MEADOW VALLEY WASH

POST-FLOOD DAMAGE ASSESSMENT AND RECOMMENDATIONS

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Prepared For:

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ACRONYMS AND ABBREVIATIONS

BLM	Bureau of Land Management
Cfs	Cubic feet per second
County	Lincoln County
GIS	Geographic information system
NDOT	Nevada Department of Transportation
r. right	The right side of the creek looking downstream
r. left	The left side of the creek looking downstream
UPRR	Union Pacific Railroad

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1.0 INTRODUCTION

In January 2005, a severe flood event in Lincoln County closed nearly 120 miles of roads and washed out portions of the Union Pacific operated rail line within the Clover Creek and Meadow Valley Wash watersheds. The flood event and post-flood mechanical disturbance resulted in widespread impacts to resources that exposed and destabilized sediments and altered sediment transport patterns. Resource Concepts, Inc. (RCI) was requested by the BLM to conduct a damage assessment that can be used to assist the United States Department of Interior, Bureau of Land Management (BLM) Ely Field Office (EYFO) in making informed decisions to ensure effective implementation of stabilization and rehabilitation activities.

This report describes the project area, methods and findings of the damage assessment with recommendations for natural resource reclamation and repairs to infrastructure. The recommendations are prioritized and include a range of estimated costs.

2.0 DESCRIPTION OF PROJECT AREA

The Project Area (Figure 1) for the post-flood damage assessment includes approximately 75 miles of Meadow Valley Wash, from Caliente to Farrier and 20 miles of Clover Creek from Barclay to the confluence with Meadow Valley Wash in Caliente (Figure 1). The elevation of Clover Creek and Meadow Valley Wash ranges from 5,300 feet above sea level near Barclay on Clover Creek, to 4,400 feet at Caliente, to 1,600 feet at Farrier. The most prominent contributing watersheds originate in the Clover Mountains and the Delmar Mountains, both of which extend over 7,000 feet in elevation. The Clover Mountains are located on the south side of Clover Creek and the east side of Meadow Valley Wash. The Delmar Mountains are on the west side of Meadow Valley Wash. Both mountains have several springs. Average annual rainfall ranges from four to six inches in the southern part of the Project Area and eight to fourteen inches in the northern part. Precipitation increases at the higher elevations.

The general landscape geomorphology and the anthropogenic constraints or infrastructure are varied for different reaches of the Meadow Valley Wash-Clover Creek project area. Landscape geomorphology is indicative of channel characteristics. For instance, in narrow canyons stream flood velocities and erosive forces are expected to be relatively high and the stream channel likely to be single thread with perennial water. In the wide-open areas, stream flood velocities are expected to be relatively low, the channel likely braided, sediment deposition more likely than channel erosion, and only seasonally wet. Infrastructure presents constraints and features that warrant protection from erosion and sedimentation. Three distinct channel reaches within the project area are described for Clover Creek in Table 1. Seven distinct reaches of Meadow Valley Wash are described in Table 2. Figure 2 illustrates the reaches and surrounding geology.

Figure 1 Project Location Map

Table 1. Clover Creek Reach Description

SITE SHEETS	LOCATION	DESCRIPTION
No Sheets	Barclay to Islen	**Geomorphology:** Open volcanic rock valley with relatively gentle channel slope. Several large tributaries including Mathews Canyon enters at the top of this reach. This reach is approximately 4.5 miles long. **Constraints:** The broad open canyon provides for a channel floodplain but the railroad tracks are in the center of the valley and partially impinge on and limit the sinuosity of the main channel. There are five UPRR track bridge crossings of Clover Creek in this reach.
70 to 76	Islen to Minto Canyon	**Geomorphology:** Extremely narrow and sinuous volcanic rock canyon with steeper channel slope, bedrock and bolder controls. Numerous springs enter along this reach. Tributaries are relatively fewer and shorter with the exception of Pine Wash that enters above Big Spring. This reach is approximately 7.4 miles long. **Constraints:** The railroad tracks and railroad access road impinge on and sometimes limit the sinuosity of the main channel. The tributaries contribute large quantities of sediment to the main channel. There are sixteen UPRR track bridge crossings of Clover Creek in this reach.
61 to 70	Minto Canyon to Caliente	**Geomorphology:** Open volcanic rock canyon, sandy bottom. Tributaries are large and contribute large volumes of sediment from the Clover Mountains (Barnes Canyon, Ash Canyon, English Canyon). This reach is approximately 9.3 miles long. **Constraints:** Much of this reach is private land and could not be completely accessed. The culvert and bridge near the confluence with Meadow Valley Wash are undersized. There is one UPRR track bridge crossing and one road crossing of Clover Creek in this reach.

Table 2. Meadow Valley Wash Reach Description

SITE SHEETS	LOCATION	DESCRIPTION
60 to 59	Caliente to USGS Gauging Station	**Geomorphology:** Wide open valley. The channel is incised through the City of Caliente. This reach is approximately six miles long. **Constraints:** There are homes on both sides of the wash through the City of Caliente and a history of flooding. There is one UPRR track bridge crossing and two road crossings of Meadow Valley Wash in this reach.
59 to 46	USGS Gauging Station to Elgin	**Geomorphology:** Rainbow Canyon, very narrow, volcanic rock canyon with local boulder and bedrock controls. Numerous large tributaries contribute sediment to the main channel. This section drains the steepest and highest elevation tributary watershed areas within the Project Area: over 7,000 feet in both the Delmar Mountains to the west and the Clover Mountains to the east. This reach is approximately sixteen miles long. **Constraints:** The naturally narrow canyon is narrowed further by fill from SR 317, and the UPRR tracks and access road. Generally the railroad tracks and SR 317 are on opposite sides of the canyon. There are three UPRR track bridge crossings and six road crossings of Meadow Valley Wash in this reach.
45 to 39	Elgin to Leith	**Geomorphology:** Variable width volcanic rock canyon, wider and more sandy than Rainbow Canyon. Pennsylvania Canyon and Cottonwood Canyon contribute large volumes of sediment to the main channel. This reach is approximately five miles long. **Constraints**: The UPRR tracks and access road, and the County road impinge on the floodplain and in places limit the sinuosity of the main channel. There are three UPRR track bridge crossings of Meadow Valley Wash in this reach. The old the flood has locally washed out County Road. Currently the access road crosses the wash under the UPRR track bridges.

SITE SHEETS	LOCATION	DESCRIPTION
39 to 32	Leith to Carp	**Geomorphology:** Very wide valley composed of alluvium (Quaternary and Tertiary gravel). There are numerous tributaries that contribute sediment to the main channel. This reach is approximately eleven miles long. **Constraints**: There are few constraints to the main channel. Most constraints are associated with crossings of the tributary channels. There is one UPRR track bridge crossing of Meadow Valley Wash in this reach.
31 to 19	Carp to Two miles north of Hoya	**Geomorphology:** Variable width limestone, sandstone and volcanic rock canyon. The total reach is approximately fifteen miles long. **Constraints**: The UPRR tracks and access road, and County road impinge on the floodplain and in places limit the sinuosity of the main channel. Tributaries contribute large volumes of sediment to the main channel. There are four UPRR track bridge crossings of Meadow Valley Wash in this reach.
19 to 14	Two miles north of Hoya to Rox	**Geomorphology:** Very wide valley composed of alluvium (Quaternary and Tertiary gravels). The total reach is approximately six miles long. **Constraints**: There are few constraints to the main channel. Most constraints are associated with crossings of the tributary channels. There are no UPRR track bridge crossings of Meadow Valley Wash in this reach.
14 to 11	Rox to Farrier	**Geomorphology:** Variable width limestone, sandstone and volcanic rock canyon. The total reach is approximately five miles long. **Constraints**: The UPRR tracks and access road, and County road impinge on the floodplain and in places limit the sinuosity of the main channel. Tributaries contribute large volumes of sediment to the main channel. There are three UPRR track bridge crossings of Meadow Valley Wash in this reach.

Table 1 and 2 References: Longwell et. al. 1965; Tschanz and Pampeyan, 1970; USGS 7 ½ minute quads.

Figure 2 Geologic Map

3.0 METHODS

3.1 Assessment of Change

This report tiers from the mapping work previously conducted by Bio-West, Inc. from 2003 to 2005 and documented in *Meadow Valley Wash Baseline Ecological Assessment* dated March 2005 and *Meadow Valley Wash Post Flood Vegetation Assessment* dated September 2005. The organization of this report follows the same atlas organization as the two Bio-West reports.

An initial assessment of change was completed by Bio-West, Inc. and documented in their September 2005 report funded by the BLM. The following information from the Bio-West study was reviewed to identify areas that needed to be assessed in detail on the ground.

- Three-band Digital Rectified Images for Meadow Valley Wash and Clover Creek captured in June 2005.
- GIS shapefiles depicting changes between the June 2005 and September 2003 aerial images by disturbance type (natural or human), and eleven types of human disturbances (new berm, new borrow pit, graded, etc.).
- GIS shapefiles depicting eighteen riparian vegetation types, eighteen upland vegetation types, and southwestern willow flycatcher habitat that existed in 2003, and the same for 2005.

3.2 Field Damage Assessment

Base Map Preparation

The digital imagery and shapefiles provided by Bio-West were used to create three types of field maps:

- 2003 Color Aerial Imagery at 1”=500’ scale (75 sheets total). These sheets were used for pre-flood comparison in the field.
- 2005 Color Aerial Imagery at 1”=500’ scale (75 sheets total, included Meadow Valley Wash and Clover Creek up to Big Spring area) depicting the Bio-West GIS delineation of southwestern willow flycatcher habitat, disturbance type and type of human disturbance. These sheets were used as guides to focus the field analysis.
- 2005 Color Aerial Imagery at 1”=500’ scale (75 sheets total). These sheets were used as base maps in the field to note current conditions and map recommendations.

In addition to the aerial images, the following topographic maps were used as supplemental, interpretive information:

- USGS 7.5 minute scale topographic maps with an overlay illustrating the extent of the aerial images described above.
- USGS 100K maps with an overlay of the sub-watershed boundaries.

An aerial mapbook index and 24K USGS topographic quadrangle index is provided in Appendix A. A CD of the 2003 Color Aerial Imagery is included with this report in Appendix B. The 2005 Color Aerial Imagery is presented in the Assessment Results and Discussion section of this report for the sheets that include recommendations.

Resource Objectives

Resource objectives were reviewed from the Draft Resource Management Plan/Environmental Impact Statement (RMP/EIS) for the Ely District, Caliente Management Framework Plan Amendment (Caliente MFP Amendment), and other pertinent documents for sixteen areas of concern and are summarized in Appendix C. These objectives describe the general resource conditions that are deemed to be optimal for providing functionality and production of goods and services on BLM administered public lands. Several additional objectives that more specifically address the function and value of the Meadow Valley Wash and Clover Creek and protecting the existing infrastructure were identified. All of these objectives were used to guide the prioritization of project recommendations. Specific objectives are outlined below.

<u>Hydrology and Jurisdictional Waters of the US:</u>

- Retain or re-establish appropriate low flow and flood flow conveyance capacity configurations.
- Reduce sediment bed load.
- Dissipate erosive energy during flood flows.
- Increase stream flow.

<u>Wildlife and Sensitive Species:</u>

- Where appropriate, reclaim areas to provide diverse wildlife and listed species habitat.
- Reestablish suitable southwestern willow flycatcher habitat and enhance potential habitat by replacing existing tamarisk wherever possible with willow and other riparian woodland species.

- Where appropriate, reestablish or enhance speckled dace and desert sucker habitat.
- Reestablish native plant communities that will be consistent the Ecological Site Inventory.
- Reclaim desert tortoise habitat identified as damaged in the 2005 Bio-West study.

Soil Resources:

- Reclaim compacted areas that reduce natural soil infiltration and permeability
- Avoid disturbance in new areas that have a soil biotic crust
- Reduce the potential for accelerated soil erosion.

Vegetation and Weeds:

- Limit the spread of noxious and invasive weeds
- Replace tamarisk with native riparian and upland species to enhance biological diversity and improve surface water flows

ROW ,Land Status, Roadways, and Access

- Protect existing infrastructure
- If existing infrastructure presents an on-going maintenance burden, consider relocation or redesign
- Maintain private land values and uses

Wilderness

- Reclaim impacts to wilderness characteristics in the Clover Mountains Wilderness Area.
- Use the minimum tool required for reclamation activity in wilderness areas.

Archaeological Resources and Historic Properties

- Avoid treatments using mechanical equipment on native vegetation and stable upland surfaces.

- Design treatments to enhance and protect in place archeological resources and elements that contribute to the significance of buildings and structures eligible to the National Register of Historic Places.
- Where no feasible alternative exists to displacing archeological resources of National Register eligible buildings or structures, design treatments to minimize damage to archeological resources and blend with materials, color, and design of significant historic sites, districts, buildings, structures, and landscapes.
- Identify, protect, and classify at-risk archeological resources, significant historic properties, and cultural landscapes (BLM 2005).

Field Reconnaissance

The field reconnaissance team was comprised of a stream restoration engineer, a reclamation specialist, and a fluvial geomorphologist. The team members have each lived and worked in the Great Basin and Mojave Desert ecosystems for over 20 years. A field reconnaissance was conducted of the entire length of the Project Area from Barclay to Farrier. The reconnaissance was performed on January 9 through 13, and January 24 and 25, 2006. The interdisciplinary team drove the entire length of the Project Area and walked portions of each site. The team focused on areas that exhibited "change" from the 2005 flood as documented in the Bio-West 2005 report. The changes were analyzed in terms of impact to stream functions and stability, habitat and other values, and potential for impacts to existing infrastructure. Alternative solutions were developed using the resource objectives as a guide in areas with excessive erosion or sedimentation.

Findings and recommendations were drawn on basemaps and detailed in field worksheets. Each site was photographed.

3.3 Assessment Result Organization

The assessment results are presented following the organization initiated by Bio-West in the baseline study and the post-flood vegetation assessment. The numbering scheme follows the Sheet number starting from the downstream end of the Project Area. For instance, Sheet 14 contains two sites, 14A and 14B. 14A is the furthest downstream. If a damaged area crossed over two sheets, the most southern sheet name carried the site onto the next page. For instance, Site 49B continues onto the bottom of Sheet 50. All sites were generally located by GPS points. The GPS data file can be used to cross-reference to stream mile or railroad milepost.

- Mitigation recommendations were made on private property when damages could be observed from the County road without trespassing. Private property was not accessed for the damage assessment.

- No attempt was made to separate out damaged areas within the UPRR ROW from adjacent BLM administered public lands because the ROW limits have not been mapped and are not clearly evident in the field.
- No attempt was made to delineate damages to historical or archaeological resources. Flood damages, relatively recent disturbances and alterations over the years to historical or archaeological resources in Meadow Valley Wash and Clover Creek have resulted in physical complexities that will require a team of trained archeologists. This type of in-depth archaeological and historical evaluation was beyond the scope and timeframe allowed for this damage assessment.

Data Reduction and Project Prioritization

Various watershed tributary parameters were compiled and analyzed to determine if there were any obvious trends or causative factors that could explain repeated patterns observed in the field. Tributaries that played an obvious roll in site damages were delineated for total area, relief ratio (elevation difference divided by basin length), weighted erosion factor (K factor from NRCS soils surveys), and percent of watershed burned in the 2005 fires.

Aerial photographs taken in January 2005 by the Nevada Department of Transportation (NDOT) were reviewed and compared with the June 2005 imagery. The flood flows are still high in the NDOT aerials and provide good guidance on where the flood flows are likely to go in the future.

The field notes and maps were digitized into GIS data layers. Spreadsheets were created from these GIS layers and used to calculate quantities for cost estimating purposes. Standard quantity costs were obtained from *RSMeans Building Construction Cost Data 2006* as well as past projects with similar treatments. Quantities were calculated using the GIS layers and multiplied by unit costs.

Projects were objectively quantified using a point system and a matrix of critical environmental and infrastructure criteria. The projects were then assigned to high, medium and low priorities according to the resulting score. The prioritization criteria and rating system is presented in Table 3.

Table 3. Project prioritization criteria and rating scores.

CRITICAL ENVIRONMENTAL OR INFRASTRUCTURE CONCERN	CRITERIA
Is the site located in Southwestern Willow Flycatcher Habitat?	Suitable = 10 points Potential = 5 points Non-habitat = 0 points
Is there a Potential for Damage to Infrastructure? (From erosion, sedimentation, flooding, etc.)	Yes = 10 points No = 1 point
Current Erosion Status: Is the site actively eroding? Has there been recent erosion at the site? Is the site stable?	Active = 10 points Recent = 5 points Stable = 1 points
Existing Location of Fill Material Recommended for Removal Is the fill located in Waters of the United States (WOUS)? Is the fill located in the floodplain?	In WOUS = 10 points In Floodplain = 5 points None = 1 point
Potential for Tributary Sediment Deposition What is the weighted K factor (Kw) for the tributary at the site?	Kw > 0.10 = 10 points Kw < 0.10 = 5 points No Tributary = 1 point
Is the site located in a designated desert tortoise Area of Critical Environmental Concern or desert tortoise habitat?	ACEC=10 points D T Habitat – 5 points Non-habitat = 0 points
Total Score and Priority Rating:	< 25 points = **Low Priority** 25 to 39 points = **Mid Priority** > 39 points = **High Priority**

Other critical elements that were not included as prioritization criteria included wilderness resources and cultural resources. Additional analyses that would be required to incorporate these elements into the prioritization process include:

- Are there impacts to naturalness, solitude, or other wilderness characteristics?
- Will treatment protect or enhance on-site (direct benefit) or downstream (indirect benefit) archeological resources or significant historic buildings or structures?

4.0 ASSESSMENT RESULTS AND DISCUSSION

4.1 Project Site Priorities and Cost Estimate Summary

A total of 53 sites were identified during the field inventory. A summary of the project site priorities and cost estimates is provided in Table 4. A detailed site prioritization table is provided in Appendix D. A detailed cost estimate for each site is provided in Appendix E. The site assessment descriptions and recommendations with maps are provided in Appendix F.

Table 4. Project Site Priorities and Cost Estimates

SITE NUMBER	SITE TITLE	COST ESTIMATE		
High Priority Sites				
13A	Jetties and widened road	$407,500.00	to	$471,200.00
13 B	High sediment deposition under bridge; jetties	$15,400.00	to	$17,800.00
14B	Emergency Stabilization Site #6: UPRR Track Bridge 397.32	$215,200.00	to	$248,900.00
19-23 A	Dredged low flow channel, jetties, and widened UPRR track road	$9,065,100.00	to	$10,481,500.00
40A	Berm and dredging in channel	$2,220,800.00	to	$2,567,800.00
41A	Unsuitable channel location	$1,009,100.00	to	$1,166,800.00
41B	Unstable road and streambank	$673,900.00	to	$779,200.00
42A	Multiple unstable stream crossings	$1,017,900.00	to	$1,177,000.00
44A	Unstable road alignment	$946,400.00	to	$1,094,300.00
47A	Constricted channel and blocked access to floodplain	$725,000.00	to	$838,200.00
47B	Constricted channel reach further confined by State Route 317	$105,900.00	to	$122,500.00
48A	Pavement failure	$202,800.00	to	$234,500.00
48B	Tributary sediment deposit relocated channel	$2,000,100.00	to	$2,312,600.00
49A	Road crossings beneath and downstream of bridge	$942,500.00	to	$1,089,800.00
51B	Bridge crossing and irrigation diversion	$950,800.00	to	$1,141,000.00
60A	Bridge constriction with road and stream channel	$249,500.00	to	$288,500.00
61A	Insufficient capacity culvert crossing	TBD	to	TBD
	Subtotal	**$20,748,000.00**	**to**	**$24,031,500.00**

SITE NUMBER	SITE TITLE	COST ESTIMATE		
Mid Priority Sites				
12 A	Washed-out road crossing	$1,500.00	to	$1,800.00
13C	Extended fill area; constricted floodplain	$1,434,000.00	to	$1,658,100.00
14 C-D	Extended fill and jetties in the floodplain	$690,600.00	to	$828,700.00
15A	Sediment piles and ponding under bridge	$208,200.00	to	$240,700.00
15B	Dredged sediments sidecast in channel; graded floodplain and jetties	$462,300.00	to	$534,500.00
20 - 23 A	UPRR track bridge crossings	$95,500.00	to	$110,400.00
29A	Widened road fill and loose soil jetty in floodplain	$383,000.00	to	$442,800.00
38A	Bermed channels below UP track bridges	$1,044,400.00	to	$1,207,600.00
39A	Temporary road crossing	$267,900.00	to	$309,700.00
39C	Culvert crossing and repaired road realignment (temporary		TBD	
46A/B	Constricted channel and blocked access to floodplain	$3,922,500.00	to	$4,535,400.00
47C	Road and culvert alignment	$141,100.00	to	$163,200.00
49B	Channel realignment	$584,900.00	to	$676,300.00
50A	Channel realignment and reclamation	$1,029,700.00	to	$1,190,600.00
50B	Road failure	$523,100.00	to	$604,900.00
50C	Road failure	$597,200.00	to	$690,600.00
51A	Road failure	$347,300.00	to	$401,500.00
52A	Fill in floodplain and unstable stream crossing	$49,200.00	to	$59,000.00
52B	Pavement failure	$130,700.00	to	$151,100.00
70A	Loose sediment berm in channel	$429,100.00	to	$496,200.00
72A	Berms in floodplain	$743,100.00	to	$859,200.00
74A	Berm and unstable sediments on slope	$321,800.00	to	$372,100.00
	Subtotal	**$13,406,900.00**	**to**	**$15,534,200.00**
Low Priority Sites				
37A	Hillside borrow area and jetty	$46,000.00	to	$53,200.00
39B	Graded floodplain and bermed stream channel	$1,138,400.00	to	$1,316,300.00
40B	Denuded floodplain	$85,400.00	to	$98,700.00
44B	Grading in floodplain	$1,065,100.00	to	$1,231,500.00
51C	Excessive fill in floodplain adjacent to State Route 317	$514,200.00	to	$594,600.00

SITE NUMBER	SITE TITLE	COST ESTIMATE		
54A	Road damage	$1,237,800.00	to	$1,431,200.00
65A	Insufficient capacity culvert crossing	$265,700.00	to	$307,200.00
65B	Steep fill slope	$226,300.00	to	$261,700.00
69A	Narrow channel constriction and blocked access to flood channel	$86,800.00	to	$100,400.00
73A	Berms at bridges	$210,000.00	to	$242,800.00
73B	Blocked access to flood channel	$157,500.00	to	$182,100.00
74B	Loose sediment piles in channel	$22,400.00	to	$25,800.00
75A	Berm in floodplain	$29,100.00	to	$33,600.00
	Subtotal	**$5,084,600.00**	**to**	**$5,879,100.00**
	TOTAL	**$39,239,500.00**	**to**	**$45,444,800.00**

4.2 Overall Description of the Current State of Meadow Valley Wash and Clover Creek

The railroad and farming came to the area in the 1870s. An oral history documents a series of floods in the Project Area (Bio-West 2005a). Portions of the railroad alignment were moved in 1912 following the 1910 flood. Portions of the railroad were moved again following the 1938 flood. There were various floods in the 1980s that affected the tributaries more than the mainstem channels. Kershaw Ryan State Park was severely damaged in 1984 and again in 1987 and 1989 from flooding within the tributary while the mainstem channel peaked at only 2,400 cubic feet per second (cfs).

The Meadow Valley Wash has been gauged since 1952. During the past 50 years, the highest recorded flow below Caliente is roughly 2,400 cfs. The USGS estimated that the 100-year flood event is 6,000 cfs (USGS, 2005). The 2005 flood event is estimated to have reached 8,000 cfs (pers. com. Jon Wilson, USGS, Jan. 2006).

Several types of problem areas occur repeatedly throughout the entire length of the study area[1]. These patterns can generally be attributed to the interaction of transportation corridors constructed in narrow, erosive watersheds.

[1] In many instances, these areas are chronic maintenance problems for the County, UPRR, and/or NDOT.

Tributaries, Excessive Sediment and Stream Morphology

The Clover Creek watershed from Barclay to Caliente and the Meadow Valley Wash watershed from Caliente to Leith are steep and comprised of very friable (easily eroded) geologic units and erodible soils. The high sediment yield and the way it is handled by on-going maintenance is an principal issue for the Project Area.

The mouths of the tributary canyons are conical alluvial vans. The alluvial fans were created over the past several million years through deposition of bed load and suspended sediment load as the tributaries exit their canyons and merge with the mainstem drainage. When water is no longer confined, it is allowed to spread out, slow down and as a result the water drops bed load and suspended sediment load. Over time, the constantly shifting watercourses and deposits build a conical alluvial fan. In this way, much of the sediment contained in a tributary is deposited on the alluvial fan before entering the mainstem drainage. The shape and extent of an alluvial fan at the junction with a mainstem channel indicate the relative amount of sediment production and mainstem stream power. For instance, if an alluvial fan causes a mainstem channel to meander around the base of the fan, it indicates that the tributary is shedding sediment at a faster rate than the mainstem channel is able to transport the sediment downstream.

Tributaries crossed by the railroad are controlled by lateral berms that direct water and sediment across the alluvial fan to a single bridge or culvert on the downstream side of the alluvial fan (relative to the mainstem wash). The lateral berms confine the tributary water flow to a single channel, rather than allowing water to spread out across the fan. The confined flow maintains high flow velocities and retains the bed load and suspended load. The railroad bridges act as small dams and slow or pond the stormwater. When the water slows, it drops its bed load and suspended sediment load. Over time, sediment accumulates behind the bridge to the point that the bridge no longer can convey flood flows under the bridge. The standard maintenance procedure is to scrape the sediment out from under the bridge and push it along the sides of the tributary and into mainstem wash. Many of the tributary channels have large berms that extend from the railroad bridge out into the floodplain or low flow channel of the mainstem wash. In some areas the piles of sediment impinge on the mainstem active channel and floodplain, creating potential hazards to downstream habitat, water quality and infrastructure, such as bridges and roads.

Once sediment is entrained by mainstem high water flows, it is transported downstream until the water spreads out or is otherwise slowed down by a constriction, such as a bridge, and looses its sediment carrying capacity. Prior to human settlement in the area, the open valleys were the depositional areas. Oral histories indicate that the channel through Caliente was multiple-thread (Bio-West 2005a). The channel through the city has been dredged repeatedly over the past 100 years, only to be filled up again with sediment during storm events. Downstream, sections of the channel are now deeply entrenched in a ditch between the railroad tracks and State Route 317 through Rainbow Canyon. These sections may have been local depositional zones prior to entrenchment. Other reaches that would normally have access to a wide floodplain and depositional areas are constricted by the railroad tracks or roads. Some of the constrictions are new, some are obviously old. Sediment and the way it is handled in the system is an important issue for the project area.

Railroad, Roads, Bridges and Stream Crossings

The bridges typically fall into three categories:

1) Railroad bridges that cross over both the road and stream at one location (occurs in Rainbow Canyon numerous times and towards the bottom of the Meadow Valley Wash);

2) Railroad bridges that cross over the stream with a gravel road crossing of the railroad over the tracks (occurs in the upper part of Clover Creek numerous times);

3) Railroad bridges that cross over tributary drainages with a light vehicle bridge parallel to the railroad bridge and a drive through heavy vehicle crossing through the tributary (shoe-fly). In addition to these crossing types, there are culverts under roads, both in the main channel as well as for tributaries and road drainage dips where the road dips and the stream flows over the road.

The following are general recommendations for the repeated stream crossing conditions observed:

- Railroad bridge/paved road/stream. The stream and paved road are parallel under the bridge. A possible improvement for this condition is narrowing the road to 20 to 24 foot two lane width (or if possible a one lane width) with the road as close to the railroad bridge abutment as possible to allow a wide stream channel area. In addition, construct a low concrete wall along the outer side of the road between the road and stream. The low wall would help prevent sediment deposition and flooding on the road during moderate flood events and allow the area to flood during larger events. Construct a lowered overflow weir in the wall so that when flood flows exceed the wall height there is a defined location for the flows to spill over onto the road. Enhance the vegetation along the banks of the stream with riparian vegetation. (A conceptual design for this condition is presented on Figure 3.)[2]

- Railroad bridge/dirt road/stream. The stream and dirt road are parallel under the bridge with the dirt road then cross through the stream. For this condition a general recommendation is to gravel the road from the points where it drops down into the floodplain on both sides of the stream. Through the stream crossing portion use gravels and

[2] Sketches will be compared to existing regulations.

cobble to minimize the potential for disturbance of finer stream substrate materials. Enhance the vegetation along the banks of the stream with riparian vegetation.

- <u>Railroad bridge/road crossing over the tracks/ and stream under the bridge.</u> This condition is typically very stable. The general recommendation is to surface the road with gravel before it nears the stream and as it leaves the crossing area. In addition, at these locations extreme care should be used to avoid placement of loose soils near the flowing stream. The primary problem noted at these locations is sediments (most likely removed after the flood) are placed directly adjacent to the stream. Improved maintenance practices are recommended.
- <u>Railroad bridge/parallel vehicle bridge/and drive through crossing of the drainage (Shoe-fly).</u> At these locations, a maintenance program should be developed for removal of deposited soils under the bridges. The soils should be hauled to areas well away from the drainage. Gravel surface the road approaches to the vehicle bridges and through the drive through crossings. The inlet and outlet areas of the bridges should be armored with rock if unstable. If the concrete bridge headwalls are functioning per standard bridge design, then rock armoring will not be required. There are sites where the railroad has culverts under the tracks and a railroad maintenance road instead of a bridge. The same recommendations would apply for this condition also.
- <u>Culverts/road drainage dips.</u> The culverts observed in the main channel during the site assessment were generally under the “County road”, which may or may not be a temporary. The primary recommendation here is to determine the flood flow capability of these culverts and if they are to be left in-place to reconstruct them in such a way that flood flows in excess of what the culvert can handle will safely pass over the road surface without destroying the road and resulting in loss of soil directly into the stream. An alternative is to construct road drainage dips. The road drainage dips appeared to work quite well during the flood. The main recommendation for the dips is to improve the rock armoring at the outlet side of the dips to assure that the dips are not undercut during high flows.

Figure 3 Conceptual Plan - Bridge, Road, and Stream Crossing

The Outside of Meander Bends

Streams have the greatest erosive power at the outside of meander bends. In many instances the railroad tracks and access road are located on the outside of meander bends. The railroad has often protected the tracks and road by placing large jetties in the active channel or floodplain to divert flows away from their ROW. In many areas these jetties reduce the channel flood capacity and create potential sediment or flood hazards to downstream habitat, water quality and infrastructure, such as bridges and roads. In most areas, ROW armoring is more effective in protecting infrastructure and less intrusive to the riparian environment and hydrologic function of the channel.

Narrow Canyons and Constrictions

Narrow canyons constrict flood flows and increase stream velocities. Through Rainbow Canyon in particular, the existing channel through the naturally narrow canyon is currently further constricted by the railroad tracks, two parallel railroad access roads, and State Route 317. This configuration will create chronic maintenance issues for all entities in the future. Linear features such as railroad access roads, public access roads, and power line access roads should be consolidated and minimized to the extent practicable through the narrow, constricted reaches of Rainbow Canyon. Maximizing the width for the stream channel will improve flood conveyance capacity thereby reducing stream velocities and the erosive power of the stream.

Noxious Weed Control and Needs for Revegetation

Meadow Valley Wash and Clover Creek are characterized by wide expanses and intermittent spots of highly disturbed, denuded landscapes. Although arid and semi-arid conditions will make revegetation of these areas difficult, widespread revegetation efforts must be a high priority throughout the entire watershed. Stabilizing sediments in-situ is the first defense against accelerated erosion, sedimentation, and noxious weed invasion. Seeding in the lower part of Meadow Valley Wash will be particularly challenging based upon harsh site conditions and limited commercial availability of native plant material.

Tamarisk (Tamarix ramosissima), a designated noxious weed in Nevada, is widespread throughout the lower reaches of Meadow Valley Wash. Tamarisk alters riparian ecology by reducing species diversity, impeding channel flood conveyance, and depleting surface water flows. Species diversity is diminished in areas dominated by tamarisk because salt accumulations in the soil from leaf litter and leaf excretions create conditions where few, if any, plants can grow under the tamarisk canopy. Flood flow conveyance can be reduced because the well-anchored trunks and heavy wood are not flexible and are less capable of bending to floodwater as compared to its native counterpart, willow. Tamarisk is also known to deplete surface flows because of higher transpiration rates than native vegetation. The trees (or tall shrubs) have an aggressive root system that reaches well into groundwater. Surface water flows are seasonal and minimal in many reaches of Meadow Valley Wash where tamarisk dominates the riparian zones. Removal of tamarisk has resulted in increased stream flow in many parts of the Southwest.

Tamarisk is a very difficult species to control once it becomes established in a waterway. A combination of mechanical control, biological control, and herbicides has proven to be the most effective. As tamarisk is removed, the area should be revegetated with native species.

5.0 CONCLUSIONS

5.1 Short-Term versus Long-Term Solutions

The Clover Creek – Meadow Valley Wash watersheds are highly erodible and have been highly altered by human activities. High sediment volumes are a natural part of the Clover Creek – Meadow Valley Wash system. Flood flow conveyance and sediment transport have been impacted and manipulated in ways that have perpetuated chronic sediment maintenance problems and hazards to infrastructure and natural resources.

Site-specific erosion and sediment control is important for the high priority sites identified in this report. However, addressing sites independently without looking for long-term solutions is an expensive short-term approach and will not result in a resilient functioning system. Long-term solutions can be gained through developing and implementing a coordinated comprehensive management and maintenance plan.

5.2 Coordinated Management and Maintenance Programs

The Clover Creek – Meadow Valley Wash system requires intensive coordinated management in order to achieve the natural resource objectives and to safely maintain existing human uses in a cost-efficient manner. The entities operating within the watersheds (Nevada Department of Transportation, Lincoln County, UPRR, the City of Caliente, BLM, private land owners, the US Fish and Wildlife Service, and the Nevada Department of Wildlife) should come together to develop a coordinated comprehensive management and maintenance plan based on specific resource objectives. A coordinated plan would minimize duplication of effort, result in the best solutions for road and bridge alignments, result in less maintenance, and achieve healthier, more resilient natural resources. The plan should include:

- Site-specific best management practices for specific types of sediment and erosion control scenarios.
- Emergency action plans for different emergency scenarios.
- Specific actions and constraints for desert tortoise and southwestern willow flycatcher habitat.
- Standards for employee and contractor training for actions in the Meadow Valley Wash and Clover Creek.
- Plan sub-sections that are specific for each agency (Nevada Department of Transportation, Lincoln County, UPRR, the City of Caliente, BLM, and private land owners) and the portion of the Meadow Valley Wash - Clover Creek system that they impact.

5.3 Need for Additional Information

Additional information is needed in order to implement the site recommendations and develop a coordinated comprehensive management and maintenance plan.

- Sediment yield of Meadow Valley Wash, Clover Creek and their tributaries.
- Hydraulics of Meadow Valley Wash, Clover Creek and their tributaries.
- A roadway uses and needs analysis of current and projected roadways.
- Site-specific historical and cultural resource surveys for use in reevaluating treatment site priorities.
- Survey and analyses of site-specific impacts to wilderness areas for use in reevaluating treatment site priorities.

6.0 REFERENCES

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USGS 7 ½ minute quadrangles all Nevada listed from upstream to downstream: Islen, Eccles, Caliente, Elgin NE, Elgin, Leith, Lyman Crossing, Carp, Vigo, Rox NE, Rox, Farrier, Rox SE, Moapa West, Moapa East.

USGS 100K maps: Caliente, Nevada; Clover Mountains, Nevada; Overton, Nevada.

APPENDICES

Appendix A

Aerial Mapbook Index and 24K USGS Topo-quad Index

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Appendix B

CD of Bio-West 2003 Aerial Photographs

Appendix C

Resource Objectives

Appendix D

Project Prioritization

Appendix E

Cost Estimate Details

Appendix F

Site Assessment Descriptions and Recommendations