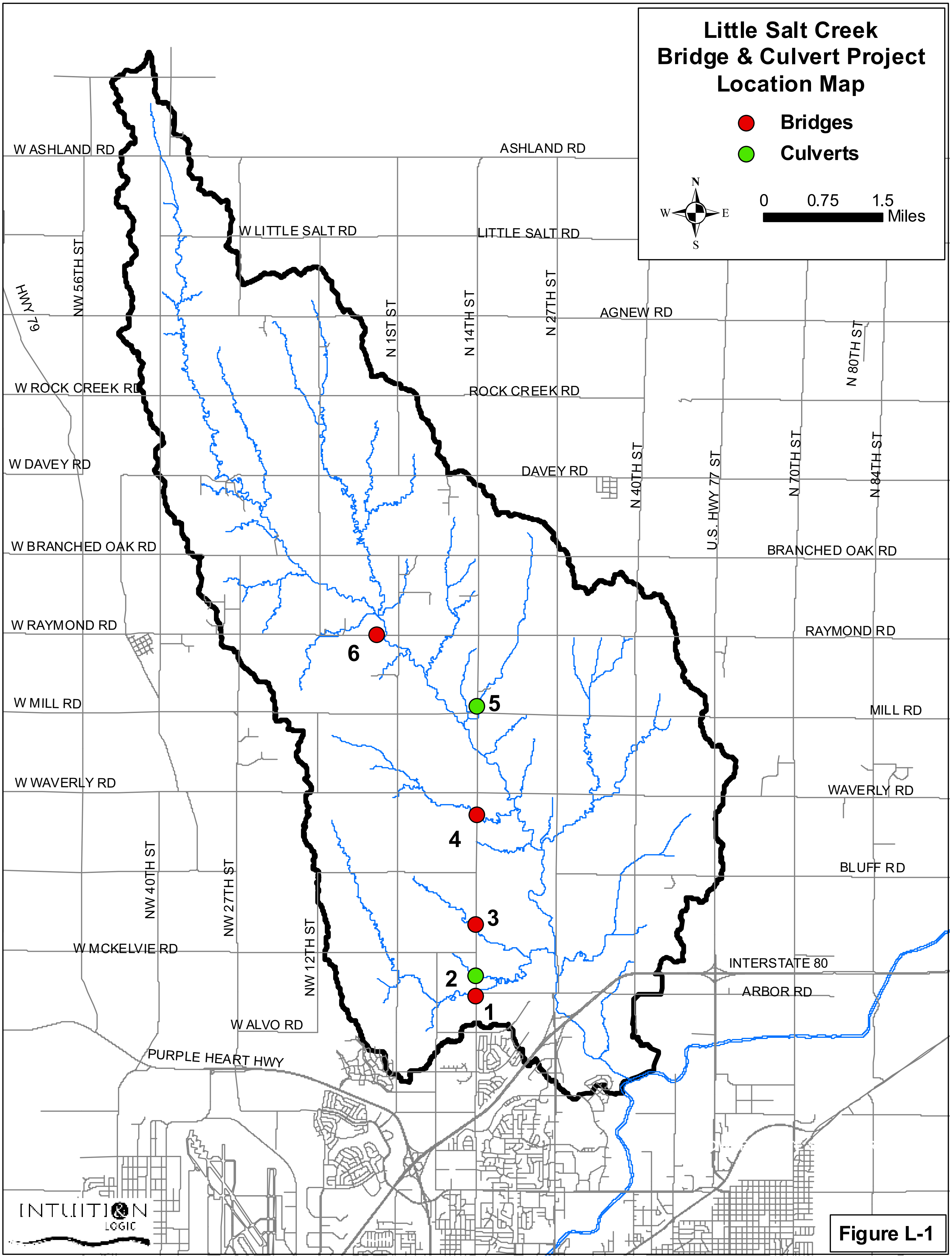

Little Salt Creek
Bridge & Culvert Project
Location Map
Bridges
Culverts
N
W
E
S
0
0.75
1.5
Miles
W ASHLAND RD
ASHLAND RD
W LITTLE SALT RD
LITTLE SALT RD
AGNEW RD
W ROCK CREEK RD
ROCK CREEK RD
W DAVEY RD
DAVEY RD
W BRANCHED OAK RD
BRANCHED OAK RD
W RAYMOND RD
RAYMOND RD
W MILL RD
MILL RD
W WAVERLY RD
WAVERLY RD
BLUFF RD
W MCKELVIE RD
INTERSTATE 80
ARBOR RD
W ALVO RD
PURPLE HEART HWY
HWY 79
NW 56TH ST
NW 40TH ST
NW 27TH ST
NW 12TH ST
N 1ST ST
N 14TH ST
N 27TH ST
N 40TH ST
U.S. HWY 77 ST
N 70TH ST
N 80TH ST
N 84TH ST
1
2
3
4
5
6
INTUITION LOGIC
Figure L-1

Other Bridge and Culvert Improvement Recommendations

Project 1: Replace North 14th Street Bridge over Tributary 15 (CO. ID F-78)

Problem description: North 14th Street is a paved roadway running north and south through the watershed. The existing 25.5' single span bridge over Tributary 15 is topped during the 10-yr storm event and Tributary 15 is incising through this reach.

Figure L-2: North 14th Street Bridge over Tributary 15

Recommendation: The recommended improvements include removing the existing bridge and replacing it with a new bridge configuration capable of passing a 25year storm event without topping the roadway. The recommendation includes constructing a grade control immediately downstream of the bridge to maintain the channel grade through bridge, protecting the new bridge and improving local stream stability. Figure L-3 below shows the proposed improvements.

Impact to Natural Resources and/or Salt Creek Tiger Beetle Habitat: This project has no impact on the possible Salt Creek Tiger Beetle habitat.

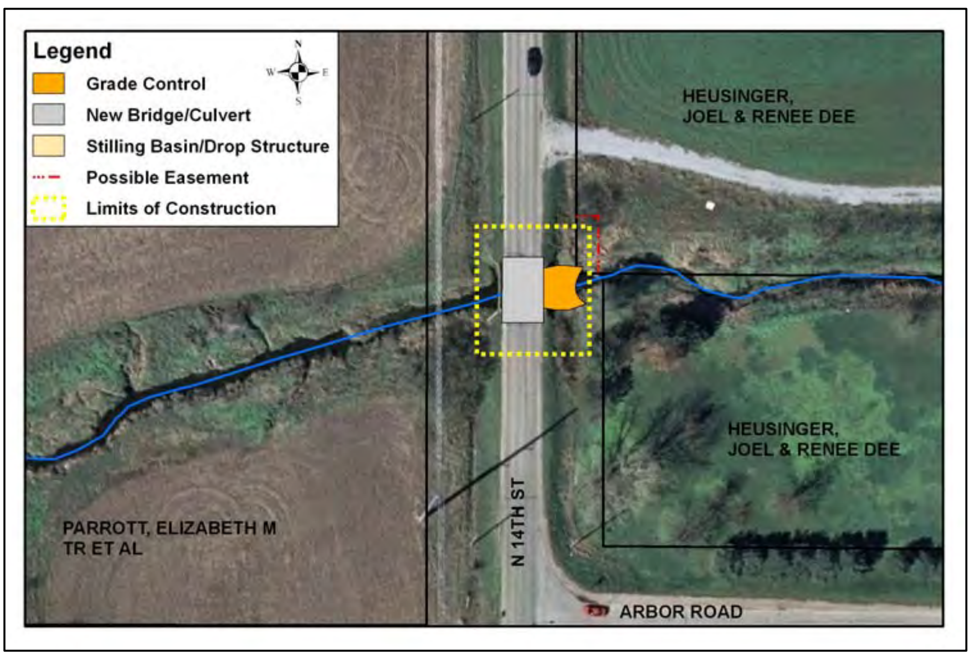


Figure L-3: Project 1 proposed improvements.

Project 2: Replace North 14th Street Culvert on Tributary 215 (CO. ID F-79)

Problem description: North 14th Street is a paved roadway running north and south through the watershed. The existing 6'W x 3'H culvert at Tributary 215 is near completely silted in with sediment decreasing its capacity by as much as 75%.

Figure L-4: North 14th Street Culvert on Tributary 215

Recommendation: The recommended improvements include removing the existing culvert and replacing it with a new culvert configuration capable of passing a 25year storm event without topping the roadway. The new culvert will need to be placed so as not to lower the flowline of the stream upstream of the crossing. Figure L-5 below shows the proposed project limits.

Impact to Natural Resources and/or Salt Creek Tiger Beetle Habitat: This project has no impact on the possible Salt Creek Tiger Beetle habitat.

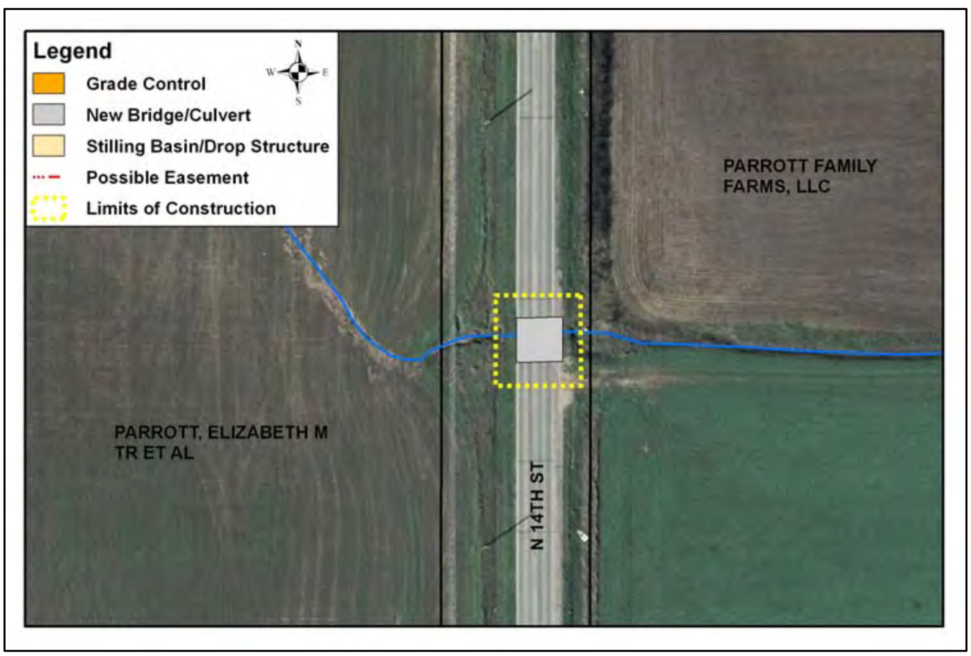


Figure L-5: Project 2 proposed improvements.

Project 3: Replace North 14th Street Bridge over Tributary 115 (CO. ID F-82)

Figure L-6: North 14th Street Bridge over Tributary 115

Problem description: North 14th Street is a paved roadway running north and south through the watershed. The existing 23' single span bridge over Tributary 115 is topped during the 10-yr storm event and Tributary 115 is incising through this reach.

Recommendation: The recommended improvements include removing the existing bridge and replacing it with a new bridge configuration capable of passing a 25year storm event without topping the roadway. The recommendation includes constructing a grade control immediately downstream of the bridge to maintain the channel grade through the bridge, protecting the new bridge and improving local stream stability. Figure L-7 below shows the proposed improvements.

Impact to Natural Resources and/or Salt Creek Tiger Beetle Habitat:
This project has no impact on the possible Salt Creek Tiger Beetle habitat.

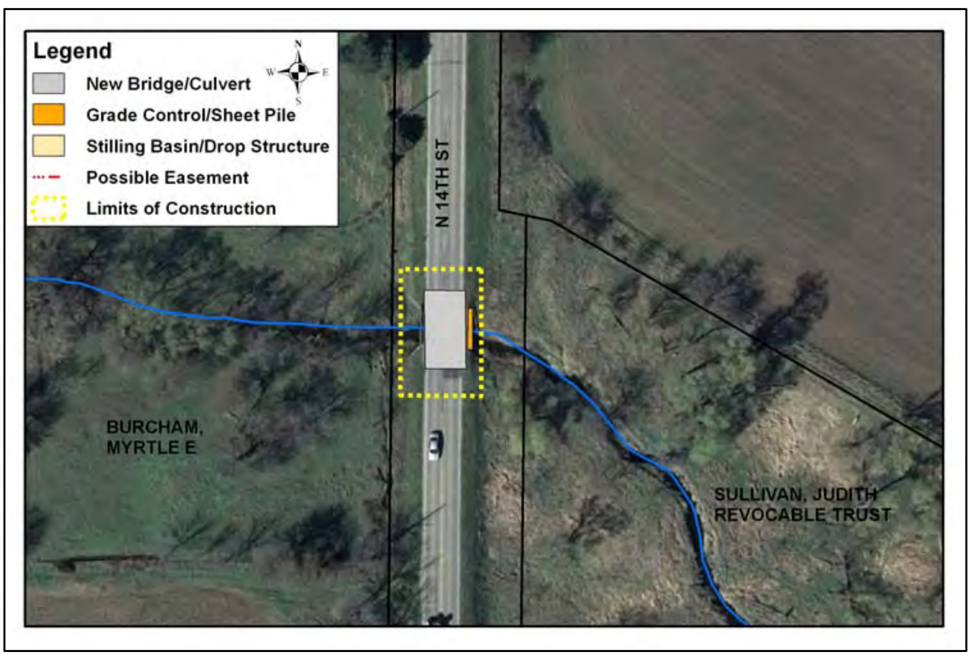


Figure L-7: Project 3 proposed improvements.

Project 4: Replace North 14th Street Bridge over Tributary 30 (CO. ID F-86)

Problem description: North 14th Street is a paved roadway running north and south through the watershed. The existing 18' single span bridge over Tributary 30 is topped during a 10 year storm event.

Figure L-8: North 14th Street Bridge over Tributary 30

Recommendation: The recommended improvements include removing the existing bridge and replacing it with a new bridge configuration capable of passing a 25year storm event without topping the roadway. Figure L-9 below shows the limits of the proposed improvements.

Impact to Natural Resources and/or Salt Creek Tiger Beetle Habitat: This project has no impact on the possible Salt Creek Tiger Beetle habitat.

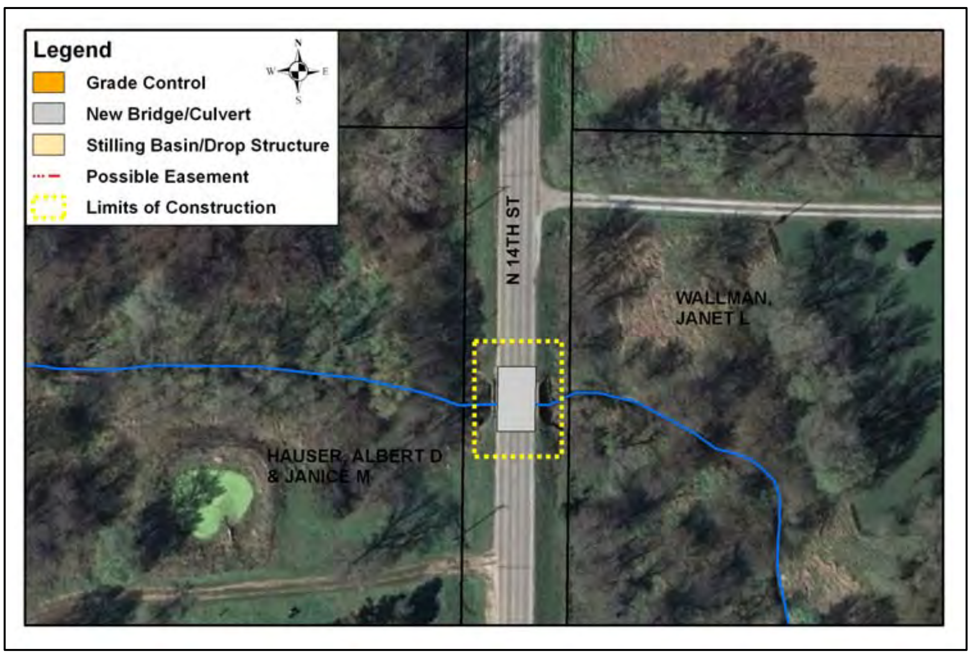


Figure L-9: Project 4 proposed improvements.

Project 5: Replace North 14th Street Culvert on Tributary 45 (CO. ID F-91)

Problem description:
North 14th Street is a paved roadway running north and south through the watershed. The existing structure is a triple 9'W x 7'H box culvert on Tributary 45, and North 14th Street is topped during a 10 year storm event.

Figure L-10: North 14th Street Culvert on Tributary 45

Recommendation:
The recommended improvements include removing the existing bridge and replacing it with a new bridge configuration capable of passing a 25year storm event without topping the roadway. Figure L-11 below shows the limits of the recommended bridge replacement.

Impact to Natural Resources and/or Salt Creek Tiger Beetle Habitat:
This project has no impact on the possible Salt Creek Tiger Beetle habitat.

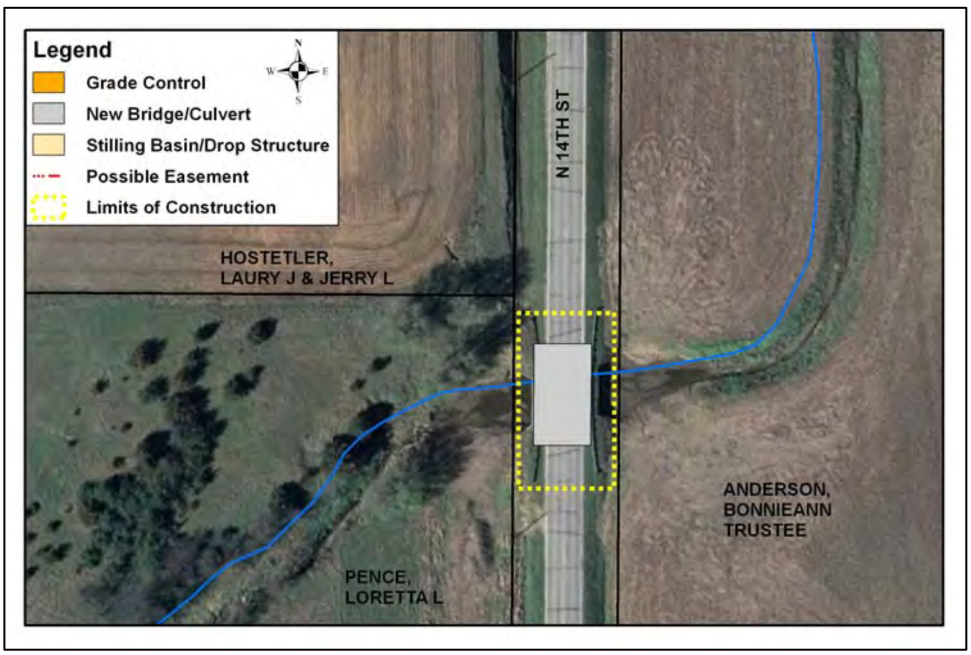


Figure L-11: Project #5 proposed improvements.

Project 6: Replace W Raymond Road Bridge over Main Stem (CO. ID C-91)

Problem description: W Raymond Road is one of the paved east/west roads that span the watershed. The existing bridge over the Main Stem is topped during the 10-yr storm event and the channel is incising through this reach.

Figure L-12: W Raymond Road Bridge over Main Stem

Recommendation: The recommended improvements include removing the existing bridge and replacing it with a new bridge configuration capable of passing a 25year storm event without topping the roadway. The recommendation includes constructing a grade control immediately downstream of the bridge to maintain the channel grade through bridge, protecting the new bridge and improving local stream stability. Figure L-13 shows the proposed improvements.

Impact to Natural Resources and/or Salt Creek Tiger Beetle Habitat: Saline Wetlands and proposed Salt Creek Tiger Beetle habitat is identified both upstream and downstream of the W Raymond Road Bridge. The Little Salt Fork Marsh Preserve is located immediately north (upstream) of W Raymond Road and the new grade control will help preserve the upstream channel by maintain the channel grade. Halting incision at this location will ultimately reduce slumping in the near upstream reaches, which intern protects the Tiger Beetle habitat at the toe of slope and saline wetlands found within the Little Salt Fork Marsh.

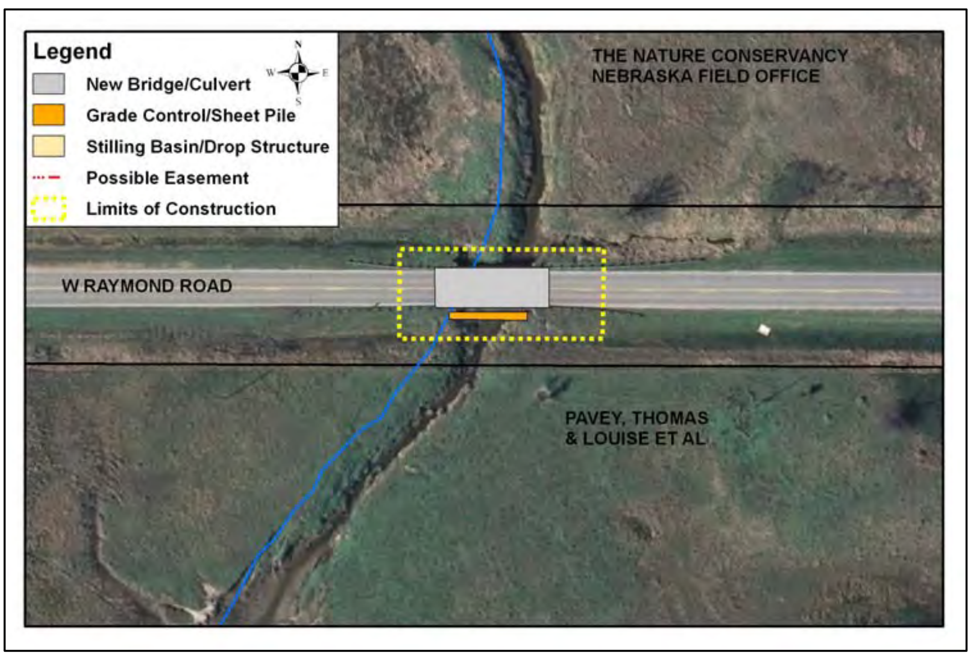


Figure L-13: Project 6 proposed improvements.

Riparian Corridor Enhancement

Problem description: One of the natural defense mechanisms to incision in this watershed is the development of woody debris jams to act as grade control. Over the past decades, the woody riparian corridor has been substantially depleted. The lack of woody riparian corridor within the Little Salt Creek watershed limits the material available to create woody debris jams. Other than the underlying Dakota Sandstone there is little durable or coarse material available to form riffles and knick zones to arrest incision or to naturally flatten the hydraulic slope for frequent flows.

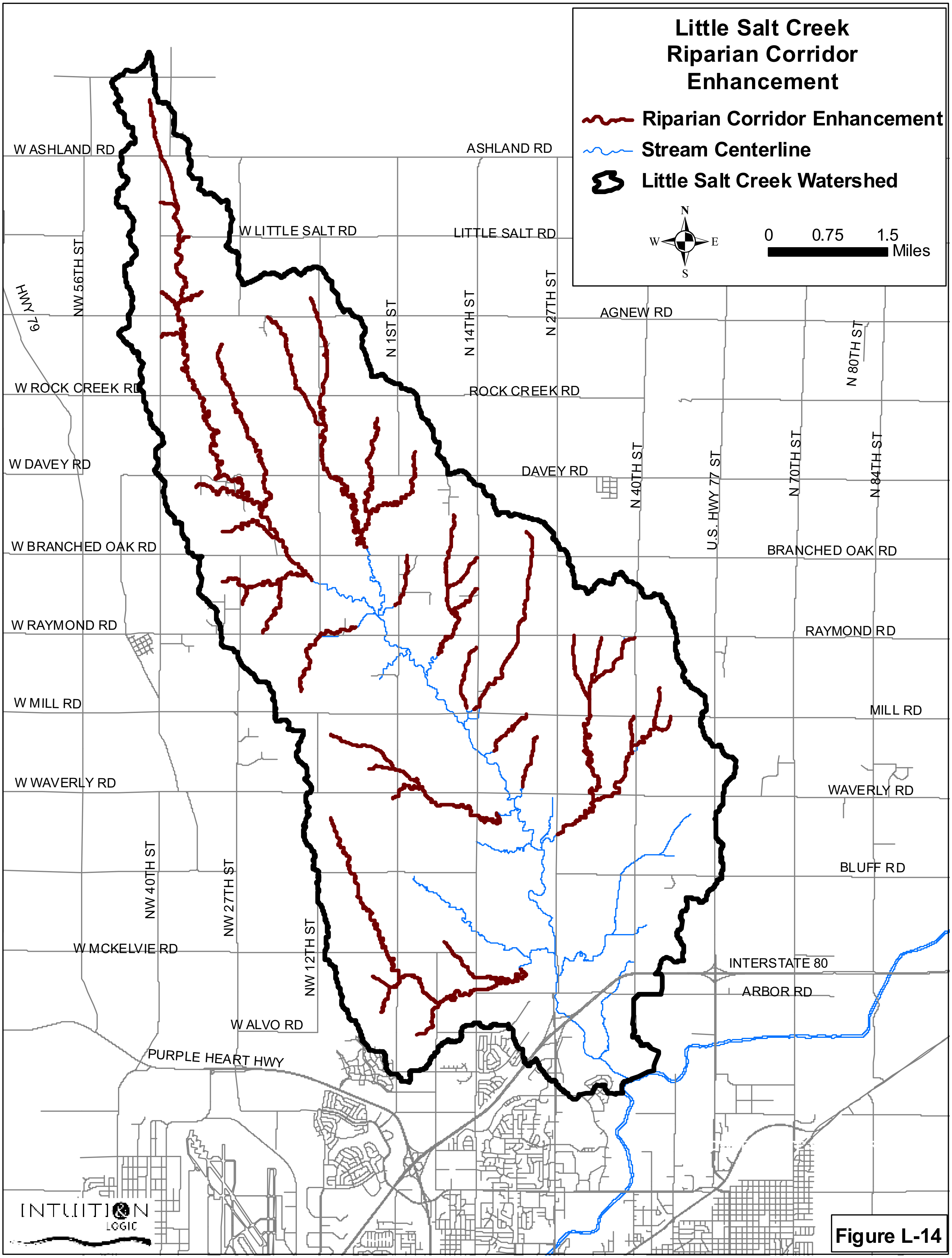
Recommendation: The recommended improvements include planting a wide, dense woody riparian corridor where the corridor is substantially depleted and enhance areas where corridor is thin or unhealthy. Ultimately, the riparian corridors should extend the entire length of the stream except in areas of the saline marsh, habitat of endangered species or where salt seeps would prevent growth of natural woody species. Species represented should include canopy and understory trees, shrubs, and where appropriate, native grasses and forbs. There is over 68 miles of corridor that may qualify for this type of restoration. If we assume a minimum corridor restoration width of 20 to 30 feet on each side of the stream, this equate to 330 to 490 acres of riparian corridor. Due to the enormous amount of potential corridor improvement and restoration, this project is recommended as a watershed management approach to be implemented incrementally throughout the watershed as opportunities present themselves. Figure L-14 shows the recommended stream reaches to plant a dense woody riparian corridor.

The riparian corridor program could be implemented using one of the existing tree planting programs available to landowners through the LPSNRD or USDA as follows:

- The NRD Conservation Forestry Program in which participants have the opportunity to purchase seedling trees in bulk through the NRD.
- The NRD Tree Cost-Sharing Program where volunteers can be reimbursed up to one half the total cost of trees and planting for quantities between 1,500 and 4,000 trees.
- The NRD Tree Planting Program makes cost-shared planting services available for those wanting to plant between 200 and 1,500 trees.
- The USDA Conservation Reserve Program (CRP) is a voluntary program in which landowners are paid for every acre the landowner enrolls in the program. There is also a 50% cost-share for tree planting through this program.

By using these programs to develop and restore the watershed riparian corridor, efficiencies are achieved by working with programs already in place. These programs already have the funding mechanisms established and administrative structure in place, ready to help.

Impact to Natural Resources and/or Salt Creek Tiger Beetle Habitat:
Dense jams composed of graded sizes of woody debris will also trap sediment and allow sufficient time for consolidation. This sediment will fill the bed and form bars upstream of the jams. As the woody material migrates down the channel the jams and subsequent exposed bars should eventually provide habitat for the Salt Creek Tiger Beetle.


Little Salt Creek Riparian Corridor Enhancement
Riparian Corridor Enhancement
Stream Centerline
Little Salt Creek Watershed
N
W
E
S
0
0.75
1.5
Miles
W ASHLAND RD
ASHLAND RD
W LITTLE SALT RD
LITTLE SALT RD
AGNEW RD
HWY 79
NW 56TH ST
N 1ST ST
N 14TH ST
N 27TH ST
N 80TH ST
W ROCK CREEK RD
ROCK CREEK RD
W DAVEY RD
DAVEY RD
N 40TH ST
U.S. HWY 77 ST
N 70TH ST
N 84TH ST
W BRANCHED OAK RD
BRANCHED OAK RD
W RAYMOND RD
RAYMOND RD
W MILL RD
MILL RD
W WAVERLY RD
WAVERLY RD
BLUFF RD
NW 40TH ST
NW 27TH ST
NW 12TH ST
W MCKELVIE RD
INTERSTATE 80
ARBOR RD
W ALVO RD
PURPLE HEART HWY
INTUITION LOGIC
Figure L-14

Water quality management approaches

Approach 1 – Reduce sediment generation

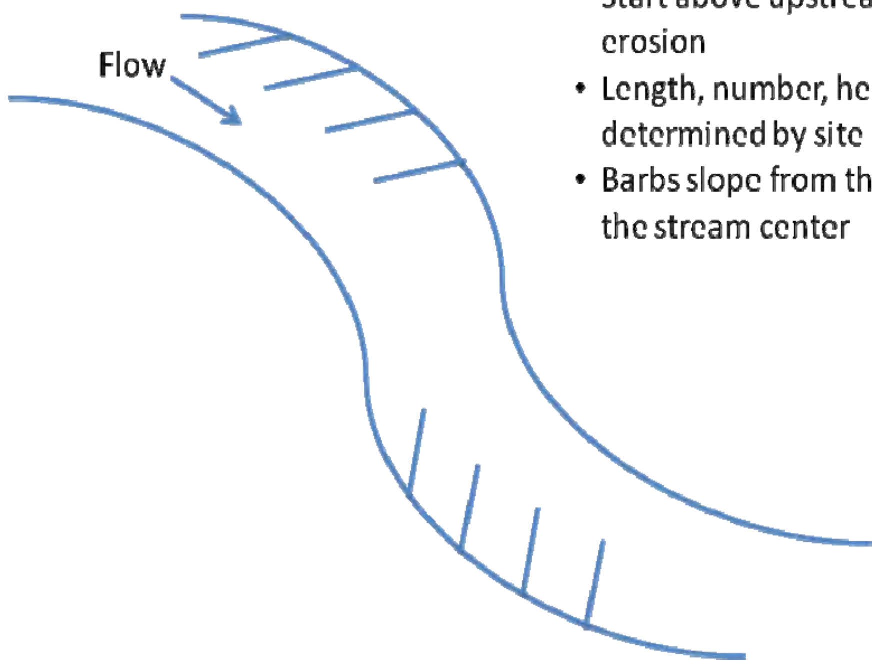
- Construct grade controls at active knickpoints in the tributaries. Incising tributaries will continue to cut-down and release sediment into the stream following the incision on the main stem. Candidates for grade stabilization are:
  - Tributary 15 and its sub-tributary 115
  - Tributary 20 and its sub-tributary 220
  - Tributary 45
  - Tributary 60 and its sub-tributaries 260 and 360
- Prevent incision before it begins by installing protective grade controls at the mouth of tributaries in dynamic equilibrium. These structures would in most cases be small and inexpensive. Candidates for grade protection are:
  - Tributary 30 upstream of widening reach
  - Tributary 40
  - Sub-tributary 160
  - Tributary 70
  - Tributary 80 above the planform adjustment reach
  - Tributary 85

Approach 2 – Trap sediments

- Stream Barbs, Vanes or Planted Sills - Stream barbs disrupt velocity gradients, reduce channel bed shear and interrupt sediment transport. The structures work best in bankfull shelf areas but could be applied in any meandering reach that receives regular inundation and moderate to low velocity, approximately 2-3 feet per second. The stream barbs promote deposition in the eddies caused by the flow separation and velocity redirection which is in turn caused by the barb. Stream barbs or vanes are rarely placed singly but are usually placed in echelon. These structures are widely used throughout the US. Janine Castro at the Natural Resources Conservation Service provides guidance on the applicability and design of stream barbs[1] and rock weirs.[2] Figure L-15 is a rough sketch of this approach.

[1] Castro, J. and Sampson, R. 2001. Design of Stream Barbs. USDA, Natural Resource Conservation Service

[2] Castro J. and Sampson R., 2001. Design of Rock Weirs. USDA, Natural Resource Conservation Service.



- Place in outside of meander
- Start above upstream limit of erosion
- Length, number, height and angle determined by site conditions
- Barbs slope from the bank towards the stream center

Odgaard[3] also described a method for using sub-parallel vanes for sediment control. Here the submerged structures induce a secondary current which negates the natural secondary current caused by centrifugal force occuring as the flow turns through the meander. It is the centrifugal current that scours the outside of the meander and is responsible for much of the bank erosion in meandering reaches. By canceling out the centrifugal current, the stress on the bank is reduced as is the erosion. The general approach is similar to that of Castro and Sampson although the angle of the vane is somewhat flatter. The US Army Corps of Engineers has also done extensive work on river barbs for aquatic habitat and control of sedimentation.

While some stream barbs are designed without vegetation, barbs in Little Salt Creek would benefit from planting. Dense growth of fine vegetation adds hydraulic roughness and improves the mechanical entrapment of the sediment particles. In addition the physical layout of the planting can direct the sedimentation downstream of the barb along the streambank.

Because the barbs are intended to direct sediments to the streambank and trap them there, this approach should not be used in reaches where this may damage critical habitat. It would be helpful to have close coordination with UNL scientists or US Fish and Wildlife before working in or near the saline seeps.

- Construction of bankfull shelves – Small internal floodplains can be designed to 1) trap sediment and 2) reduce stress on vulnerable streambanks thereby reducing the generation of sediment. Within prudent limits, the designer can vary the emphasis between trapping sediment and reducing erosion by varying the elevation of the bankfull shelf relative to the bankfull depth. A slightly over-excavated shelf, say six inches below bankfull depth, with well-vegetated leading and trailing edges is a functional sediment sink. Because the stream is most likely sediment rich during bankfull events, the deposition on the shelf will come from the entrained particles. The hydraulically rough vegetation is important to further reduce the risk of the over excavation inducing upstream erosion. In another design variation, the internal shelf slopes from upstream to downstream to provide the volume for sediment trapping. Hydraulic roughness on the leading and trailing edges is important here too.

  To reduce erosive stresses with only minimal sediment accumulation the shelf is placed just slightly below the bankfull depth. As in any technical discipline that presumes to model the natural world, there is some uncertainty in determining the exact depth at which bankfull flow occurs and the careful designer sets the shelf slightly lower than the estimate. In some reaches of the creek, the bankfull shelf can be designed to effectively reconnect the stream to its larger floodplain, particularly if public land is available for occasional inundation.

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[3] Odgaard , J.A., River Training and Sediment Management with Submerged Vanes, ASCE Press, in press.

Bankfull shelves are a widely used and well-understood method for improving stream stability and water quality. While this technique stands on its own geomorphic merits, in some reaches of Little Salt Creek, there may be benefits to critical habitat as well. The preferred habitat of the Salt Creek Tiger Beetle is moist salt flats. The beetles are using the stream banks now because the salt flats are too dry during the summer months to sustain them.[4] It is possible that a carefully designed series of bankfull shelves could provide enough water to re-establish some salt flats as sustainable habitat. There are many open questions such as the optimum frequency and depth of inundation and whether inundation can be reliably achieved in the hottest months. However, there may be benefits to exploring this possibility further.

[4] Steve Spomer, University of Nebraska at Lincoln, personal communication, February 17, 2009.

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