides a refuge from strong flows, and traps other matter providing additional habitat for a variety of organisms including fish. Woody debris provides a food source for the microbial layer growing in the stream (=biofilm) and is used for a carbon and nutrient source. The biofilm then in turn provides a food source for many small macroinvertebrates. Additionally, the wood provides habitat for other macroinvertebrates especially collector-filterers that filter particles from the passing water.

Riparian zones also function as a zone of the transmission of groundwater and upslope water from colluvium (i.e.; unconsolidated sediment at the base of slopes deposited by gravity), in the case of Gunnison River, into a stream, lake or wetland. In addition, exchanges from the stream to the groundwater in the riparian zone can occur thus ameliorating some of the drastic changes in flow throughout the year, season or day. In this way, riparian zones help maintain water quantity in streams (Figure 2) (Loheide and Gorelick, 2006; Loheide and Gorelick, 2006; Braatne and others, 1996). Many people and the agricultural industry in the Gunnison Basin derive their water from the river and the hydrologically connected adjacent aquifer. Proper

management of the riparian zone in this region can help maintain this water supply and protect against changes in supply and provide a buffer against the random nature of precipitation.

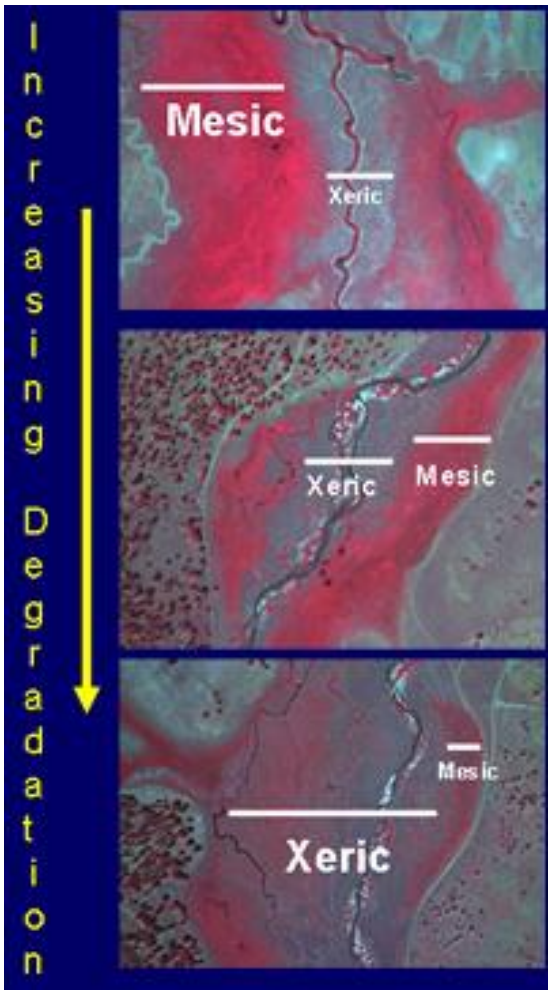


Figure 2. Illustration from Loheide and Gorelick (2005) showing the connection between degraded streams and riparian zones with increasing aridity in the valley.

These riparian zones act as filters to intercept sediment or nutrients that would enter the stream and otherwise decrease water quality. The sediment can be trapped by the riparian vegetation because the riparian zone has a lower gradient than the surrounding areas and thus reduces the velocity of water flowing overground. The vegetation also acts as a filter to slow the water velocity and to trap this sediment. The nutrients, such as phosphorus or nitrogen, or ions and metals from surrounding land use can be absorbed by the plants through the uptake of riparian groundwater. Thus, maintaining riparian vegetation is important to maintaining water quality.

Recently, the high degree to which aquatic habitats and riparian zones interact and are linked has been documented (Polis and others, 2004) and the scientific community has begun

understanding how these systems are energetically dependent on each other. The food energy and nutrient transfer between the two systems is considered a "cross ecosystem subsidy" where food energy from each system is supplied to the other. Some studies (Wipfli, 1997) have shown that fishes such as trout depend on terrestrial invertebrates from the riparian and upland zones for as much as 50% of their energy. Additionally, the flow of adult aquatic insects from the stream system feed terrestrial animals such as birds, bats and other insects. Additionally, bears, dippers, otters and minks may also depend heavily on aquatic organisms for food sources. These systems are then linked energetically to other systems further away by the downstream movement of water. Due to this ecological connection, we can no longer think of these systems as separate systems but as one contiguous entity. These connections have important management implications on how riparian systems may affect aquatic systems, support productive fisheries and maintain rare species.

Healthy rivers and riparian zones are necessary wildlife habitat and corridors. These systems often comprise less than one percent of the landscape yet are often utilized by a disproportionately high number of wildlife species and perform a disparate number of ecological functions, some of which are described above. These zones across the landscape often function as corridors for wildlife movement and dispersal between larger areas of habitat. Thus, keeping riparian zones intact helps protect biological diversity, allows animal movement, enhances gene flow and provides habitat to animals either outright or during periods of disturbance (Fischer and others, 2000). Rare or imperiled species that have been documented or suspected along the upper Gunnison River riparian zones include river otters, yellow-billed cuckoos, boreal toads, Gunnison sage-grouse and northern leopard frogs.

Riparian buffers also are significant because they offer a potential check against the effects of increased precipitation and runoff predicted by some models of climate change (IPCC). Overhead leaf canopy mechanically slows water velocity as it falls, thereby reducing the eroding capacity of the water and the ability of it to carry other particulates. Riparian vegetation absorbs greenhouse gases and store carbon in biomass and soil that may ameliorate or buffer against climate change. Managing for these functions will also provide a degree of resiliency within the aquatic and climatic system.

Overall, riparian systems have many values including benefits to: water quality and quantity; wildlife and biological diversity; and human quality of life. They reduce pollutants and trap sediment that improves water quality and through the interactions with groundwater they store and release water that supplies flow to the stream. The riparian vegetation also reduces the energy carried by flowing water thus decreasing the impacts of floods. The riparian zones have been considered "keystone nodes" within the landscape where a disproportional amount of wildlife and other biological diversity is dependent upon them (Naiman and others, 2005).

Human quality of life is greatly improved by riparian zones because humans use them for activities such as water based recreation and non-motorized transportation plus there are numerous social benefits of recreation in riparian zones such as hiking, running, hunting, skiing, walking and nature observation. In addition, these riparian zones also act as carbon sinks within the carbon cycle that may help with climate regulation. Therefore, riparian zones are critical to healthy streams, watersheds, and ecosystems as well as providing immeasurable benefits to allow humans to lead quality lives.

Introduction to the Riparian Areas associated with the Gunnison River between Almont and McCabe's Lane

The study area encompasses riparian areas that are associated with approximately 16 miles of the Gunnison River that lies between the Town of Almont and the McCabe's Lane Bridge. This reach of the Gunnison River is of low gradient and is situated in the sagebrush steppe, ranchlands and alluvial plain that comprise the upper Gunnison Valley in the vicinity of Gunnison, Colorado (Figure 3).

The terrain includes: drier, sagebrush hills that descend to the river in steeper less developed areas (Figure 3, Map 1), the ranchlands and associated pastures that are indicative of the upper Gunnison Valley along with various developed landscapes associated with development within the City of Gunnison and Gunnison County subdivisions.

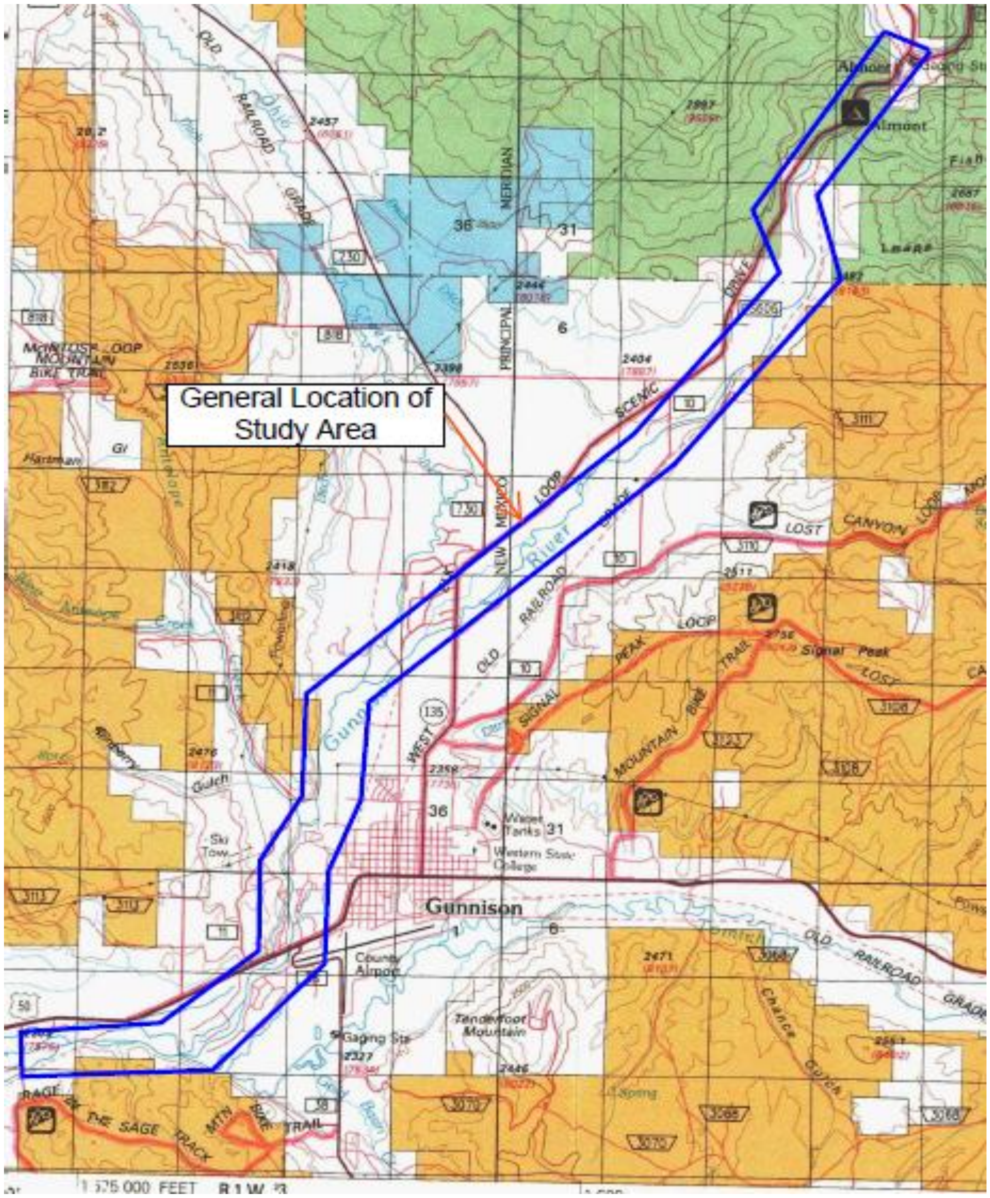


Figure 3. General Location of the Study Reach between the Town of Almont and the McCabe's Lane Bridge.

Vegetation

The Gunnison River within the study reach supports a prevalence of Hydroriparian (water dependent) systems along the valley floor with some Mesoriparian and Xeroriparian systems existing along the banks where sagebrush steppes and dry upland hillslopes descend to the riverbank.

The riparian zones along the upper Gunnison River generally support an overstory consisting of narrowleaf cottonwood (*Populous angustifolia*) with a shrub stratum that is dominated by species such as thinleaf alder (*Alnus tenuifolia*), willow (*Salix spp.*) red osier (*Cornus stolonifera*) and woods rose (*Rosa woodsii)*. The understory is comprised of both upland and wetland grass species along with rushes (*Juncus spp.*) and sedges (*Carex spp.*) and a variety of wetland forbs in the more saturated portions of the riparian areas.

The River is associated with large riparian areas that comprise significant nodes of functional riparian systems with some active and abandoned beaver ponds, along with wet meadows (Map 1). In particular in a local scale, there are many wetland plants in the narrow riparian corridor that are not found in drier soils found upslope. As a result and is typical of most other riparian areas, wildlife use of these areas is high which contributes to local biodiversity and high plant and animal productivity. The riparian zones in this study are also important for essential functions such as dissipating flood energy and filtering sediment and pollution.

Soils

Gunnison River's riparian zone soils are comprised of alluvial deposits of silt, sand, gravel, cobbles and boulders within the alluvial river channel. When riparian areas extend outside of the alluvial channel, the vegetation is established on a variety of soils that are mapped and identified by the Natural Resource Conservation Service (NRCS). These soils and there characteristics are described below. Knowledge of the soils that are associated with particular riparian areas could aid in future management decisions regarding restoration, enhancement or conservation of valued riparian areas.

Soil moisture is the ultimate determinant of riparian vegetation type. Riparian vegetation occurs only where there is sufficient soil moisture. Soil moisture depends on natural stream flows and soil type. A natural hydrologic cycle including naturally high flooding flows with a slow decrease to average flows and then natural base flows determines the amount of soil moisture in riparian areas. Due to diversions and water management in the upper Gunnison River Valley, the Gunnison River no longer has a natural flow regime resulting in riparian soils that may not be sufficiently flooded and saturated to support historic riparian vegetation patterns.

Soils in natural riparian areas consist of stratified sediments of varying textures that are subject to intermittent flooding or a fluctuating water table that may reach the surface. The duration of soil wetness depends on the water levels of the adjacent water body.

The type of soil that is associated with riparian areas determines soil moisture potential that exists in that area. The physical characteristics and composition of a particular soil type affect soil functions including the absorption of water, the retention of water, run off of surface water, and the return of water back into the hydrologic system. Soils with high clay content have a greater ability to retain water, are poorly drained with high run-off of surface water while soils that are sandy or comprised of cobbles are typically well drained with high permeability and low available water capacity.

The identification and classification of soils that are supporting the riparian areas that exist along the Gunnison River can aid in the assessment of factors including streambank stability, vegetation types that are associated with the different soils, and potential restoration efforts to impaired areas or those that are at risk.

According to the *Soil Survey of the Gunnison Area, Colorado parts of Gunnison, Hinsdale, Saguache Counties* and the National Resource Conservation Service (NRCS 2010) (Maps 2a, 2b,2c), the Gunnison River channel is generally associated with one soil type as the river courses through the upper Gunnison River Valley. The river channel and adjacent riparian areas lie generally within the Alluvial Land, occasionally flooded (Ao) soil type. This soil type is found on flood plains along streams and side drainageways. It consists of material recently deposited by streams. This soil type varies widely in texture and commonly has very cobbly or stony areas interspersed throughout. Due to its position adjacent to the river, this soil is subject to erosion from flooding and channel changes. Slopes are generally 0-5 percent. This alluvial soil type is suited to grazing, wildlife use and recreation. In most areas this soil supports an overstory of narrowleaf cottonwood (*Populus angustifolia*) with a shrub stratum comprised of willows with an understory of grasses, sedges and rushes. Alluvial Land, occasionally flooded is a somewhat excessively drained soil with a very low available water capacity and a moderately high to very high capacity to transmit water.

The river corridor, flood plain and adjacent areas outside of the main channel are associated with several soil types of various characteristics and qualities within the study reach.

The flatter grasslands and associated with the ranchlands and pastures that exist along the river throughout the valley are generally situated on two similar soil types identified as the Gas Creek and Irim loam. Both the Gas Creek (GaA, GaB) and Irim (IrA, IrB) loams are deep, poorly drained soils that are found on flood plains and low terraces with slopes of 0 to 5 percent that are adjacent to major streams and side drainageways. Both soils formed in recent alluvium of

mixed origin. These soil types include a mat of partially decomposed organic material in the first 2-3 inches below the ground surface. These soils support grasslands and meadows comprised of timothy, redtop, tufted hairgrass, slender wheatgrass, rushes and sedges and are important for the production of native hay and pasture in the Gunnison Region. The Gas Creek and Irim Loams are subject to a fluctuating water table that is dependent on the water level in the adjacent water body. A characteristic that separates these soils from other soils that are associated with the river corridor is the fact that they are identified as *Hydric* by the NRCS. A Hydric soil is defined by the NRCS as "a soil that is formed under conditions of saturation, flooding or ponding long enough during the growing season to develop anaerobic (lacking oxygen) conditions in the upper part" (Federal Register, 1994). The concept of these soils includes soils that develop under sufficiently wet conditions to support the growth and regeneration of hydrophytic (water dependent) vegetation. The identification and location of the hydric soils may be valuable in restoration or conservation efforts to the riparian areas that exist in the study area.

Small areas of a land identified as Alluvial Land (Ad) are also identified along the river corridor (Maps 2a, 2b, 2c). This soil type is well drained and is found in narrow winding valleys and on small fans and mountain toe slopes and consists of the accumulation of valley fill sediment that was derived from many kinds of rocks and upland soils. This land is subject to flooding and deposition of sediment with little or no soil development in most areas; drainageways that are not protected by adequate vegetation cover (i.e riparian areas) are prone to entrenchment and headcutting. In the Gunnison Valley, this Land type is used mainly for range, wildlife and recreation, and supports vegetation such as upland grasses and mixed stands of sagebrush and grass.

Two non-hydric soil types are identified along the river corridor within the study area. The Fola cobbly sandy loam, with 1 to 8 percent slopes (FoB) is identified on stream terraces and alluvial fans throughout the study area (Maps2a, 2b, 2c). The Fola soil type is a deep well drained soil that formed in cobbly sandy soils that was derived from a wide variety of rocks. Much of the land that is situated on this soil is used mainly for hay and pasture and comprises much of the ranchland that exists on the terraces that are located above the flood plain along the Gunnison River. This soil type supports native upland vegetation including sagebrush, Arizona fescue, wheatgrass, and native bluegrass and is used for hay and pasture. The Duffson-Spring Creek stony loam, 5 to 40 percent slopes is a well drained soil that is found on various steeper northern exposures that exist along the river corridor (Maps 2a, 2b, 2c). This soil type is typically found on benches, ridges and hills and is derived from calcareous, interbedded sandstone and shale. This soil type commonly supports native upland vegetation similar to that of the Fola cobbly loam and is used for range, recreation, and wildlife.

Two rocky soils are also identified in association with the upper Gunnison River corridor within the study reach. The Rock outcrop (Ro) and the Stony rock land (St) are found in areas where steep rocky terrain descends directly to the banks of the river (Maps 2a, 2b, 2c). The Rock outcrop soil series consists of bare exposures of bedrock along canyon walls, on escarpments surrounding mesa tops, and on very steep upland slopes. It is nearly 90% exposed bedrock that provides concealment to wildlife and is used for wildlife and recreation. Stony rock land consists of exposed bedrock along with loose stones, boulders, and soils that are very shallow over bedrock. These soils are found on steep terrain (10 to 80 percent slope) and support sparse vegetation comprised of climatically adapted grasses shrubs, and forbs in the Upper Gunnison valley. This land type provides concealment and escape for wildlife.

Stream classification

The position of a stream in its landscape and watershed setting is a strong determinant of that stream's ability to develop and support significant riparian-wetland resources. Stream classification can provide a description of the stream's position in the landscape as well as the potential range of variability in bed composition, bank materials and parameters related to channel size, shape, and pattern (Prichard and others, 1998).

According to *Applied River Morphology* (Rosgen 1996), the Gunnison River within the study reach is classified as a C3/C4 Stream Type. This Stream type is a slightly entrenched, meandering, gravel dominated, riffle pool complex with a well developed flood plain. This stream type is found in U-shaped glacial valleys; valleys bordered by glacial and Holocene terraces; and in very broad, course alluvial typical of plains areas. C3/C4 stream types have gentle gradients of less than 2%, display a high width depth ratio, and are slightly more sinuous with higher meander width ratios. The riffle pool sequence averages 5-7 bankfull channel widths in length. The stream banks are generally composed of unconsolidated, heterogeneous, non-cohesive, alluvial materials that are finer than the gravel dominated bed material. Consequently the stream is susceptible to accelerated bank erosion. Rates of lateral adjustment are influenced and controlled by the presence and condition of riparian vegetation. Sediment supply is moderate to high, unless streambanks are in a very low erodability condition. The C3/C4 stream type is characterized by the presence of point bars and other depositional features and is very susceptible to shifts in both lateral and vertical stability caused by direct channel disturbance and changes in the flow and sediment regimes of the contributing watershed (Rosgen, 1996).

Methods

To preliminarily assess riparian condition and coverage of riparian areas within the study area, 2009 National Aerial Photography Program (NAPP) imagery was obtained for the Gunnison River Corridor. The NAPP data archive contains high quality aerial photography that has been acquired dating back to 1980. This imagery was used in a Geographic Information System (GIS) to produce base maps as well as to manually interpret components such as land use, land cover, as well as river channel and adjacent land condition. The imagery was also used to quantify the percentage of riparian vegetative cover and to make comparisons to previous years riparian cover through analysis of historical aerial imagery and to quantify ground cover occupied by impervious surfaces (houses, roads, etc.) to evaluate the percent of area occupied by vegetation, soil, geology and other natural cover features (Map 1).

From spring through fall 2010, we conducted a field survey of known and accessible riparian habitat along a reach of the Gunnison River watershed, Gunnison County, Colorado. These sites included all of Gunnison River from its origins at the confluence of the East and Taylor Rivers in Almont, CO to where the Gunnison River crosses County Road 32 at McCabe's Lane Bridge. The Gunnison River has the major tributaries of Ohio Creek and Tomichi Creek enter through this reach.

The riparian and aquatic habitats included in this report were assessed using protocols similar to those in Chapter 5 in Barber and others (1999) (Appendix A); and Prichard and others (lotic waters 1998) (Appendix B). In using these and similar protocols, we assessed the watershed for characteristics such as: Epifaunal Substrate/Available Cover, Substrate Embeddedness, Velocity/Depth Regime, Sediment Deposition, Channel Flow Status, Channel Alteration, Bank Stability, Frequency of Riffles, Vegetative Protection, Width of Riparian Zone, Age-Diversity of Riparian Vegetation, Appropriate Riparian Soil Moisture Characteristics, Lateral and Vertical Stream Channel Stability, Dominant Riparian Vegetation Type, Watershed Contributions to Stream Degradation, Overall System Hydrology, Riparian Plant Vigor, and Presence of Known Noxious/Invasive Weeds. These individual criteria were noted on forms and functional scores were provided where applicable that range from a low of 0 to a high of 200. Additionally and provide a separate and alternative analysis, riparian areas were scored using Proper Functioning Criteria (see Prichard an others 1998, 1999 for further definitions) into:

Proper Functioning Condition – when the riparian zone is achieving all of its potential and is performing all of the riparian functions

Functional – At Risk – when the riparian zones are impacted making them susceptible to degradation

Nonfunctional – are clearly not providing their main functions of reducing erosion, improving water quality and dissipating stream energy at high flows.

Prior to the field survey, the participants analyzed representative sites along Gunnison River together and calibrated ourselves to the metrics being used. When questions arose or critical designations were in question, we then consulted each other and analyzed the sites together. The Colorado Natural Heritage Program (2009) field tested Ecological Integrity Assessment protocol for Subalpine-Montane Riparian system that is similar to the ones we used and in a similar habitat. They found that the biological condition metrics used in the Ecological Integrity Assessment and most similar to the ones used in this study were "robust and reliable" indicators of riparian condition. Additionally, they found that overall "Ecological Integrity" scores proved reliable across users. This finding supports our use of calibrated observers in this study.

Based on the above criteria, the watershed segments were then analyzed, scored and characterized as to their "health" and functioning. These watershed segments were photodocumented, points were taken using Geographic Information System (GIS) software and maps were produced that illustrate the various watershed segments and their classification. Impaired areas were then prioritized for restoration based on issues such as the potential impacts of continued or future degradation, feasibility and degree of impairment.

Aerial photographs of this reach of the Gunnison River from 1950 (Figure 4), 1979 and 1989 were digitized from prints obtained from the Gunnison Office of the Natural Resources Conservation Service (NRCS). Areas of riparian vegetation were digitized using GIS software and aerial coverage was calculated. Additionally, soils maps (Maps 2a, 2b, 2c) were utilized to corroborate the historical distribution of riparian communities since specific soils develop under specific flood regimes.

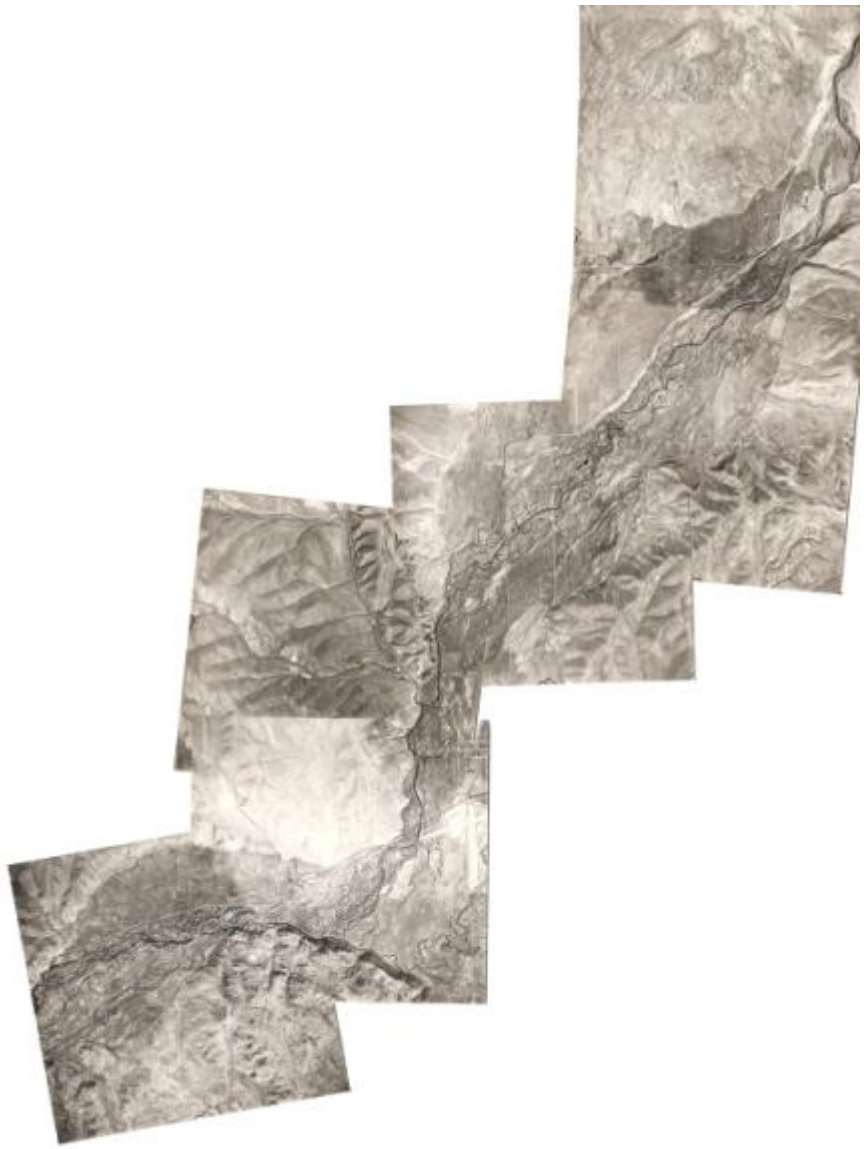


Figure 4. Series of aerial photographs of the Gunnison River (Gunnison County, CO) in the study reach from 1950. Photographs obtained from the Natural Resource Conservation Service, Gunnison, CO.

Additionally, the riparian Assessment Segments were classified as to the values of Water Quality, Flood Management, Microhabitat Regulation and Wildlife Habitat.

The riparian characteristics desirable for Water Quality Protection were:

- Low slope in the riparian area (steep slopes require greater setbacks);
- High degree of vegetative cover to filter runoff;

- Vegetative cover on stream banks to prevent erosion.

The riparian characteristics desirable for Flood Management were:

- Flat areas adjacent to the Gunnison River that can store floodwaters;
- Woody vegetation in flood prone areas that slow flood flows;
- Lack of channelization and bank stabilization structures that increase water flow potentially increasing flood damage downstream.

The riparian characteristics desirable for Microclimate Regulation were:

- Riparian vegetation of sufficient height and cover to shade the Gunnison River during midday sun;
- Riparian vegetation of appropriate density to decrease evaporative winds;
- Woody riparian vegetation overhanging the Gunnison River.

The riparian characteristics desirable for Wildlife Habitat were:

- Abundant and diverse riparian vegetation;
- Minimal human disturbance.

Results

The following are riparian reaches (segments) that are associated with the Gunnison River channel and corridor within the study area. The assessment segments are defined based on similarity of conditions for analysis and are identified with alternating red and blue boundaries in the following 'segment overview' photographs and the attached Riparian Assessment Map (Map 1). These areas and their current condition are represented, numbered and color-coded on the Riparian Assessment Map and the results of our field discussion listed below follow these numbers and segments accordingly. Due to the scope and detail of the assessment, a larger 24" by 36" Riparian Assessment Map (Map 1) is provided as a supplement to the Map 1 that can be found in the *Maps* section of this report. The "Assessment Segments" along the Gunnison River are numbered consecutively going downstream from the confluence of the Taylor and East Rivers (Segment 1) to the McCabe's Lane Bridge (Segment 12). As illustrated in the legend of Map 1, unfragmented riparian areas identified as being in "Proper Functioning Condition" are represented with green shading while isolated or fragmented/perforated yet functioning areas are represented with yellow-green shading. Streamside areas that are identified as "Functioning At Risk" are represented with orange linear demarcation and areas that are identified as being "Non-functional" are represented with yellow linear demarcation

(Map 1). The Gunnison River floodplain is represented by the sky-blue line that generally follows the river course. The overview and maps also include the location of many of the irrigation diversion structures identified with brown circles as well as the location of many of the irrigation return features that are identified as smaller orange circles (Map 1). A summary of all areas including the total area, stream length of reduced functioning, and riparian values is contained in Table 1.

General Conditions

We found that the Gunnison River riparian zones are largely in Proper Functioning Condition with the exception of numerous discrete areas along the streambank that have been subject to various anthropogenic impacts. Areas of impaired riparian zones are described in their individual sections below. Where upper Gunnison River riparian zones are in Proper Functioning Condition the areas generally support robust hydro-riparian vegetation of diverse composition and age class; have functional hydrology; and appropriate stream morphology. These areas include an overstory dominated by narrowleaf cottonwood (*Populous angustifolia*) with a shrub stratum that is dominated by species such as alder (*Alnus tenuifolia*), willow (*Salix spp.*), red osier (*Cornus stolonifera*) and woods rose (*Rosa woodsii)*. The understory to this cottonwood/alder/willow complex is comprised of both upland and wetland grass species along with rushes (*Juncus spp.*) and sedges (*Carex spp.*) and a variety of wetland forbs in the more saturated portions of the riparian areas.

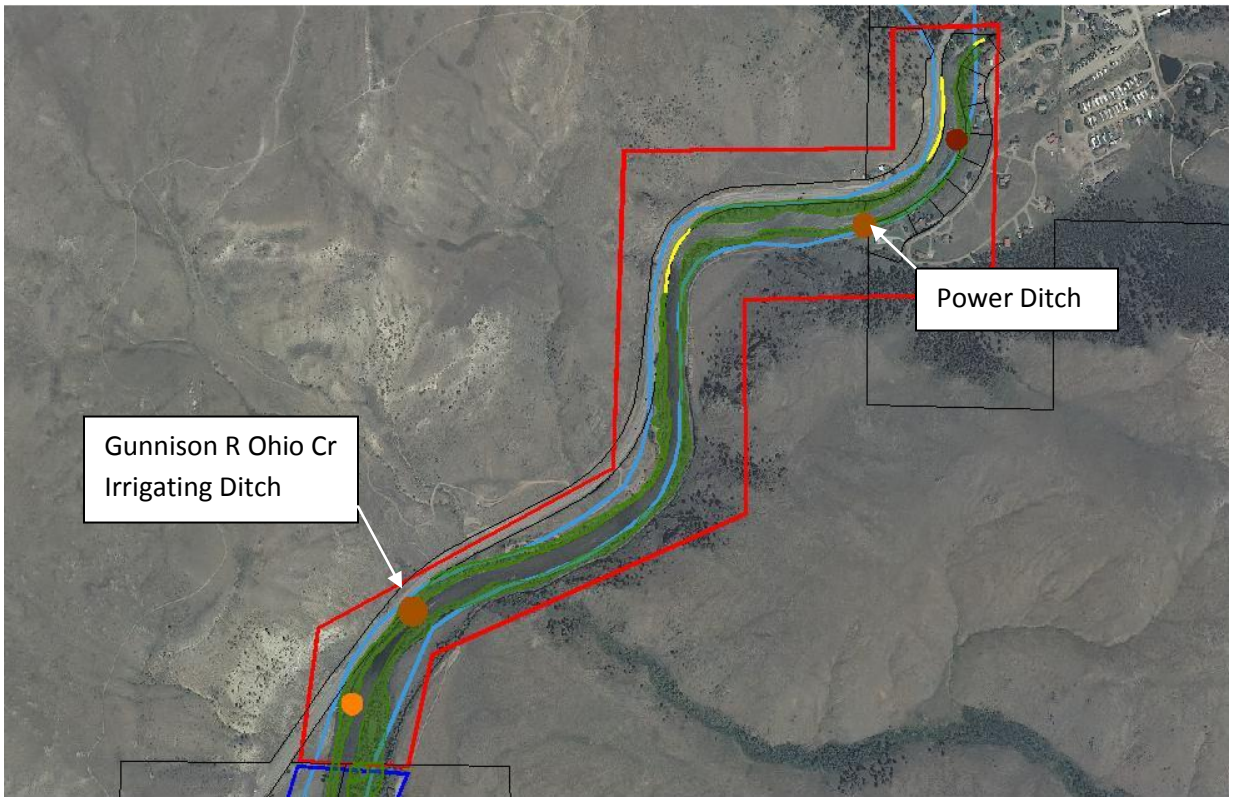
Gunnison River Riparian Segments

Map 1

Assessment Segment 1 (7690 Linear Feet (LF), 1.45 mi.): Confluence of the East and Taylor Rivers in the Town of Almont to the southern boundary of the Almont Campground area. (Scores: 184/200.) Overall Proper Functioning Condition with two sections of Nonfunctional riparian areas.

Segment 1 encompasses approximately 7690 linear feet of the Gunnison River as it courses through the Almont Canyon. This segment is adjacent to HWY 135 and includes steep rocky hillslopes and rock formations of Almont Canyon, large irrigation carriers and associated diversion structures and return features along portions of both banks, as well as the Almont Campgound (west bank) (Photograph 1). These ground surface conditions and aforementioned

features naturally confine riparian vegetation with little extension of riparian areas beyond the edges of the streambank in this segment.



Photograph 1. Aerial overview of Segment 1 (2009 NAPP imagery of Gunnison County).

The northern boundary of this segment is the beginning of the Gunnison River at the confluence of the Taylor River and the East River in the Town of Almont while the southern boundary of this segment marks the location where the river channel leaves the canyon and enters the alluvial area that comprises the upper Gunnison Valley.

Due to the steep, rocky hillslopes in this area, riparian vegetation is restricted to the Alluvial land, occasionally flooded (Ao) soil type that comprises the river channel throughout the study reach. Outside of the alluvial channel, the western streambank is associated with the Fola cobbly sandy loam, 1 to 8 percent slopes. This comprises the benches that descend to the streambank and soils mapped as the Rock outcrop complex (Ro) where steep rocky hillslopes and rock outcrops descend directly to the streambank. The eastern streambank is comprised almost entirely of the Stony rock land (St) soil type outside of the alluvial river channel (Map 2a).

The riparian areas along the west bank of Segment 1 are bordered to the west by HWY 135 in the northern portion and the Almont Campground and HWY 135 in the southern portion. An irrigation diversion structure that supplies a large irrigation carrier that runs along the western

bank is located in the southern portion. This irrigation carrier includes an irrigation return just north of the southern boundary to this segment. Although the western bank of Segment 1 supports stretches of healthy functioning riparian area, two stretches that are located adjacent to HWY 135 are identified as Non-functional (Photograph 1). The natural rocky terrain and encroachment of the highway on the western bank have resulted in a lack of vegetation at these locations. The denuded stream banks leave these stretches subject to further bank degradation from scouring by higher flows and resulting bank erosion. These degraded areas also cause the fragmentation of the riparian zones that exist along the western bank outside of these impaired areas. Although the geology, terrain, and adjacent highway confine the riparian vegetation to the edges of the incised river channel within this segment, the irrigation features and campground impact the functional riparian areas along the west bank of Segment 1. The campground entrance and campsite access are located primarily on the upland bench that exists above the river; however, many of the campsites are located within the narrow riparian area that is naturally confined by the geology in this area. While the perforation of the riparian area associated with these established campsites is apparent, the campground area also provides an example of recreational use within the riparian area and represents another valuable aspect of upper Gunnison Valley riparian zones.

Another condition worth noting in this and other segments is the hydrologic contribution to the riparian areas from the irrigation carrier that runs along the southern portion of Segment 1 and in many other locations within the study reach. In locations where the irrigation ditches leave the diversion structure features to run along the stream bank, it appears that where gradient is sufficient, water that leaks from the mostly cobble lined ditches contributes to the riparian areas situated between the river channel and the carrier. This anthropogenic condition may extend and enlarge riparian areas where these conditions exist along the stream banks.

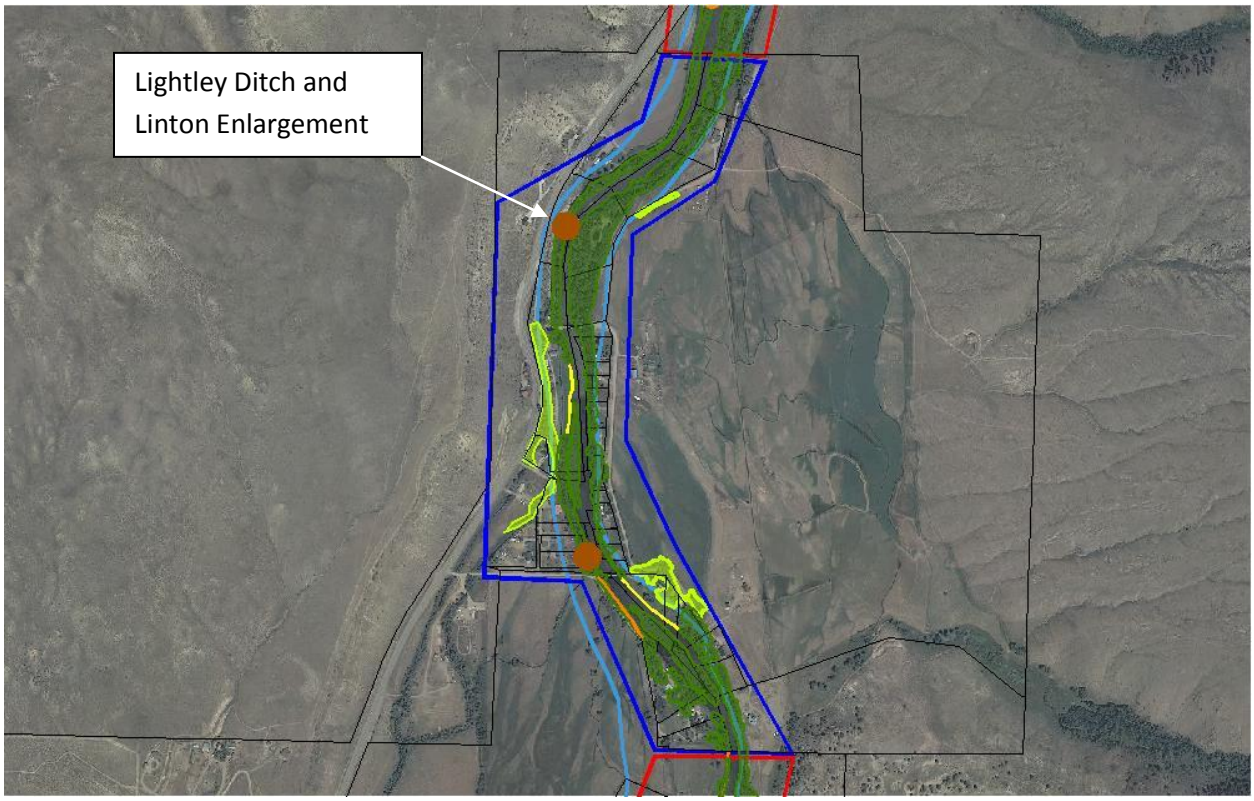
The eastern bank of Segment 1 is bordered by housing and building lots to the northern reach and relatively natural land associated with the canyon in the southern portion. The eastern bank includes one large irrigation diversion structure feature that supplies an irrigation ditch that begins near the southern end of the housing area and runs along the bank to the southern end of the segment. One small section of streambank is identified as Non-functional in the northern most portion of the eastern bank. This impaired area is situated at the confluence of the Taylor and East Rivers and appears to be the result of stream bank stabilization to mitigate the impacts of high flows at the confluence. To the south of this small impaired area, the narrow riparian zone that is naturally confined by the steep rocky hillslopes that descend to the river represents a healthy, continuous stretch of riparian zone along this eastern bank.

Excluding the three impaired streambanks, this segment generally supports diverse composition and age class distribution of riparian vegetation. The establishment of mature

and immature narrowleaf cottonwood, alder and willow with an understory of riparian forbs and grasses provides adequate protection of the streambank and an ongoing supply of large woody material along most of the channel in this segment. The three impacted areas are reducing the ecological functions of riparian habitats and reducing the aesthetic qualities of this otherwise properly functioning stream section.

Assessment Segment 2 (5995 LF, 1.14 mi.): Lost Canyon Area and adjacent subdivisions (Scores: 182/200.) Overall Proper Functioning Condition with two stretches of Non-functional and one stretch of Functioning at Risk riparian area.

Segment 2 courses through the Lost Canyon Resort (resort) vicinity and various housing and subdivisions that are located to the downstream of the resort. The northern boundary of this segment marks where the Gunnison River leaves the Almont Canyon area to enter the alluvial valley that comprises the majority of the study area. The downstream boundary to this segment is located at the northern boundary to the Gunnison River Banks development (Photograph 2).



Photograph 2. Aerial overview of Segment 2 (2009 NAPP imagery of Gunnison County).

Riparian areas along the western and eastern banks are adjacent to the resort and existing development throughout much of this segment. Three areas of isolated and

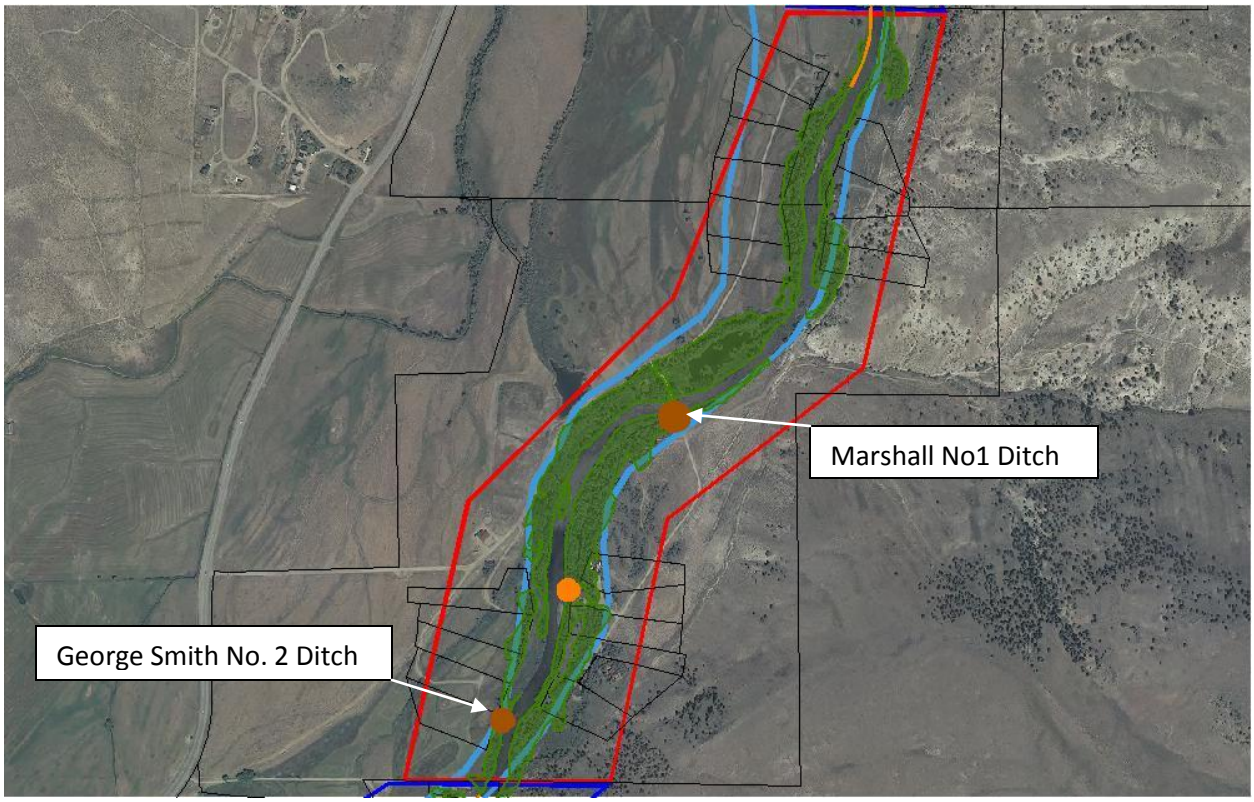
fragmented/perforated riparian areas are identified in the northern, middle and southern portions of the segment. There are two irrigation diversion features established along the western bank. This area includes the Lost Canyon Bridge and a private bridge further downstream to the south.

The riparian areas along the west bank of Segment 2 are situated on Alluvial land, occasionally flooded (Ao) within the channel and the Fola cobbly sandy loam, 1 to 8 percent slopes (Fo) where riparian areas extend outside of the channel. The eastern bank in this segment is comprised of Alluvial Land (Ad) directly adjacent to the channel (Map 2a).

The riparian areas of Segment 2 are subject to encroachment of development and housing; this segment includes two small reaches of streambank identified as Non-functioning located along the western bank in the central portion of the segment and the eastern bank in the southern portion of the segment. It appears that the riparian vegetation has been removed along these banks leaving them exposed to the fluctuating flows of the river. These impaired areas also appear to be subject to impacts resulting from the bridges that exist near these areas. An additional reach located along the western bank in the southern portion of this segment is identified as Functioning At Risk. This reach of streambank is subject to encroachment by an access road that services the subdivisions in the southern portion of the segment and possibly the private bridge that is located directly north of this area.

Assessment Segment 3 (6045 LF, 1.14 mi.): Gunnison River Banks Development (Scores: 184/200.) Overall Proper Functioning Condition with one stretch of Functioning at Risk.

This section is healthy with minimal impacts as it passes through the Gunnison River Banks development which has building lots established on portions of the bench that runs along both sides of the river in this area. Segment 3 is defined by the northern and southern boundaries of the Gunnison River Banks parcel (Photograph 3).



Photograph 3. Aerial overview of Segment 3 (2009 NAPP imagery of Gunnison County).

This segment represents the location at which the alluvial corridor and valley floor begins to widen as it extends south through the study reach. As the valley floor expands, the river enters irrigated ranchlands and various housing and development that exist along both banks of the river. This segment includes an irrigation diversion structure on the eastern and western banks as well as an irrigation return feature along the eastern bank. An iron bridge spans the river in the central portion of the segment but does not appear to have major negative impacts on riparian vegetation in this segment.

Soils associated with the riparian areas along the eastern bank in Segment 3 are generally the Alluvial land (Ad) soil type where vegetation extends outside of the alluvial (Ao) channel. Riparian areas that extend outside of the alluvial channel along the western bank may be situated on the Fola cobbly sandy loam (Fo) in the northern portion of the segment and the Gas Creek sandy loam in the southern portion of the segment (Map 2a).

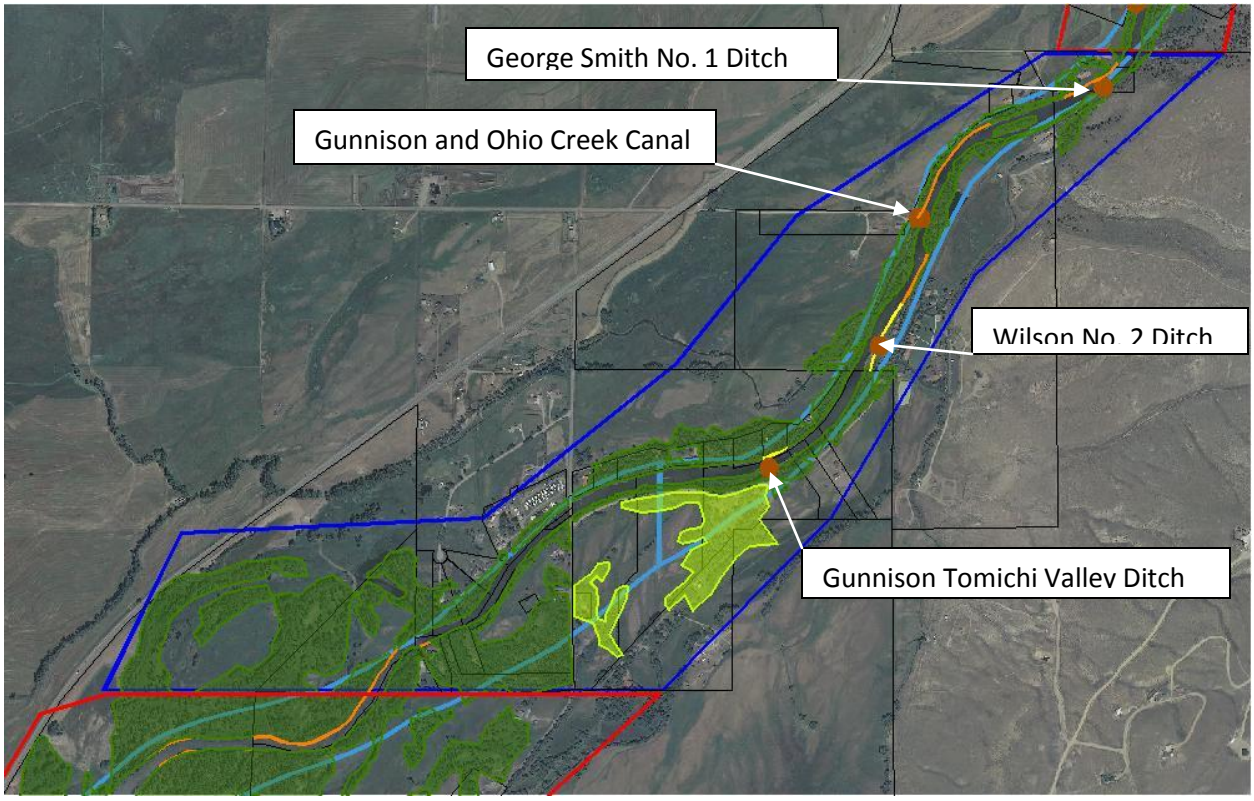
Excluding a small stretch of western streambank in the northern most section of this segment, the river currently supports healthy, relatively continuous riparian zones throughout. Riparian vegetation is limited only in areas where the riparian areas are naturally restricted due to the geology, steep hillsides and rock formations that lie along the eastern bank. The aforementioned stretch of streambank identified as Functioning At Risk along the western bank

to the north appears to be impacted by livestock grazing with riparian vegetation grazed to complete or near complete removal along this bank.

This segment also represents planned development that includes building lots that are established outside of the active floodplain and associated riparian zones. This lot configuration reduces impacts to the riparian vegetation in this segment and contributes to the continuous nature of riparian zones.

Assessment Segment 4 (8630 LF, 1.63 mi.)**:** North of County Road 10 to the Gunnison River Banks boundary-South of County Road 10 approximately 0.5 miles (Scores: 186/200.) Proper Functioning Condition with six areas identified as Non-functioning or Functioning at Risk.

This segment includes approximately 8630 linear feet of ranchlands, communities, resorts and housing along the streambanks. The segment includes four irrigation diversion structures located in the northern 2/3 of the segment along with the County 10 Bridge in the southern 1/3 of the segment (Photograph 4).



Photograph 4. Aerial overview of Segment 4 (2009 NAPP imagery of Gunnison County).

The soils that are mapped outside of the Alluvial land, occasionally wet (Ao) soil type that comprises the river channel in Segment 4 experience a transition from the cobbly, sandy and rocky soils that exist within the northern segments to loamy flood plain type soils of the

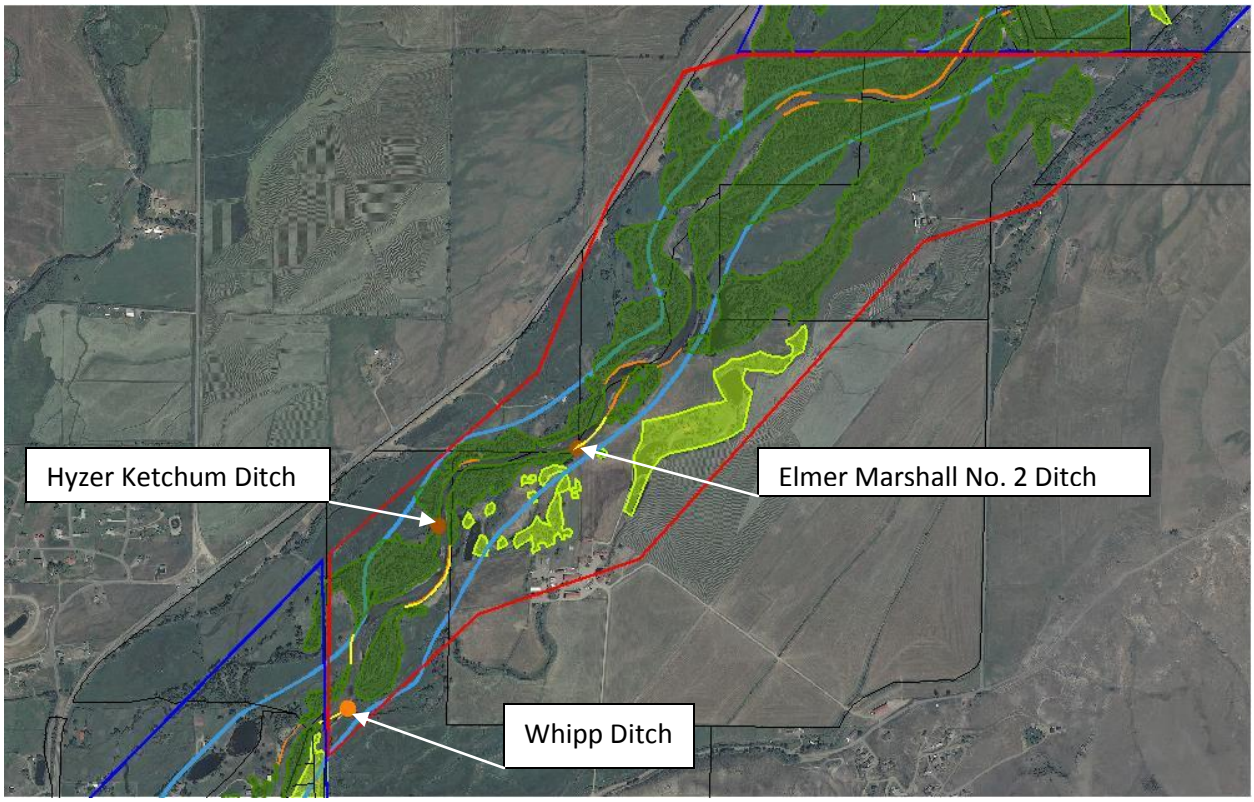
expanded alluvial plain. As the river channel extends to the south, riparian vegetation that exists outside of the river channel extends on to soils identified as the Gas Creek sandy loam, 1 to 5 percent slopes (GaB) . The Gas Creek loams have high clay content and subsequently have a high capacity to retain water resulting in saturated conditions for much of the year. The saturated environment that is indicative of these soils supports vegetation that is adapted to prolonged saturated and flooded ground surface conditions (Figures 3a and 3b).

The riparian areas that are in Proper Functioning Condition in this section are currently and historically narrow to the north of the County 10 Bridge with areas expanding below the bridge as the alluvial plain and valley floor become wider at this location. Several areas of fragmented/perforated functioning riparian exist in the southeast portion of the segment. These areas are isolated and perforated by diffuse housing and an access road, Segment 4 includes six stretches of streambank that are identified as Non-functioning or Functioning at Risk. The areas that are identified as Non-functional appear to have been subject to the active removal of vegetation leaving the banks bare and exposed to river flows. The areas that are identified as Functioning at Risk are portions of the streambank that exhibit erosion and lateral and vertical cutting of the existing bank. These impacts are the result of the removal of vegetation near adjacent housing and encroachment to the riparian areas by adjacent agricultural land. A large diversion structure that exists along the eastern bank, a short distance to the north of the County 10 Bridge, appears to have been recently reconfigured. It appears that the excavation associated with improvements to this diversion structure is impacting the riparian area in the vicinity as well as the bank directly across the river on the western bank.

As Segment 4 extends to the south below the County 10 Bridge, the river begins to support expanded riparian areas that make up the larger “nodes” of riparian areas associated with the ranchlands that exist to the north of the HWY 135 bridge vicinity.

Assessment Segment 5 (10200 LF, 1.93 mi.)*:* Ranchlands north of the HWY 135 Bridge (Score: 187/200.) Proper Functioning Condition with six areas identified as Non-functioning or Functioning at risk.

This approximately 10,200 linear foot segment includes the ranchlands that exist to the north of HWY 135 and the adjacent housing, RV parks and various developments that are in the HWY 135 vicinity. Segment 5 includes portions of three ranches and associated pasture land with very dispersed housing and development. As the segment extends to the south, the surrounding slope decreases allowing the alluvial channel to expand on to the flatter terrain. The segment includes three irrigation diversion structures and one irrigation return feature (Photograph 5)



Photograph 5. Aerial overview of Segment 5 (2009 NAPP imagery of Gunnison County).

Soils associated with the riparian areas along both banks in Segment 5 are generally the Alluvial Land, occasionally flooded (Ao) soil type with some adjacent areas associated with the Gas Creek sandy loam, 0 to 1 percent slope (GaA). The decreased slope and expansion of the alluvial and loamy soils in this area result in the widening of the alluvial channel and associated riparian areas (Map 2b). These more extensive riparian areas contribute to the existence of large "nodes" of riparian areas that exist on these ranchlands providing high degrees of riparian values.

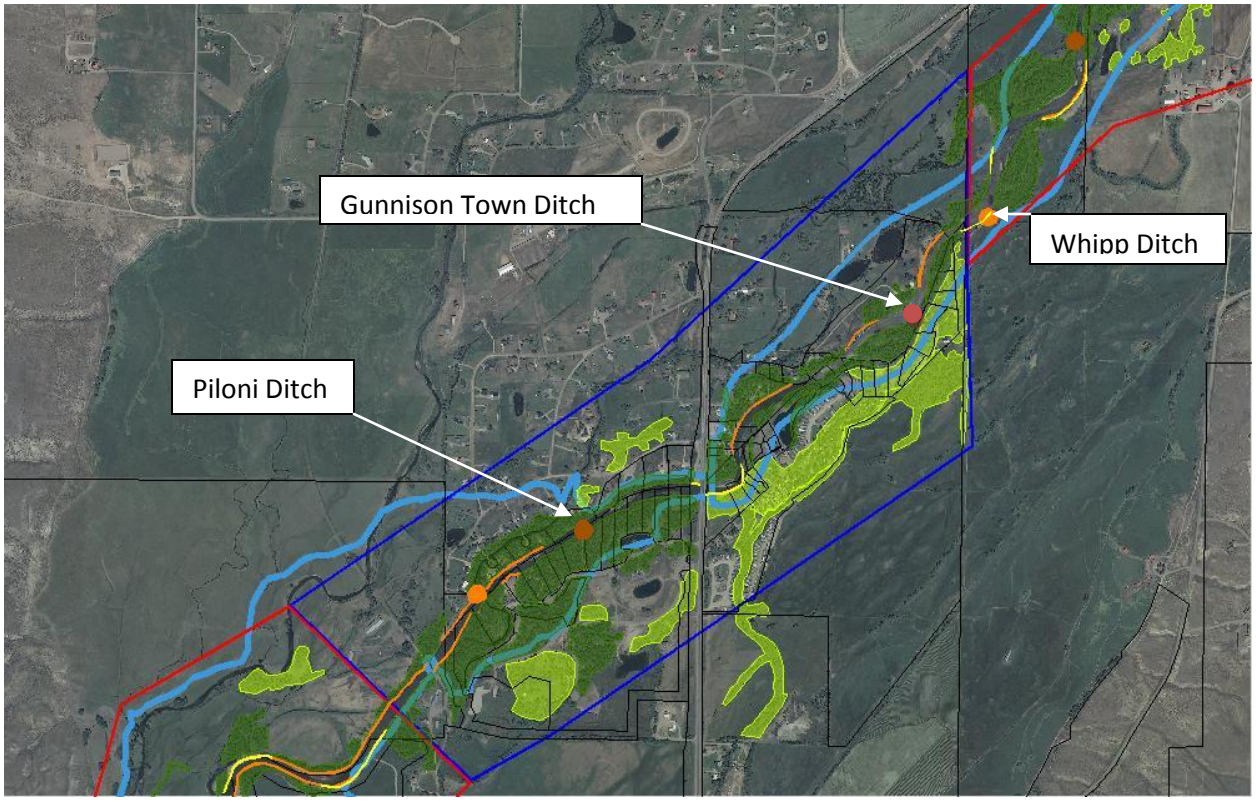
Due to the decrease in slope, the riparian vegetation in Segment 5 begins to exhibit expansion on to the flatter terrain and a dramatic increase in overall surface area coverage. The greater vegetative cover in this segment results in the existence of large nodes of riparian zones that are identified as being in Proper Functioning Condition as well as areas that are identified as Fragmented/Perforated or Isolated. These larger riparian areas and nodes are of great importance to the watershed and support high riparian values.

Although this segment includes high quality riparian zones, numerous areas along the streambank are degraded and exposed to the hydrologic influence from fluctuating flows in the river. This section of the channel has been subject to extensive channelization especially along the eastern bank. In all, six relatively long reaches of streambank (Table 1) in Segment 5 are

identified as Non-Functioning or Functioning At Risk. The impacts to the streambank appear to be the result of: the active re-working of irrigation diversion features causing the reconfiguration of the existing channel, the armoring of streambanks to mitigate erosion resulting from the re-configuration of the channel, the intense grazing of livestock along the streambank which removes valuable riparian vegetation along with the associated streambank stability and flood abatement the vegetation provides.

Assessment Segment 6 (8200 LF, 1.55 mi.)**:** Highway 135 Bridge (North Bridge) vicinity (Scores: 155/200.) Proper Functioning Condition with ten areas identified as Non-functional or Functioning at Risk.

The approximately 8200 linear foot section of river encompasses the establishment of RV resorts, private residences, existing and developing subdivision lots along the streambank, and the North Bridge. The reach extends approximately 0.75 miles to the north and 0.75 miles south of North Bridge. Many of the developed areas are established within the active floodplain of the river in this reach of the river channel. The segment includes one irrigation diversion structure on the east bank and one irrigation return feature where the Clark Stream enters the river along the west bank to the south of the North Bridge. This segment is situated at a point in the upper Gunnison River valley where the alluvial plain of the upper Gunnison River joins that of the Ohio Creek valley which extends from the north causing a large increase and a broadening the alluvial plain that comprises the valley floor (Photograph 6).



Photograph 6. Aerial overview of Segment 6 (2009 NAPP imagery of Gunnison County).

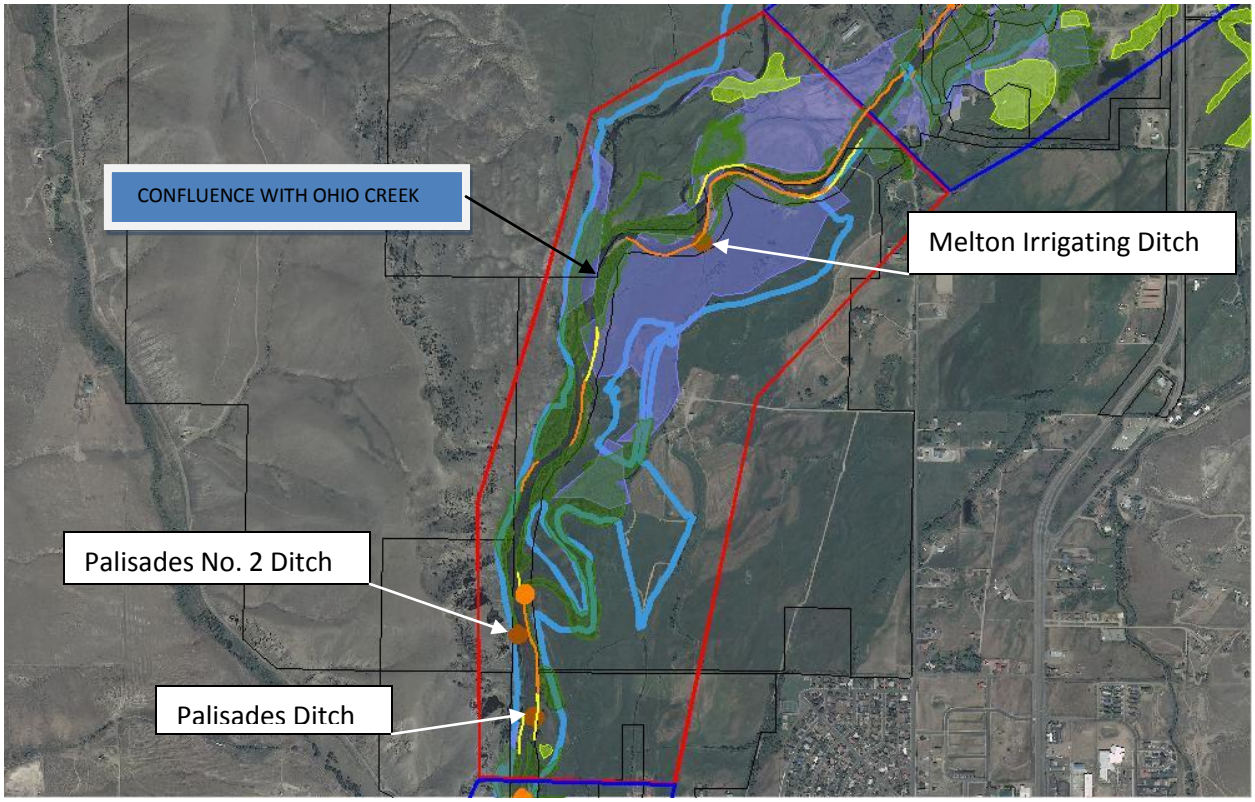
Riparian vegetation in Segment 6 is established on soils similar to that of Segment 5 as the alluvial channel expands on to terrain with little slope (Map 2b).

This segment generally supports riparian areas that are in Proper Functioning Condition; however, numerous impacted segments of streambanks and expanded riparian zones exist within this reach with 10 sections of bank identified as Non-Functioning or Functioning At Risk. Much of the riparian areas within Segment 6 are subject to perforation and fragmentation from existing and planned development within the riparian zone. Some of the streambanks along both sides of the river have been altered and armored to mitigate erosion and overbank flooding possibly as a resultof the loss of riparian vegetation within this reach and those segments located upstream. Other sections of the banks have been subject to the removal of riparian vegetation where housing encroaches on the river channel.

Assessment Segment 7 (9145 LF, 1.73 mi.): Van Tuyl Ranch (Scores: 161/200). Functioning at Risk with a downward trend. Numerous segments of streambank identified as Non-Functioning or Functioning at Risk.

Segment 7 encompasses the river corridor and the floodplain associated with the approximately 500 acre Van Tuyl Ranch property on the east side of the river and other

undeveloped ranchland, private property and housing along sections of the west bank. Both the Van Tuyl parcel and the ranchland on the west side of the river are generally comprised of relatively undeveloped hay meadows and include extensive flood plain coverage in the northern 2/3 of the segment. To the north, the river channel becomes more sinuous as it courses through the wide floodplain and robust wet meadows and hay pastures. As the segment extends south, the river channel turns to run due south and is confined by the Palisades rock formation along the western streambank and a narrower flood plain and agricultural practices to the east of the river channel. The segment includes three irrigation diversion structures and one irrigation return feature. The river channel, particularly in the northern section, has been impacted by extensive channelization and streambank armoring that result from efforts to mitigate large areas of overbank and overland flooding that occurs in this region during high waterevents. The re-configuration and armoring of the streambank in the northern section of Segment 7 appears to be causing the hydrologic energy of the river to "bounce" from armored streambank to armored streambank as the river courses south, causing an imbalance in the channel within the landscape, channelization of the stream and downcutting into the stream bed. This segment also includes the confluence with Ohio Creek along the western bank and represents the point at which Ohio Creek contributes biological, chemical and physical components to the Gunnison River system. This segment also encompasses the area where the flood plain of the Ohio Creek drainage joins the flood plain of the Gunnison River resulting in the expansion of the aforementioned floodplain in this region (Photograph 7).



Photograph 7. Aerial overview of Segment 7. The area in the photograph that is shaded in purple represents the riparian area that was assessed on 1950 aerial photography (GIS assessment of 1950 USDA aerial imagery, 2009 NAPP imagery of Gunnison County).

Soils that exist within this segment are the Alluvial Land, occasionally flooded (Ao) within the expanded flood plain. The poorly drained Gas Creek (GaA) and Irim loams (IrA) border much of the alluvial channel to the north and east while rocky upland soils consisting of the Duffson Spring Creek stony loams (Dse), the Stony rock land (St), and the Rock outcrop (Ro) soil types bound the channel to the west along the Palisades formation (Map 2b).

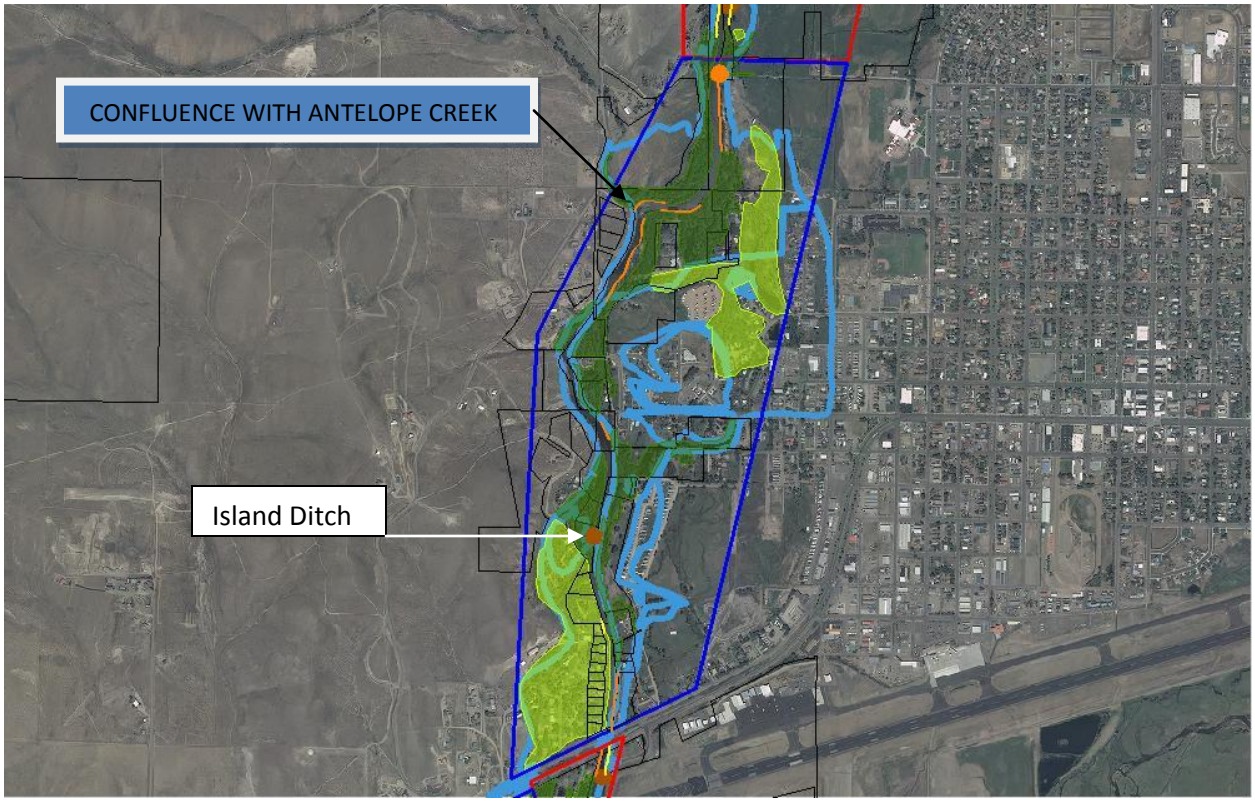
Historically, the river channel and associated flood plain supported extensive riparian areas in the northern portion of Segment 7 with riparian vegetation established within much of the floodplain in some locations (Photograph 7). Based on GIS comparisons of 1950 and 2009 aerial photographs, Segment 7 has experienced the loss of roughly 90.0 acres of riparian vegetation in the 1950 to 1979 time frame representing one of the largest decreases in riparian vegetation within the study reach over that time period. These areas may have been cleared historically to facilitate the large hay meadows that are established in portions of this segment. Much of the streambank on both sides of the river where the large riparian zones existed historically is degraded and identified as Non-Functioning or Functioning At Risk. The river channel in this area has been repeatedly altered and the streambanks have been artificially armored to

presumably mitigate large areas of overbank and overland flooding that occurs during high water events typically in the spring. Streambank degredation and the need for repeated stream channel and bank reconfiguration is likely the result of the loss of the large areas of riparian vegetation that would dissipate, absorb and abate the occurrence of high flows in this section of the river.

The river channel and associated flood plain in the southern reach of Segment 7 becomes narrower and is bound to the west by the locally known Palisades rock formation and the dispersed housing that exists near the southern border of the segment. Long reaches of streambank are identified as Impaired in this portion of Segment 7 as well. These areas appear to be impacted by the encroachment of agricultural areas and intensive grazing along the west bank and the sections with active removal of riparian vegetation or armoring of banks to protect against flooding.

Assessment Segment 8: City of Gunnison (Scores: 139/200.) Proper Functioning Condition, Fragmented/Perforated with seven sections of streambank identified as Non-Functioning or Functioning at Risk .

In this segment, the river channel enters more populated residential communities that are part of the City of Gunnison and Gunnison County. The stream gradient is relatively low and is associated with another broadening of the flood plain after a noticeable narrowing of the floodplain in the southern section of Segment 8. This segment includes the confluence of the Gunnison River with Antelope Creek which extends from the north to join the river along the west bank. The confluence with the Antelope Creek drainage and floodplain may also contribute to the broad floodplain that exists in Segment 8. The segment encompasses several communities, subdivisions and private lots along the river channel and within the mapped floodplain. The section includes one irrigation return feature along the west bank to the north and one irrigation diversion structure along the east bank in the southern portion. There is also a side channel of the river known as the East Branch of the Gunnison River which splits from the river at the irrigation diversion structure located along the western bank in the southern portion of Segment 8 to re-enter the river system at a return feature located at the other end of Segment 9 (Photograph 8).



Photograph 8. Aerial overview of Segment 8. (2009 NAPP imagery of Gunnison County).

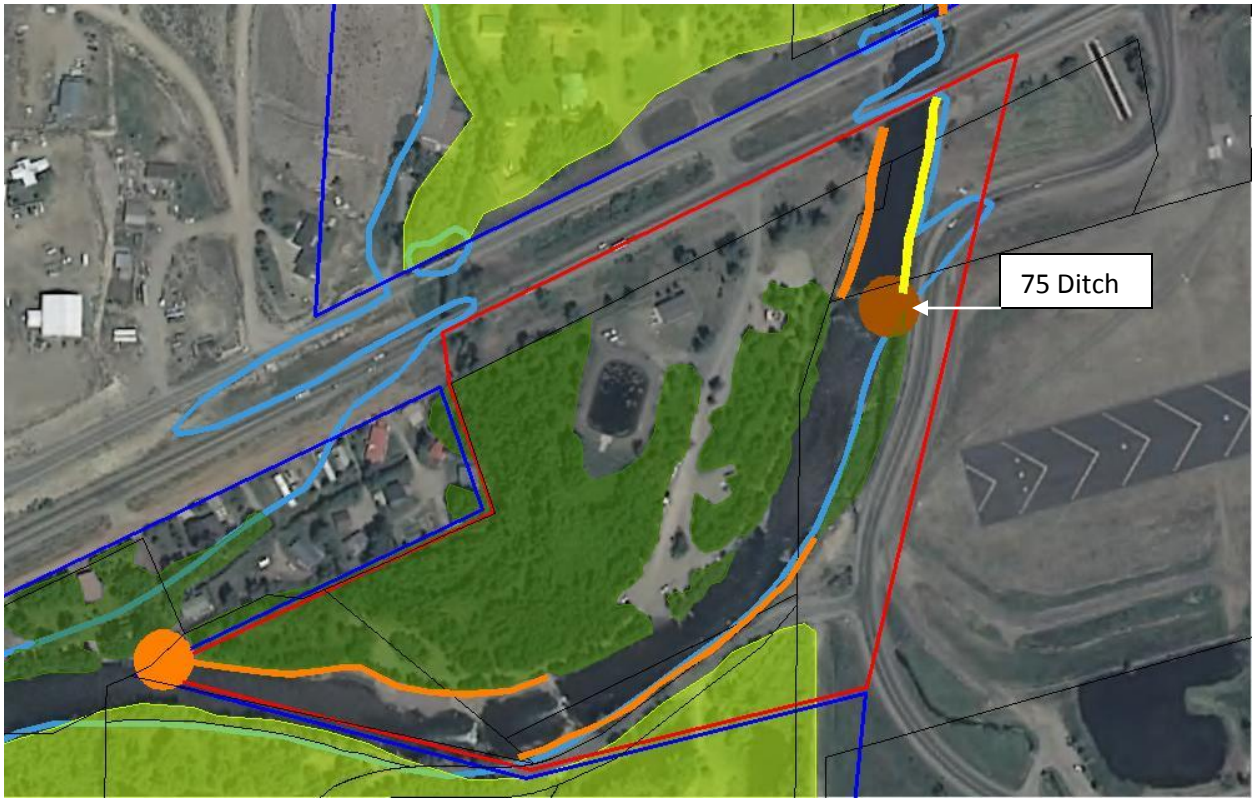
Soils associated with the river channel and riparian areas in Segment 8 are the Alluvial Land, occasionally flooded type common to the river bottom and flood plain in the Gunnison valley with small pockets of the Gas Creek sandy loam (GaA) and the Fola cobbly sandy loam (FoB) in locations along the east side of the river and rocky stony soils that exist along the alluvial channel on the west side of the river (Map 2c).

The relatively large riparian areas in Segment 8 appear to be generally in Proper Functioning Condition, however, much of the vegetative cover is Fragmented, Perforated and Isolated in Segment 8 due to the existence of the private residences and residential communities within the riparian zone. Some portions of the streambank in Segment 8 consist of bedrock. In these areas vegetation may be naturally absent or limited to the fringes of the streambank where the bedrock is present. Seven reaches of streambank are identified as Non-Functioning or Functioning at Risk in this segment. As in other segments the banks are impaired by the active removal of riparian vegetation from the bank causing erosion and cutting of the bank or re-channelization of the river channel and the artificial armoring of the bank to protect residences and residential communities from overbank and overland flood events. Several of the communities and residences along the bank and inland in this area have been subject to flooding making the restoration and conservation of riparian areas and associated streambank

in this segment crucial in order to reduce the severity and regularity of flood events in the impacted residential areas.

Assessment Segment 9 (2150 Lf, 0.41 mi.)**:** Gunnison Whitewater Park (Score: 144/200.) Functioning at Risk with downward trend and the majority of streambank identified as impaired.

This segment extends approximately 2150 linear feet southwest from the HWY 50 Bridge (Twin Bridges) and is comprised entirely of the Gunnison Whitewater Park and the Dos Rios Water Treatment facility (Gunnison County). The Gunnison Airport is directly east of the area and the Dos Rios Subdivision lies to the south. The western bank that extends southwest from the HWY 50 Bridge down through most of the Gunnison Whitewater Park is prone to overbank and overland flooding during high water events in the river. Riparian vegetation consisting of large mature narrowleaf cottonwoods and associated understory that historically existed in the northern portion of this segment near the highway bridge was removed to meet FAA regulations. The river channel within Segment 9 has recently undergone major reconfiguration to produce much utilized whitewater boating features and to construct a more permanent and stable irrigation diversion feature that enhances irrigation supply and allows better boater navigation of the diversion feature. The segment includes an improved irrigation structure along the east bank to the north and a return feature along the western bank, at the very south end of the property (Photograph 9).



Photograph 9. Aerial overview of Segment 9. (2009 NAPP imagery of Gunnison County).

Soils in this segment are comprised entirely of the Alluvial Land, occasionally wet (Ao) soil type (Map 2c).

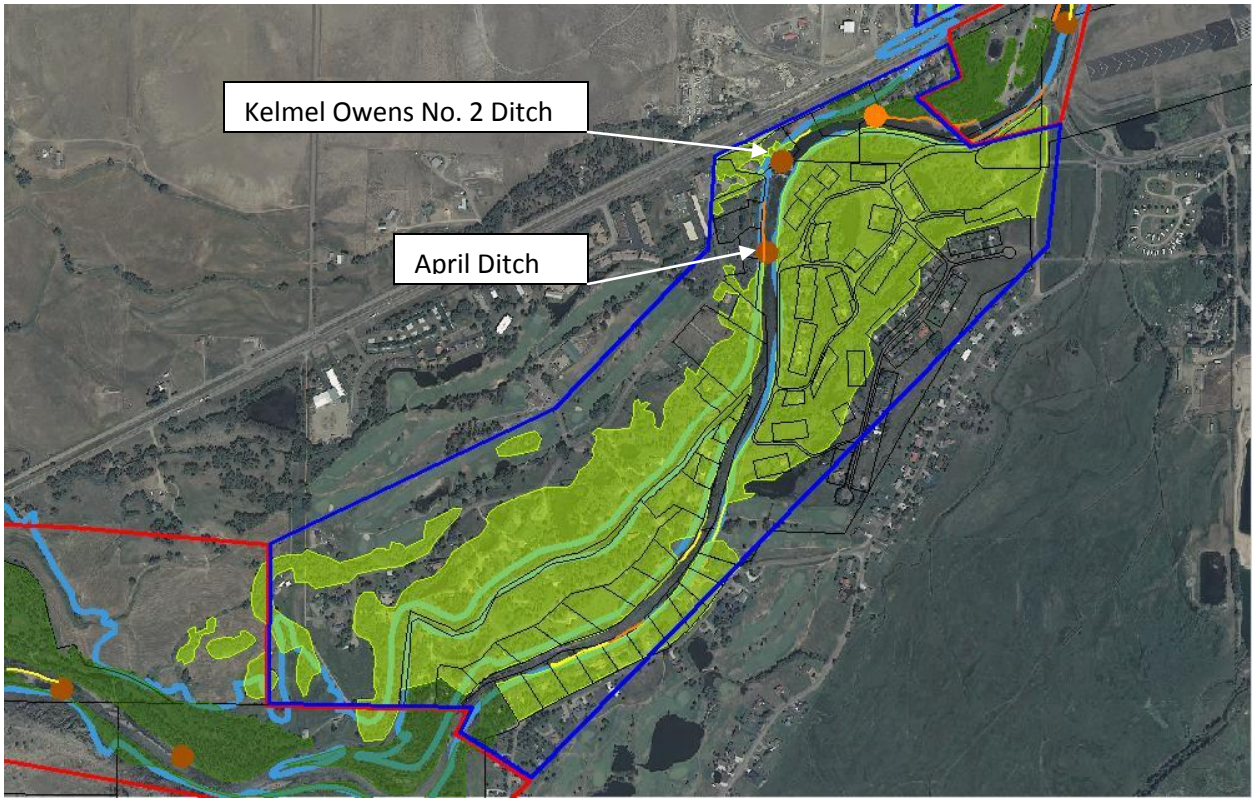
There is a large riparian area along the western side of the river channel in Segment 9. This riparian zone includes access and parking associated with the Whitewater Park and City of Gunnison infrastructure . Four sections of streambank are identified as Functioning at Risk. Impaired sections of streambank that are located along both the eastern and western banks, just south of the Hwy 50 Bridge, have been subject to the recent removal of riparian vegetation to fulfill FAA standards as the area is situated within the airport runway safety zone. The placement of concrete rip-rap along these banks has also limited the establishment of vegetation to these reaches. The area was denuded of riparian vegetation at the time of removal; however, willows have become established along the fringes of the river channel. Although the sparse vegetation is limited to the fringes of the streambank, the growth of the willows is beginning to replenish the valuable shrub stratum of riparian vegetation in this area. A longer section of streambank along the eastern bank is impaired due to the recent river enhancements for boating and more so by the encroachment of the road that is directly adjacent to the streambank. These impacts have resulted in the presence of a very narrow riparian area that consists of sparse stands of cottonwoods that lack a vegetative understory. A

reach of streambank located along the western bank is also identified as impaired. Although this reach of streambank is associated with the relatively healthy riparian area that exists to the north, impacts resulting from erosion are contributing to the impairment and degredation of the streambank. This erosion appears to be associated with hydrologic currents created by the powerful back eddies from enhanced boating structures and the recent cropping of riparian vegetation along the bank in the far western portion of the property.

This area is in a Functioning at Risk status due to the historical and current removal of riparian vegetation, impairment and armoring of the streambanks in areas that have been enhanced for boating, and the perforation of the riparian zone.

Assessment Segment 10 (5567 LF, 1.05 mi.)*:* Dos Rios Community and Golf Course (Scores: 131/200.) Fragmented/Perforated riparian zone in Proper Functioning Condition with five sections of streambank identified as Non-Functioning or Functioning at Risk.

This approximately 5567 linear foot segment includes residences in the Dos Rios community and small portions of the Dos Rios Golf Course along both sides of the river. Many of the developed areas in this segment are situated directly adjacent to the streambank. This segment includes an intact side channel of the river that creates an island that is comprised of higher ground with established residences. The segment includes two large irrigation diversion structures along the western bank in the northern portion (Photograph 10).



Photograph 10. Aerial overview of Segment 10. (2009 NAPP imagery of Gunnison County).

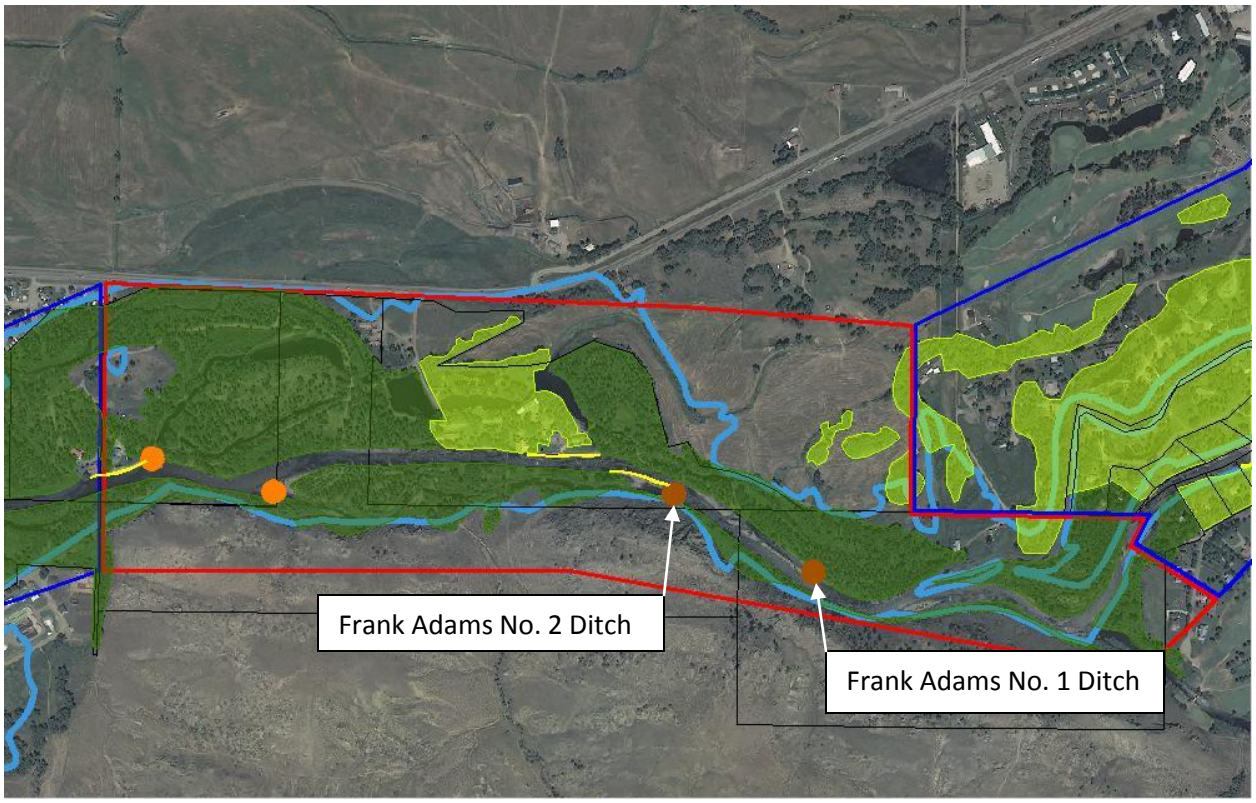
Soils associated with the relatively wide alluvial channel and riparian zone are primarily the Alluvial Land , occasionally flooded (Ao) with the Gas Creek sandy loam adjacent to the east and the Fola cobbly sandy loam (FoB) to the west (Map 2b).

The riparian areas in Segment 10 are perforated throughout and represent riparian zones that continue to retain at least some ecological function associated with the plant communities that persist in the perforated riparian zone. There are four reaches of streambank identified as impaired. Like other impaired areas within the study reach, these streambanks have been subject to re-channelization efforts, irrigation diversion improvement, and the active removal of riparian vegetation along streambanks near residences.

Assessment Segment 11 (7141 LF, 1.35 mi.)*:* Ranchlands to the north of McCabe's Lane wetlands and bridge (Scores: 188/200). Proper Functioning Condition with three sections of streambank identified as Non-Functional.

Segment 11 encompasses portions of large, relatively undeveloped parcels along both sides of the river channel. The river channel shifts from a generally southwest flow to a more westerly flow where the river enters the segment. The floodplain becomes expanded as it extends west and is bounded by the steep rocky hillsides that descend to the river corridor along the

southern bank. The segment has an irrigation diversion structure established along the northern and southern banks in the eastern portion of the segment and an irrigation return feature along the northern and southern banks in the western portion of the segment. The confluence of the Gunnison River with Tomichi Creek is located in the far western portion of the segment. The segment has an irrigation diversion feature and an irrigation return feature along both the northern and southern banks (Photograph 11).



Photograph 11. Aerial overview of Segment 11. (2009 NAPP imagery of Gunnison County).

Large reaches of river channel in this segment have been modified with various structures including improved irrigation diversion structures and multiple wing dams and weirs, presumably established for enhanced fish habitat and stream bank protection.

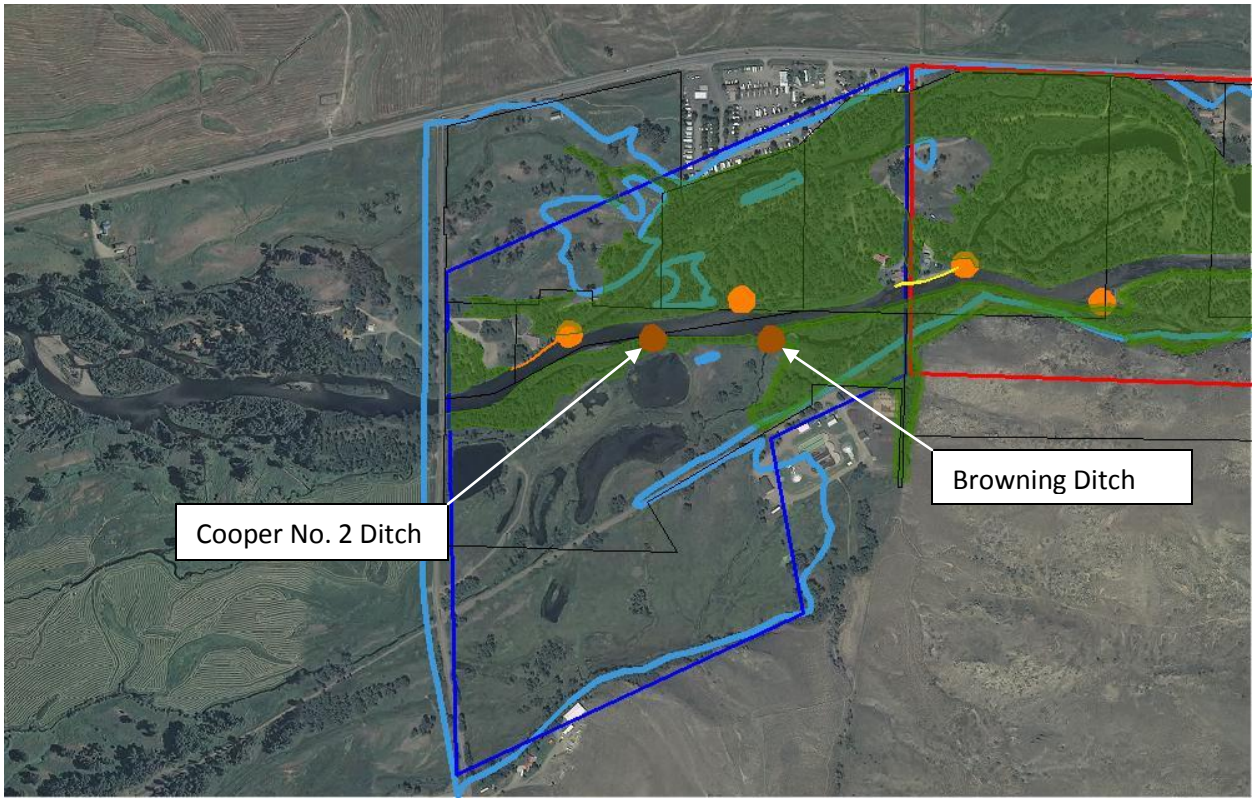
Soils along the northern bank of the river channel are the Alluvial Land, occasionally flooded (Ao) which extends to the Irim loam (Ia) soil type that is located within the flood plain further north. Soils along the southern bank of the river channel are the Stony rock land that comprises the steep hillsides that descend to the river from the south ridge (Map 2c).

The reach of river in Segment 11 supports relatively large, healthy riparian areas that are in Proper Functioning Condition with one area related to historically established ranch facilities being perforated. The large riparian areas in this segment represent another valuable node of

riparian zone that is similar to the large nodes of riparian vegetation that exist on ranchlands in segments that are north of the HWY 135 Bridge. Areas along the southern streambank in the western and eastern portions of the segment support narrow zones of riparian vegetation that are limited by the natural confinement of the steep rocky terrain in these locations along the left bank. Although the river channel has been subject to modifications including the addition of multiple structures, the improved areas appear to have undergone a natural re-vegetation of riparian species over time leaving the streambanks that are associated with these structures in good condition along much of the riverbank. There are three reaches of streambank that are identified as Non-Functioning within the segment. Two of the impaired areas along the northern bank appear to have had riparian vegetation removed in association with residences that are situated along the banks. A section of streambank along the southern bank appears to be impaired due to its proximity to a foot bridge that spans the river and a large irrigation diversion feature that exists at this location.

Assessment Segment 12 (2625 LF, 0.50 mi.): McCabe's Lane Bridge area and McCabe's Lane Wetlands and (Scores: 162/200). Proper Functioning Condition with one section of streambank identified as Functioning at Risk.

This segment is relatively undeveloped excluding the Gunnison County Water Treatment Plant that is located outside of the floodplain just south of Segment 12 and two residences that are located along the northern bank. The floodplain expands to its greatest extent within the study area within this segment as the river valley broadens to the expansive alluvial plain that exists to the south of the study area, just above Blue Mesa Reservoir. The expanded flood plain and the river support the McCabe's Lane Wetland Area in the southwest portion of Segment 12. This valuable wetland complex is established and conserved as mitigation for wetland impacts associated with an expansion to the Gunnison County Airport. The segment includes two irrigation return features along the northern streambank and two irrigation diversion features along the southern bank (Photograph 12).



Photograph 12. Aerial overview of Segment 12. (2009 NAPP imagery of Gunnison County).

Soils that are adjacent to the north of the river channel are the Alluvial Land, occasionally wet (Ao) soil type with the Irim loam (Ia) existing further to the north. The Gas Creek sandy loam is mapped in the McCabe's Lane wetland area to the south of the river channel (Map 2c).

The riparian areas that exist in Segment 12 are generally in Proper Functioning Condition with one large node of riparian vegetation established north of the river channel in the northeastern portion of the segment (i.e.; large areas shaded green in Photograph 12). The less extensive riparian zone to the south of the river is associated with the McCabe's Lane wetlands. Although the wetland area supports limited stands of mature cottonwood and overstory vegetation that would supply large woody material to the river system, the wetland area provides similar valuable ecological functions such as flood water absorption and abatement, ground surface stability and wildlife habitat. Due to the enhanced hydrology and existing hydric soils that are associated with these created wetlands, the establishment and enhancement of more diverse riparian vegetation in the wetland area would contribute to the creation of a larger node of riparian vegetation.

Summary

There are approximately 16 river miles of Gunnison River from Almont to McCabe's Lane that are contained in this assessment. Of this, approximately 83% of the Gunnison River riparian corridor is in Proper Functioning Condition which is a measure of having a riparian community that continues to function yet also allows for human land use. However, 24,408 linear feet of bank (about 17%) were rated as nonfunctional or Functional At Risk. Even though the study zone was predominantly functioning, based on a GIS analysis of aerial photographs riparian forests aerial coverage has declined by approximately 50% since 1950 (Photographs 13 and 14). In addition to riparian community loss, some riparian community has been degraded through perforation (Photograph 15).

Photograph 13 and 14. Aerial photograph of Van Tuyl Ranch and vicinity (Gunnison County, CO) with shading indicating extent of riparian forest in 1950 (top photograph, blue) and 2006 (bottom photograph, green).

Photograph 15. Aerial photograph of Dos Rios subdivision (Gunnison, CO) in 2009 illustrating perforation of riparian forest (light green).

Ultimately, riparian communities and human activity are often not congruent, but through thoughtful, scientifically based management, the conflict between use and ecosystem function may not be inevitable. Thus we recommend a focused effort to protect strategic nodes and restore function where possible to maximize the riparian values of water storage, water quality protection, flood management, microclimate regulation and wildlife habitat. Proper overall management both longitudinally and laterally from the river, will help maintain functional and structural diversity making the system resilient to perturbations.

Conservation Priorities.

Overall, the riparian condition of Gunnison River is in relatively healthy condition. There are some areas that provide the greatest values and the highest priority areas for protection and conservation. These are:

- The large intact ranches and land primarily upstream of Highway 135 but below Almont Canyon (Assessment Segments 4 through 6) that have large riparian zones. The riparian areas are some of the highest value in the study reach and by being upstream of the higher density population centers downstream they function to dissipate flood energy,

maintain water quality and provide some degree of water storage for areas in the vicinity and downstream. Maintaining these riparian zones prevents streambank erosion and maintains healthy stream morphology while providing lateral connections between the associated groundwater that supports a higher groundwater table in the adjacent meadows. These sites also act in maintaining the stream continuum and supporting a healthy riverine ecology.

- The Van Tuyl Ranch has a riparian zone and associated wet meadows in a valley with low slope that provides a valuable groundwater recharge for area residents and provides a potential area to dissipate flood energy immediately upstream of the City of Gunnison.

- There are several large riparian zones that function as “nodes” throughout the study reach but also those downstream of the City of Gunnison and upstream of McCabe’s Lane that function as “nodes” of large, intact riparian vegetation in valleys with low slope. These areas provide the array of riparian functions and protect regions downstream to, and including, Blue Mesa Reservoir.

- Also working with landowners to manage riparian grazing by domestic livestock so that riparian function is maintained. Recent studies have shown how important these are to healthy stream functions as well. For example the results such as those from Saunders and Fausch (2010) are summarized best by a statement in their executive summary: "In general, these results suggest that terrestrial invertebrate subsidies to streams can be relatively resistant to short, but high intensity, bouts of grazing. However, annual season-long riparian grazing by livestock which results in little above ground herbaceous vegetation and reduced streamside woody vegetation produces fewer terrestrial invertebrate inputs which support fish populations. Therefore, managers should design rotational grazing management systems which incorporate periods for plant recovery both within a grazing season, and among years, either by resting different pastures or deferring use to different periods of the year. A key feature should be to maintain streamside woody vegetation, which provides vertical structure and overhead cover, which apparently are important to support terrestrial prey resources that fall, crawl, or blow into streams and feed trout."

Funding for cost-share to agricultural uses for planning and implementation of riparian conservation is available. Some of these funding sources include the Conservation Reserve Program, Wildlife Habitat Improvement Program, Environmental Quality Improvement Program and the Fish and Wildlife Service’s Partners for Wildlife. Maintaining the riparian gallery forests will not only protect water quality but may also reduce the impacts of flooding and for

providing greater water supply especially in times of lower seasonal water flows (Braatne and others, 1996).

Restoration Priorities.

Overall, the riparian condition of Gunnison River is in relatively healthy condition. There are some areas in need of restoration and the **highest priority areas** are:

- Van Tuyl Ranch, Ohio Creek confluence and areas immediately upstream (Assessment Segment 7) needs the restoration of overbank, side channel high water flow, plus the restoration of riparian forests and instream habitat. This assessment segment has lost approximately 80 acres of riparian forest (about 60%) between 1950 and 1979 plus saw catastrophic flooding in 1984. The stream has been channelized, the banks armored (Photograph 16) and the stream habitat has been homogenized. Riparian and instream restoration is recommended since this area includes a large node of riparian habitat and is publicly owned. This region provides substantial groundwater recharge that is used by domestic water wells for the City of Gunnison. Additionally, this is an area immediately upstream from a human populated area in the City of Gunnison and this may be used an area to reduce some of the impacts from floods. Improved overbank and side channel flow during normal spring floods (Photograph 17) and instream channel restoration will also benefit the fishery in the Gunnison River. This wetland enhancement could also function as a wetland bank for other public works projects in the Gunnison River basin.

Photograph 16. Photograph taken during peak runoff, 2010, of bank armoring of the Gunnison River (Gunnison County, CO) upstream of the confluence with Ohio Creek near Van Tuyl Ranch.

Photograph 17. Photograph taken during peak runoff, 2010, of overbank flow of the Gunnison River (Gunnison County, CO) upstream of the confluence with Ohio Creek near Van Tuyl Ranch.

- Restore wet meadows at McCabe's Lane wetlands (Assessment Segment 12). Even though the riparian vegetation was not present in the 1950 aerial photo, the soils are historical wetland soil types (Gas Creek Loam) that could be restored to more wet meadows and less lentic habitats. This wetland complex was established and is conserved as mitigation for wetland impacts associated with an expansion to the Gunnison County Airport. The segment includes two irrigation return features along the southern bank that are used to fill the ponds. We would recommend general overland flow of water to restore the historical wet meadows that most likely formed the soils in this area. This could diversify the riparian zone/wetlands and also function as a wetland bank for other public works projects in the Gunnison River basin.

- Design and engineering of Diversions/Ditches to Reduce Riparian and Instream Disturbance from Maintenance (All Assessment Segments). One pattern that was apparent during this assessment was that near almost every diversion structure was a zone of impaired riparian habitat (Photographs 18 and 19). We recommend the redesign of diversion structures (Photograph 20) along with

restoration of these areas, where practical. This restoration project could increase reliable irrigation supply, reduces impact to riparian zones and decrease maintenance costs for owners of the diversion structures. Funding for these projects or other water supply projects could come from the Colorado Water Control Board's (CWCB) Water Supply Reserve Accounts Grant program, the Upper Gunnison River Water Conservancy District's grant program, or a variety of other CWCB grants or possibly the new Colorado River District Water Resources Grant Program.

Photograph 18. Aerial photograph of diversion structure and impaired riparian zone along the Gunnison River (Gunnison County, CO).

Photograph 19. Photograph of impaired riparian zone near the diversion structure on the Gunnison River (Gunnison County, CO) documented in Photograph 18.

Photograph 20. Photograph of engineered diversion structure provided by Elk River Construction, Pagosa Springs, CO.

- Often housing owners remove the riparian vegetation along the Gunnison River (various Assessment Segments). This vegetation removal (Photographs 21, 22) decreases the ability of the riparian zone to absorb pollutants, reduces the riparian zones ability to absorb flood waters, reduces the ability to prevent erosion and leads to increased stream sedimentation. Additionally, there are declines in the ability of the riparian zone to maintain microclimatic conditions or support wildlife and fisheries. Often after homeowners remove riparian vegetation, the banks are armored with rocks or concrete to prevent the resulting erosion and loss of stream bank. This activity often displaces stream energy downstream and may be causing erosion on nearby downstream properties. This displaced stream energy eroding downstream banks often results in additional streambank armoring at properties downstream continuing to exacerbate the impacts to the Gunnison River riparian zone.

Photograph 21. Photograph taken in 2010, documenting armoring on the streambank of the Gunnison River to reduce erosion by displaced stream energy from the diversion on river left (left side of photo) and the removal of riparian vegetation on river right (right side of photo).

Photographs 22 and 23. Photographs of housing on the Gunnison River with riparian vegetation removed (Photograph 22) and riparian vegetation relatively intact (Photograph 23).

- The narrowleaf cottonwood gallery forest removal immediately downstream from Van Tuyl ranch (Assessment Segment 7) may need restoration or mitigation on Van Tuyl Ranch. During 2009 and 2010, a large tract of riparian forest was removed downstream from Van Tuyl Ranch. Additionally, planning for riparian protection within the City of Gunnison should be considered. Urban riparian forests such as these protect water quality and may help reduce the impacts from floods (Photographs 24 and 25).

Photographs 24 and 25. Aerial photographs of riparian cottonwood gallery forest from 2005 Photograph 24, upper) and 2009 (Photograph 25, lower).

- Implement Best Management Practices for reduction of sediment from road maintenance in regions where Highway 135, Highway 50, and residential streets within the city of Gunnison (various Assessment Segments).

Watershed Management Recommendations

In general, the riparian area throughout the Gunnison River watershed within the County of Gunnison is generally protected by a 25 foot setback from wetlands for general construction and a 100 foot setback from wetlands for septic systems through the current Gunnison County Land Use Regulations (LUR) (these can be modified based on slope or other specific case conditions). Additionally, the LUR on pages 216 through 218:

- restricts the removal of "existing live vegetation" except noxious weeds, dead/dying trees in riparian zones;
- restricts impacts to features that provide bank stability or riparian area protection including vegetation and "natural features" within the restrictive inner buffer;
- prevents impacts in areas of a known flood event where the restrictive setback shall be 100' beyond the restrictive inner buffer;
- and provides for a variable outer buffer to provide bank stability or riparian area protection.

We recommend consulting the document and legal advice in regards to interpreting these regulations. We are also unsure of how well the LUR is understood or enforced.

Though these regulations are protective to riparian zones during the issuance of a new permit they do not apply to modifications to the riparian corridor outside of the permitting window. There are, however, many studies (see Fischer and others, 2000 for a list) that indicate that the 25 foot setback, as designated as a restrictive inner buffer in the LUR, is inadequate at protecting water quality and riparian values. For the sole protection of water quality, studies indicate from 4 meters to 30 meters and the Planner's Guide to Wetland Buffers for Local Governments (Environmental Law Institute 2008) indicates 20 to 175 feet is necessary with corrections for land use intensity, wetland category and slope adjustment. With these recommendations in mind the Gunnison County LUR only minimally protects water quality and other values of riparian zones. Since the maintenance of riparian values is a concern for stakeholders and the UGRWCD, as discussed in their mission and values statement, then scientifically based planning for larger buffers from wetland and riparian zones in the Gunnison River watershed should be a priority. In areas with already intact housing, then maintaining

and restoring riparian vegetation especially along a zone of six meters from the riverbanks should be a priority.

When wildlife and their habitat (including amphibians, reptiles, birds and mammals) is considered, recommended buffers to riparian zones increases. Of the groups of wildlife needing the greatest buffer zones, the amphibians, reptiles and migratory birds need the greatest zones of protection. These recommendations are often hundreds of meters wide and the Planner's Guide to Wetland Buffers for Local Governments (Environmental Law Institute 2008) indicate that habitat buffers should range from 75 to 300 feet is necessary with corrections for land use intensity, wetland category and slope adjustment. It should also be noted that with the steep slopes in some portions of the Gunnison River drainage that the buffer zones for water quality and for habitat are multiplied by up to 1.5. So, the Gunnison County LUR only minimally protects riparian wildlife habitat and if habitat protection and enhance is a concern for the UGRWCD, then planning for larger buffers from wetland and riparian zones in the Gunnison River watershed should be a priority similar to water quality protection. Already some regions in the Rocky Mountain west have proposed additional restrictions. For example, the Madison County, Montana planning board voted to recommend a 300-foot setback from rivers and a 125-foot setback on tributaries to keep homes from being built too close to waterways to protect wildlife, water quality and fish (Montana Standard, October 27, 2010).

As discussed in the "Introduction to Riparian Ecology and Functions," longitudinal connections down the length of a stream and its riparian zone are important for natural ecological function, organism migration and gene flow. The disruption and breaking up of this connection is termed "fragmentation." "Perforation" is reducing the overall quality and continuity throughout an area such as the riparian corridor along the Gunnison River. Throughout the Gunnison River watershed, the riparian zone and stream is potentially fragmented and perforated by roads and housing. In watershed planning, the UGRWCD and stakeholders should consider maintaining stream and riparian areas that are already contiguous such as Assessment Segments 4, 5 and 11 as well as the tributaries.

However, where these segments are separated by more intensive land use, efforts should be made to connect these. The City of Gunnison represents the greatest degree of fragmentation along the stretch of Gunnison River and the potential development of a "greenbelt" could help remedy some of this fragmentation. Additionally, planning for riparian maintenance, restoration or mitigation within the City of Gunnison should be given additional careful consideration. This should include encouraging homeowners along the riverbanks to maintain some degree of riverbank vegetation.

There is noticeable large woody debris (=large, downed trees in the riparian zone and stream) throughout much of this stretch of the Gunnison River. However, we are concerned that the riparian cottonwood canopy forest has declined approximately 50% since 1950 and we are also experiencing a loss in thinleaf alders throughout the basin (Worrall 2009). Since large woody debris is important for stream and riparian habitat then the amount should not continue to decrease in the stream through time and the Gunnison River should be assessed periodically to assure that riparian communities are still providing sufficient large woody debris to the Gunnison River. Also, the presence of large woody debris in the stream or riparian zone should not be removed unless it poses a human safety risk.

Riparian communities are very complex systems that we only minimally understand thus generalizations about specific functions are often minimal. Maintaining healthy riparian zones and the services they provide requires working across many scales and maintaining connectivity with flows and organisms contributes to greater resilience. This conservative and inclusive management approach best prepares the UGRWCD and other stakeholders for maintaining the values and resource of the Gunnison River watershed into the future. However, greater understanding of this area, especially of groundwater flows would be of great benefit to the UGRWCD and other stakeholders in managing the upper Gunnison River and its riparian zones.

Lastly, the UGRWCD and others should develop a coordinated effort to continually monitor and assess the quality and health of riparian zone and stream habitats. This could involve rapid assessments of these areas periodically and the compilation of data. This document could serve as a reference condition and then changes, either positive or negative, could then be documented with appropriate actions following.

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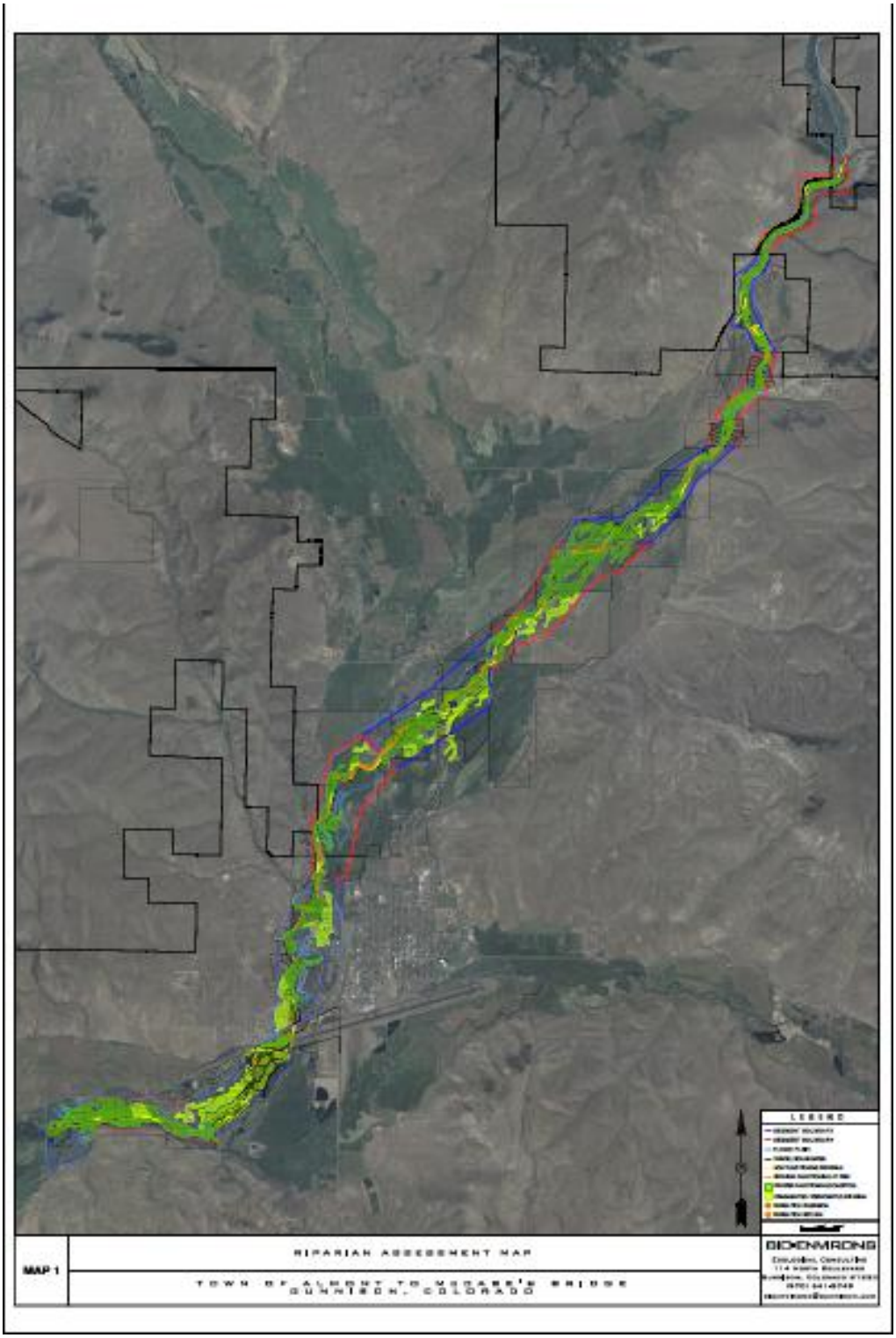
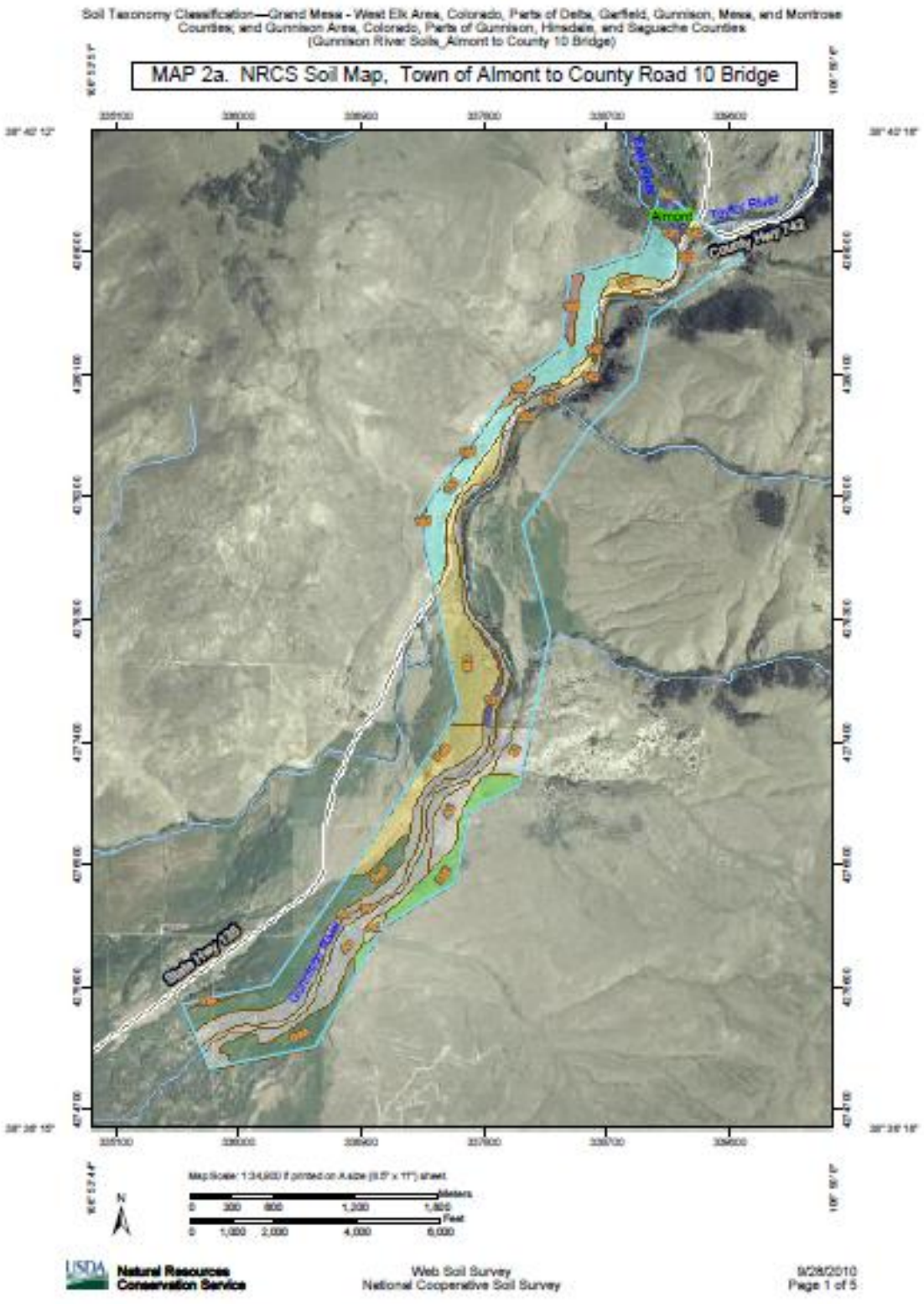
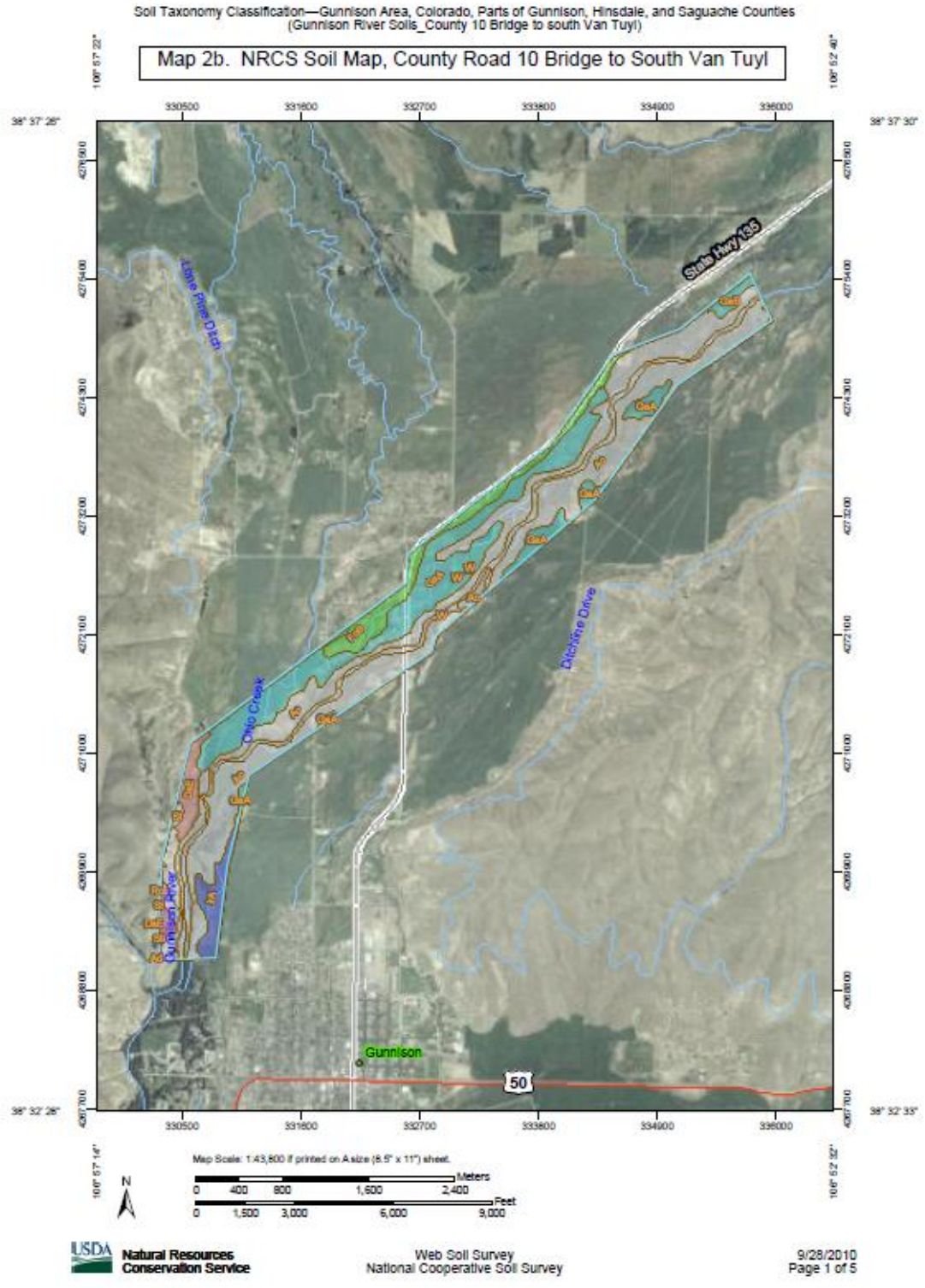
Maps



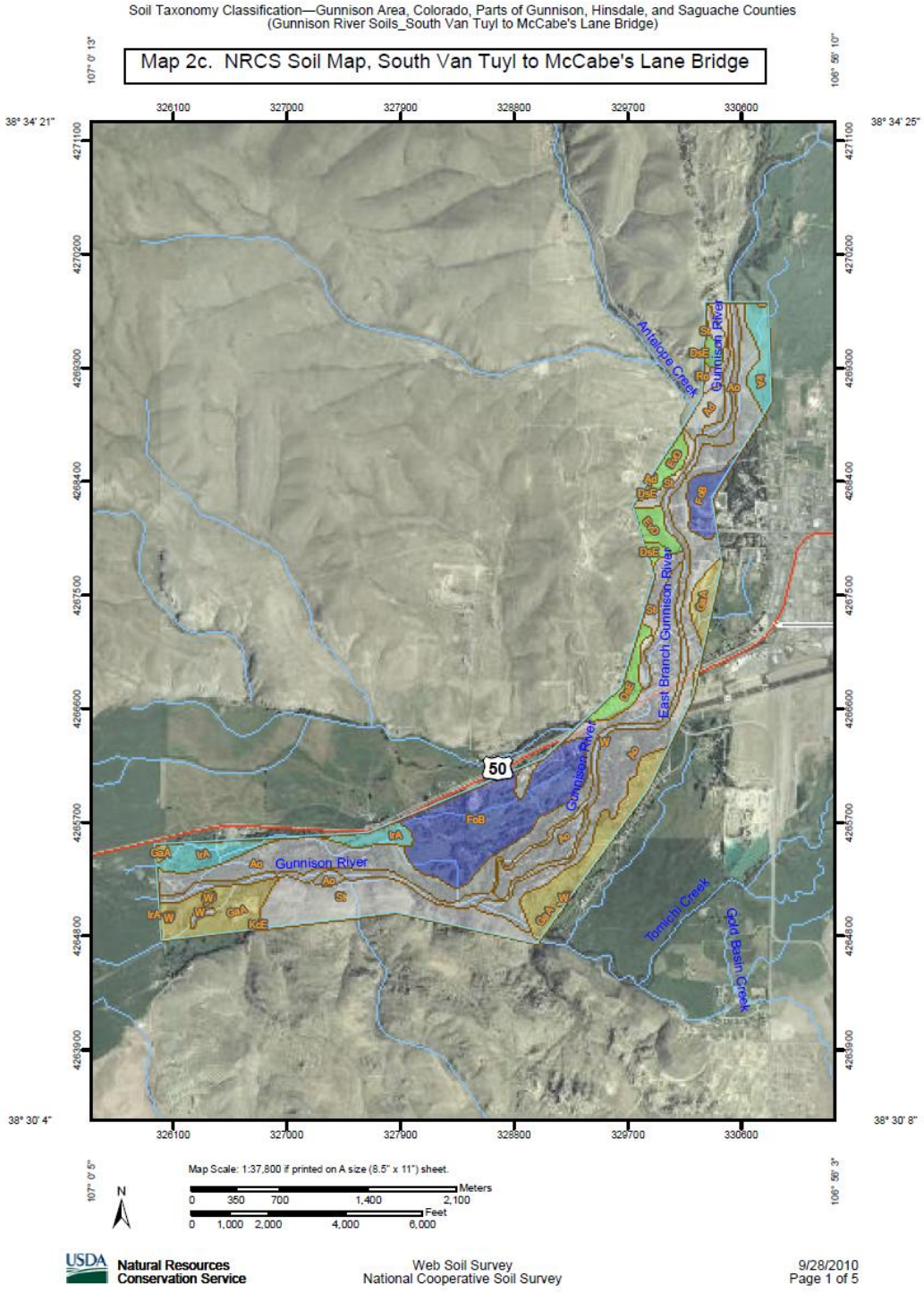
Map 1. 2010 Riparian Assessment Map of the Gunnison River from the Town of Almont to McCabe's Lane Bridge.



Map 2a. NRCS Soil map, Town of Almont to County Road 10 Bridge (Gunnison County, CO.)



Map 2b. NRCS Soil Map, County Road 10 Bridge to South Van Tuyl (Gunnison County, CO)**.**



Map 2c. NRCS Soil Map, South Van Tuyl to McCabe's Lane Bridge (Gunnison County, CO).

Tables

Assessment Segment	Non-Functioning (LF)	Functioning At Risk (LF)	Proper Functioning Condition-Intact (Acreage)	Proper Functioning Condition-Perforated (Acreage)	Proper Functioning Condition Total (Acreage)	Water Quality Protection	Flood Manage-ment	Micro-climate Regulation	Wildlife Habitat
1	1160	0	15.7	0	15.7	Low	Low	High	Medium
2	1106	572	25.5	3.0	28.5	Medium	Medium	High	Medium
3	0	555	34.9	0	34.9	High	Medium	High	Medium
4	617	2430	80.0	14.2	94.2	Medium	High	High	Medium
5	1930	4202	148.3	19.9	168.1	High	High	High	Medium
6	685	4683	73.9	59.9	133.8	Medium	Low	Medium	Low
7	3382	6199	55.4	3.6	59.0	High	High	High	High
8	140	3496	58.9	74.9	133.8	Medium /Low	Low	Medium	Low
9	375	1724	8.7	0	8.7	Medium	Medium	Medium	Low
10	1111	740	3.5	152.0	155.5	Medium	Low	Medium	Low
11	827	0	94.5	13.4	107.9	High	High	High	High
12	0	323	41.8	0	41.8	High	High	High	High

Table 1. Summary of Proper Functioning Criteria and relative riparian functioning values of the upper Gunnison River from the Town of Almont to the McCabe's Lane Bridge, Gunnison County, Colorado (2010).

Appendices

HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (FRONT)

STREAM NAME	LOCATION
STATION # _____ RIVERMILE _____	STREAM CLASS
LAT _____ LONG _____	RIVER BASIN
STORET #	AGENCY
INVESTIGATORS	
FORM COMPLETED BY	DATE _____ TIME _____ AM PM / REASON FOR SURVEY

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Slow is <0.3 m/s, deep is >0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel, or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

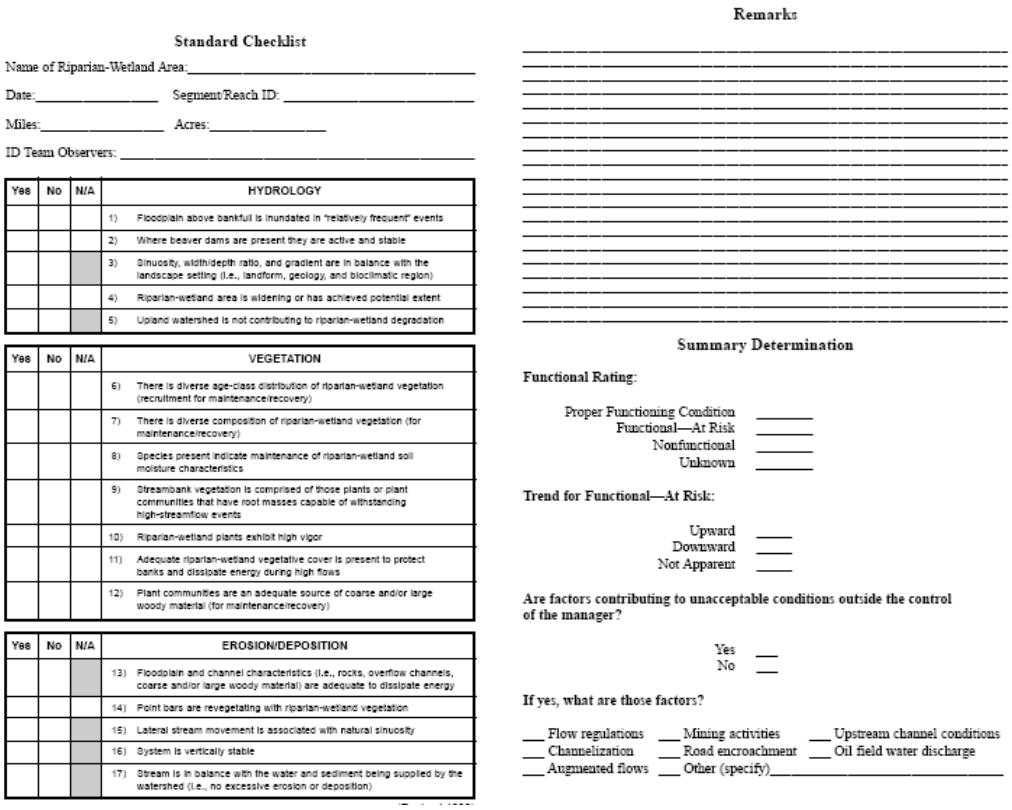
HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (BACK)

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or concrete; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas, "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities.
SCORE (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score _____

Appendix A. Data sheets from Barber and others, 1999 used in assessment segment analysis for flowing water sections.



Standard Checklist

Name of Riparian-Wetland Area:_____

Date:_____ Segment/Reach ID: _____

Miles:_____ Acres:_____

ID Team Observers: _____

Yes	No	N/A	HYDROLOGY
			1) Floodplain above bankfull is inundated in "relatively frequent" events
			2) Where beaver dams are present they are active and stable
			3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
			4) Riparian-wetland area is widening or has achieved potential extent
			5) Upland watershed is not contributing to riparian-wetland degradation

Yes	No	N/A	VEGETATION
			6) There is diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
			7) There is diverse composition of riparian-wetland vegetation (for maintenance/recovery)
			8) Species present indicate maintenance of riparian-wetland soil moisture characteristics
			9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high-streamflow events
			10) Riparian-wetland plants exhibit high vigor
			11) Adequate riparian-wetland vegetative cover is present to protect banks and dissipate energy during high flows
			12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)

Yes	No	N/A	EROSION/DEPOSITION
			13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) are adequate to dissipate energy
			14) Point bars are revegetating with riparian-wetland vegetation
			15) Lateral stream movement is associated with natural sinuosity
			16) System is vertically stable
			17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

Remarks

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Summary Determination

Functional Rating:

Proper Functioning Condition _____
Functional—At Risk _____
Nonfunctional _____
Unknown _____

Trend for Functional—At Risk:

Upward ____
Downward ____
Not Apparent ____

Are factors contributing to unacceptable conditions outside the control of the manager?

Yes ___
No ___

If yes, what are those factors?

___ Flow regulations ___ Mining activities ___ Upstream channel conditions
___ Channelization ___ Road encroachment ___ Oil field water discharge
___ Augmented flows ___ Other (specify)_____

Appendix B. Data sheets from Richard and others, 1998 used in assessment segment analysis for flowing water sections.